BIOLOGY

COMPLETE SOLUTION TO NEET/AIIMS/JIPMER

. THEORY NOTES
. MULTIPLE CHOICE
. EXCERCISE

ALL MODULES
COMPLETE BOOKLET

V.EDUCATIONAL SERVICES

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Module - 1
Type Study of Botany

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ULOTHRIX

- **Discovered by Knitzing.**

SYSTEMATIC POSITION

Kingdom	:	Plantae
Sub kingdom	:	Thallophyta
Division	:	Chlorophyta
Class	:	Chlorophyceae
Order	:	**Ulotrichales**
Family	:	Ulotrichaceae
Genus	:	**Ulothrix**

HABIT AND HABITAT

- Ulothrix mainly found in **fresh water.**
- The majority of species of Ulothrix occurs in **cold slow moving streams.**
- Marine species, **eg., Ulothrix flacca. (intertidal zone** of sea and **saline marshes)**
- **Lithophyte species. – Ulothrix implexa**
- **Fresh water species. – Ulothrix zonata.**
- **Ulothrix zonata** is the main species of **Ulothrix** which is found in **India.**

STRUCTURE

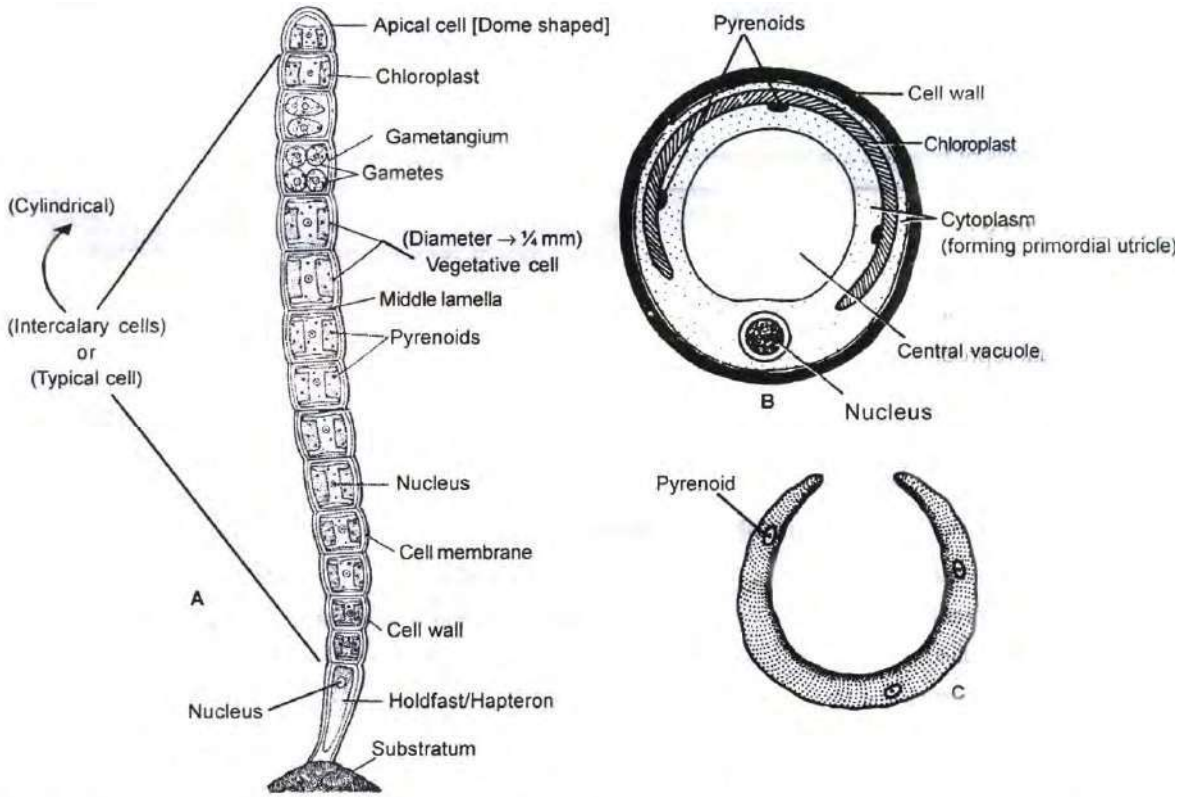


Fig. (A) Ulothrix filament (B) T.S of a cell (C) Structure of Chloro plast

THALLUS STRUCTURE

- The thallus of **Ulothrix** is multicellular, filamentous, unbranched and **bright green** in colour.
- All the cells of the filament are similar but basal cell and apical cell are different. All cells present between basal cell and apical cell are called **intercalary cells.**
- Shape of the cells are **cylindrical** but they looks **rectangular** in **external appearance.**
- The upper most or apical cell is somewhat **dome shaped** and basal cell is elongated and narrow at the base.
- The filament attached to the substratum with its specialized cell which is called **Holdfast** or **Rhizoidal cell** or **Hapteron.**
- At the base of holdfast develops fine **processes or fingers like** structure are called **Haptera.**
- The **holdfast** cell of the thallus is **living** and **non green.** Chloroplast absent in hold fast.
- The cell wall of the filament is double layered.
- The outer layer is **Protopectin.** (Precursor of **pectin** and insoluble in water). The inner layer is **cellulose.**
- A large vacuole is present in the centre of the cell. Surrounding the vacuole, the cytoplasm present as a thin layer and to form a **primordial utricle.**
- Chloroplast contains **two** or **three pyrenoids.** (Protein particles which are surrounded by starch.)
- These pyrenoids are concerned with storage of starch.

Special Points

- **Centriols** are present in **Ulothrix.**
- All the cells of Ulothrix have power of cell division except hold fast.
- **Diffused growth** found in Ulothrix.
- All the cells of filament are joint together through the **middle lamella.**

REPRODUCTION

- Ulothrix reproduce by three methods :
  (1) Vegetative reproduction.
  (2) Asexual reproduction.
  (3) Sexual reproduction.

1. Vegetative Reproduction

- It takes place generally in **favourable conditions.**
- **Fragmentation :**The filaments break up into two or more pecies. They are called fragments.
- Each fragment divides to form a **new Ulothrix filament.**
- Fragmentation occurs due to-
  - Incidental reasons.
  - Death of intervening cells or **middle lamella.**
  - Strong waves of water.
  - Change of pH or temperature

2. Asexual Reproduction :

- It takes place in **favourable** and **unfavourable** conditions.

(I) In favourable conditions : By Zoospores.

- Zoospores formation occurs generally near the apex and progresses towards the base of filament. **(Basipetal order)**
  - Any cell of the filament **except hold fast** can form zoospores.

– A cell which produce zoospores is called **zoosporangium.** A sporangium produces **8-32** zoospores.
– Zoospores are formed through the **mitotic division.**

- Zoospores are of two types –

(1) Micro zoospores

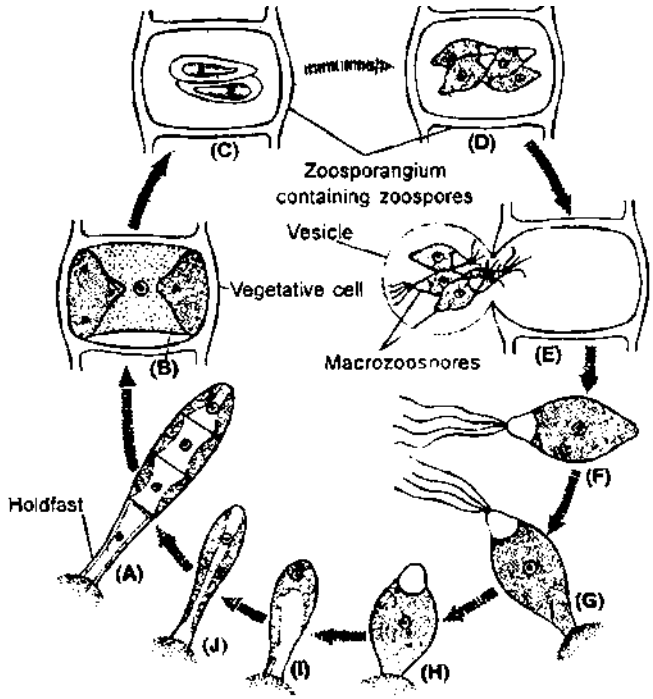
(2) Macro zoospores

(1) Micro zoospores : They are oval shped. They may be **biflagellate** or **quadriflagellate.**

- Eye spot lies at the **anterior lateral position.**
- Their swimming period is **2-6 days.** Their number in mother cell varies from **8** to **32.**
- Their germination begins from the anterior end.

(2) Macro zoospores : They are spindle or pear shaped with a pointed posterior end.

- They are always **quadriflagellate.**
- Eye spot lies at the anterior in middle region. Their swimming period is about **24 hours** (1 day).
- The number of macro zoospores in sporangium from **4-8.**
- Their germination begins from the posterior end.



Asecual reproduction by macro zoospores formation

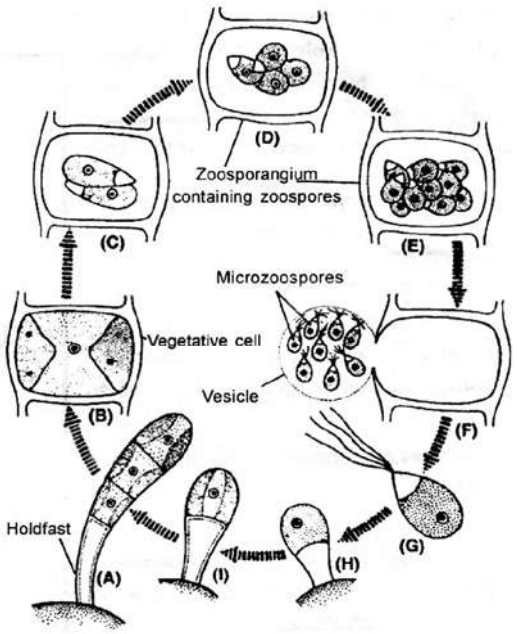
STRUCTURE OF ZOOSPORE

- Zoospores are **naked.** It means cell wall is absent in them. **Cup shaped** chloroplast is present in which one **pyrenoid** is present.
- A **contractile vacuole** is present which is concerned with **osmoregulation.**
- A red colour eyespot is found in zoospores for **reception** of light, which is made up of **carotenoids.** (Hematochrome)

  Note : Contractile vacuole is absent in zoospore of ***Ulothrix flacca.***

GERMINATION OF ZOOSPORE

- Zoospores, after the liberation from zoosporangium swim in water for sometime.
- When they tired then settle down on any solid object.
- Micro zoospore attached with their anterior end and macro zoospore attached with their posterior end.
- The zoospore withdraws its flagella and secretes a wall around it. During this period it elongated and divides.
- First of all **transverse division** takes place, it is **asymmetrical** after that two cells are formed.
- The lower long cell transform into hold fast and upper cell divides continuous transversely to form Ulothrix Filament.



Asexual reproduction by microzoospores formation

(ii) Asexual Reproduction in Unfavourable condition :

(A) By Aplanospore :

- When the unfavourable condition returns **slowly,** then all the cells of thallus except hol fast form **aplanospore.**
- Divided protoplast becomes round inside the cells of **Ulothrix** and form a cell wall around it self.
- Aplanospores are **thin walled** and **Non-flagellated** structure.
- The thallus of **Ulothrix** degenerates in **unfavourable conditions.** Aplonospores pass unfavourable conditions.
- On the approach of favourable condition the aplanospore may germinates by two different ways:

(i) Direct germination :

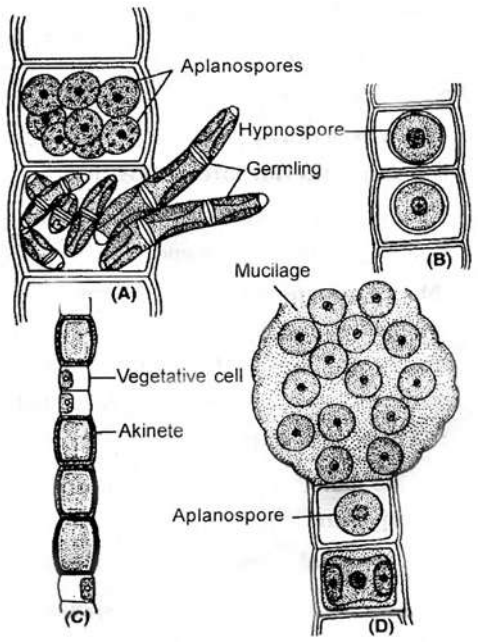
- Aplanospores germinates directly, when the availability of **water is less.**
- Aplanospores absorb water and swells up and their covering breaks and aplanospores become free then transverse division takes place.
- Lower cells transform into hold fast and upper cell produce Ulothrix filament through **continuous** transverse division.

(ii) Indirect germination :

- It take place by formation of zoospores. When water is available in more amount then zoospores are formed in alpanospores.
- Each **alpanospore** act as a **zoosporangium and each** zoospore produce new Ulothrix filament.
- Alpanospore shows **"in situ" germination** also.

(B) By Hypnospores :

- When highly adverse conditions are **coming fast** then the protoplast of the **Ulothrix** cell shrinks and collect in the centre.



Asexual reproduction in unfavourable condition

- Shrinked protoplast secretes a thick wall around itself. These **thick walled non-motile** structures are called **Hypnospores.**
- They are **more resistant** as compared to aplanospores. These are **perennating** bodies.
- On the approach of favourable conditions hypnospores also germinates **directly** or **indirectly.**
  Example – *U. fimbriata.*

(C) Akinetes :

- When adverse conditions come **suddenly** then vegetative cell transform into **thick walled** structure, in which **food** has been accumulated, called **akinete.**
- They shows **perennation.** When favourable conditions come they germinate either directly or indirectly.
  Example : *U. idiospora, U. zonata, U. subtilissima.*

(D) Palmella stage :

- This type of reproduction take place in those Ulothrix species, which lies at the banks of reservoirs.
- The water start drying in the unfavourable conditions, Ulothrix faces deficiency of water **step by step.**
- Certain cells of the thallus divides in uncontrolled manner during such type of changes and to form group of a large number of small daughter cells.
- The cell wall of cells dissolves and to form a **mucilaginous** envelope. Later it dries and form a protective covering.
- On the approach of favourable conditions, mucilage layer dissolves and cells give rise to new thallus through **direct** or **indirect** germination.
  Note : Above stage is identicle to an another **algae-Palmella,** therefore it is known as **Palmella stage.**
  Note : In **Ulothrix,** colony formation occurs during palmella stage.

3. Sexual Reproduction

- Sexual reproduction **isogamous type.** (Such type of sexual reproduction in which fusing gametes are morphologically and physiologically similar called as isogamous.)
- Gametes are type of zoogamete. They are motile and **biflagellated.**
- Each cell can function as **zoogametangium** except the hold fast. The process of gamete formation and liberation is similar to that of zoospores. **8 to 64** zoogametes are formed in a zoogametangium.
- The fusing gametes first unite by their anterior ends in lateral side and later on they get fused completely and a **diploid, quadriflagellated** structure is formed which is called **synkaryon.**
- In the beginning zygote is **quadriflagellate** and later losses its flagella. Zygote secretes a thick wall around it self. It is known as **zygospore.**

GERMINATION OF ZYGOSPORE

One zygospore $\xrightarrow{\text{Germination}}$ 4-16 Ulothrix filament

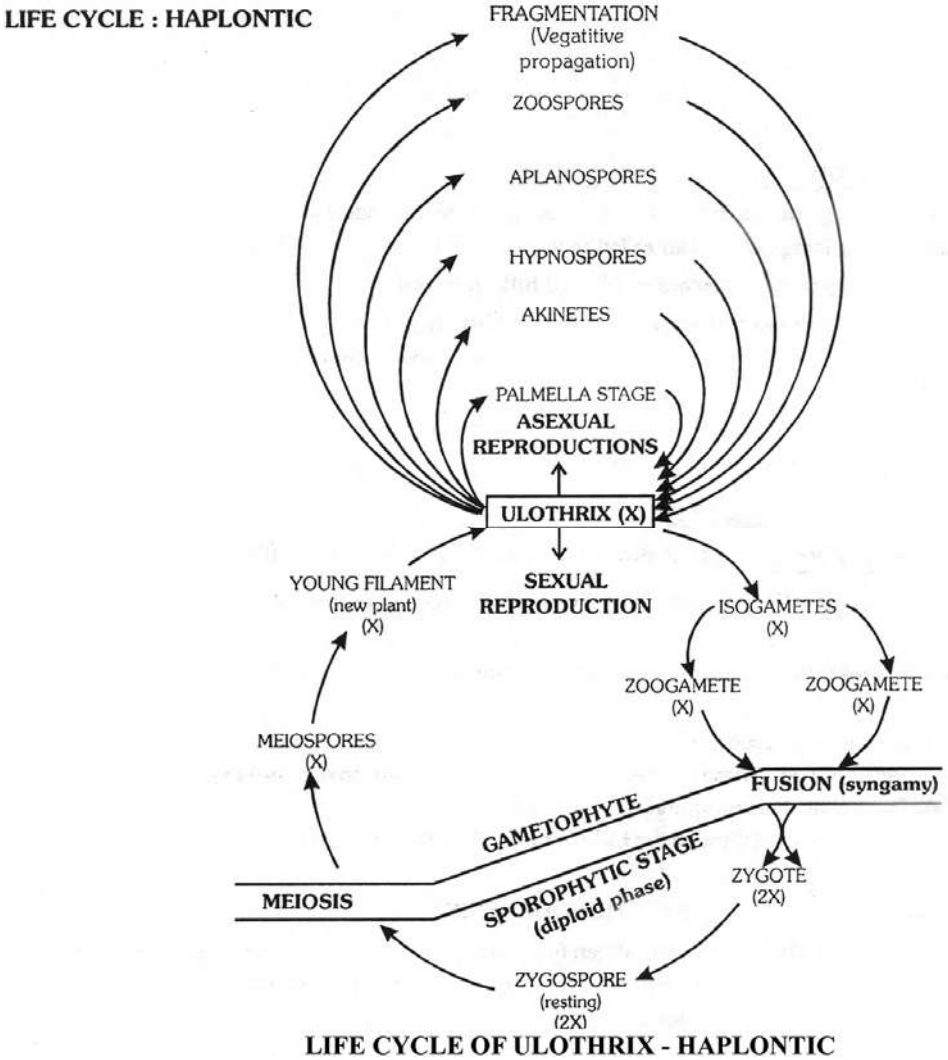
- Germination of zygospore is direct or indirect in favourable conditions and meiotic division takes place during germination.
- A **heterogenetic** thallus is formed throught the **direct germination** in which some of the cells are of opposite strains.
- During indirect germination of zygospores **meiotic divisio**n takes place and **four haploid** spores are formed. They are called **meiospores.**
- These meiospores may be motile **(meiozoospores)** or non motile **(meio aplanospores).**
- The motile meiozoospores are **quadriflagellate.**
- A **homogenetic** thallus is formed through the **indirect germination** of zygospore. It mans all the cells formed in thallus are identicle.

PARTHENOGENESIS

- Fusion of motile gametes is a thought of luck.. When these gametes fail to fuse. They settle down, withdraw their flagella, round off and secretes a thick wall around itself. These are called as **azygospores or parthenospores.**
- Their germination is through the **mitotic** cell division. Homogenetic thallus is formed through the germination of azygospore.

Special point :

- **Ulothrix** is heterothallic. It means fusing isogametes have different strains genetically.
- Sexual reproduction of **Ulothrix** begins after the growth period/ Vegetative season.
- Sporophytic generation is represented only by the zygote. In the life cycle of Ulothrix, Zygote is very short in duration.
- Gametes are formed in **semi drying** condition and released in the **morning.**
- In Ulothrix primary division of labour is found. The work of the holdfast is to make the filament stable on the base. For food it depends on other cell, which does the work of food formation and reproduction.
- In Ulothrix gamete unite first by flagella then by opposite ends then laterally and proceeds towards posterior end.
- In the initial state of zygote of **Ulothrix** have four flagella, two eye spots, two chloroplasts and one diploid nucleus are present.
- **Ulothrix zonata** shows the origin of **Sexual reproduction**.



LIFE CYCLE OF ULOTHRIX - HAPLONTIC

SPIROGYRA

- **"Pond Scum", "Pond Silk" or "Water Silk" or "Mermaid's tresses".**

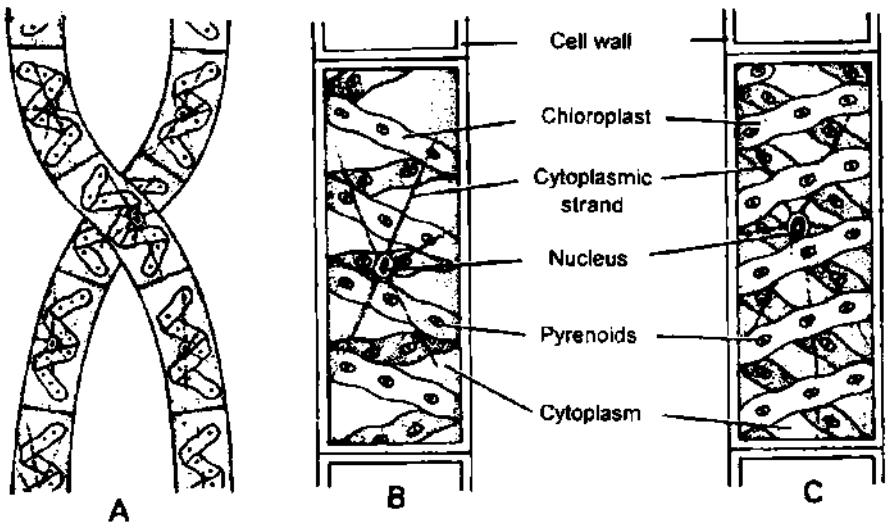
SYSTEMATIC POSITION

Kingdom	:	Plantae
Sub kingdom	:	Thallophyta
Division	:	Chlorophyta
Class	:	Chlorophyceae
Order	:	**Conjugales/Zygnemales**
Family	:	Zygnemaceae/Zygnemataceae
Genus	:	**Spirogyra**

HABIT AND HABITAT

- It occurs in **stagnant fresh water** as **free floating.** It occurs in water of changing temperature.
- ***Spirogyra adnata*** **=** Occurs in stream and river.

STRUCTURE



Spirogyra : A- Two filaments, B - C - Detailed structure of cell.

- **Spirogyra** is a **multicellular, unbranched** and **filamentous algae**. It is **olive-green** in colour.
- All the cells are similar in shape, size and structure. These are arranged in a linear row.
- Hold-fast is normally absent but **S.fluviatalis** contains hold-fast.
- Cell-Wall is **double-layered,** outer layer is made up of **pectose** (which dissolves in water to form a mucilagenous sheath) and inner layer is made up of **cellulose**.

Note: Filament is silky smooth due to presence of pectin in outer layer. Due to this reason epiphytes are not attached with filament.

- Each cell contains a large central vacuole.

- Cytoplasm occurs in the form of a thin layer around the vacuole. Thin layer of cytoplasm is called **"primordial utricle".**
- Cytoplasm contains a large nucleus and it is held by cytoplasmic-fibres.
- Each cell contains **spirally coiled or ribbon-shaped** chloroplasts, with a left **handed twisting (sinistral).**
- Number of chloroplasts varies from one to sixteen in each cell (according to species). (Single chloroplast was recorded in S.Venkataramanii). and 16-chloroplasts in S-rectispora)
- Chloroplast have **many** Pyrenoids.
- Spirogyra grows in length by **intercalary** growth.

  Note: Some species contain **rhizoid like out growths.**

  e.g. ***S.affinis*** ***S.dubia*** ***S.rhizobrachialis***

REPRODUCTION

- **These are of following type -**

1. Vegetative Reproduction

By fragmentation : Fragmentation takes place by -

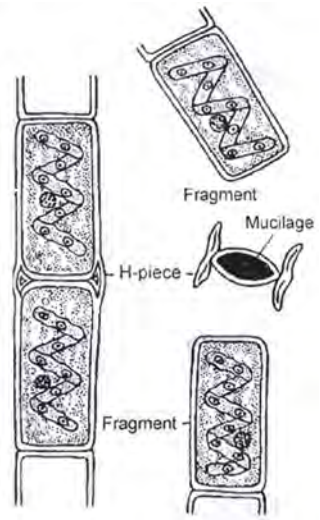
(i) Accidental breakage

(ii) Dissolution of middle-lamella

(iii) By the formation of H-shaped segments -

E.g. Spirogyra colligata

- In some species cell-wall between two cells form **H-shaped** thickening, called **replicate wall/replicate septum.**
- Middle lamella of these cells dissolves and both cells remain connected by replicate wall.
- Replicate wall facilitates fragmentation without dissolution of cells.



2. Asexual Reproduction

- Normally asexual reproduction is **absent** in **Spirogyra.** It takes place only in some species by the following methods-
- **Zoospores** are totally absent in **Spirogyra**. It's reproductive structures are **non flagellated.**

(A) By aplanospore - e.g. ***S.aplanospora***

(B) By akinete

- Under unfavourable conditions, the cells of a filament develop into thick walled structures. Such thick walled structures are called as **akinetes.**
- Thick cell-wall of akinete is made up of **cellulose** and **pectose.** In akinetes, **food** has been accumulated.
- When favourable conditions return, akinete **directly germinates** to form a new thallus.

  e.g., ***S. farlowii.***

(C) By Parthenospores or Azygospores –

- When gametes fail to fuse they form **parthenospore.** Sudden variation in environment leads to the formation of parthenospores.
- **"Kleb"** artificially induced the formation of parthenospores in **S.varians** by placing it in **sugar solution.**

- In ***S.daedalea*** both the gametes form parthenospores **in situ** (at their original place)

Note: In **S.rhizoides** parthenospores are developed from **rhizoids**.

3. Sexual Reproduction

- It takes place towards the **end of growing** season-usually in the late spring.
- It takes place by **conjugation.** Gametes are **non-ciliated** or **non-flagellated** and oval shape.
- Eye-spot is **absent** in gametes.
- Gametes perform **amoeboid movement** during conjugation.
- Gametes of Spirogyra are called **aplanogametes** (due to the absence of cilia or flagella).
- **Physiological anisogamous** type of sexual reproduction is found in ***Spirogyra.***
- Following conditions which favour the process are:

(i) Nitrogen deficiency

(ii) The change in pH of the aquatic medium to alkaline side.

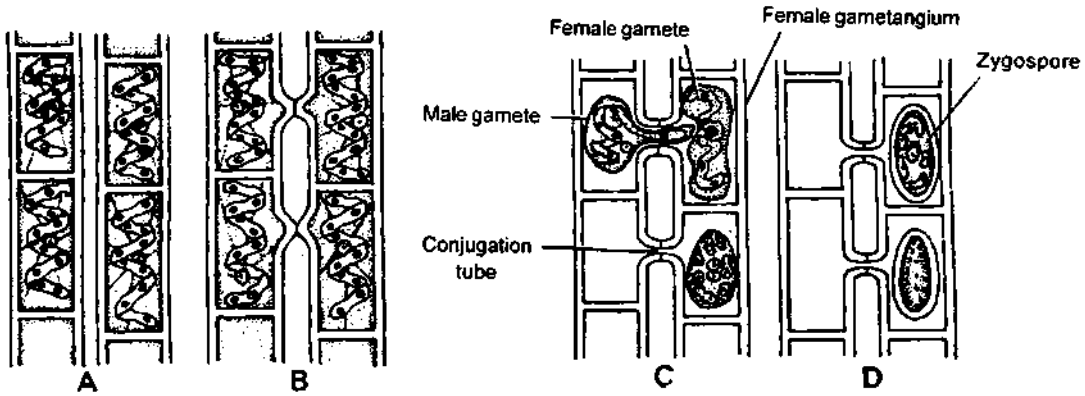
- **Types of Conjugation**

(i) Scalariform or Ladder like conjugation

(ii) Lateral conjugation

Scalariform Conjugation

- It is most common type of conjugation and occurs in **"heterothallic"** species of **Spirogyra.**
- It mainly takes place during **night.**
- Two filaments arranged parallel to each other.
- After some time cells of two filaments opposite to each other form **cylindrical out growths** which fuse to form a **conjugation tube.**
- Cells united by conjugation tube are called **aplanogametangia.**
- Protoplast of gametangium constricts to form gamete.
- In the cells of one filament, male gametes are formed and in the cells of another filament female gametes are formed.
- Male gamete perform **amoeboid movement** and migrate to female gametangium through **conjugation tube,** it fuses with female gamete to form a **diploid zygote.**
- **After this a three layered wall is formed around the zygote, now it is called zygospore.**



Spirogyra - Scalariform Conjugation

- In scalariform conjugation cells of one filament become empty and the other filament contains **zygospore** in its cells.
- Zygote is initially green but soon after chloroplast of male gamete degenerate followed by the degeneration of chloroplast of female gamete. Due to this reason the filaments of **Spirogyra** do not remain green after fusion.

Lateral Conjugation

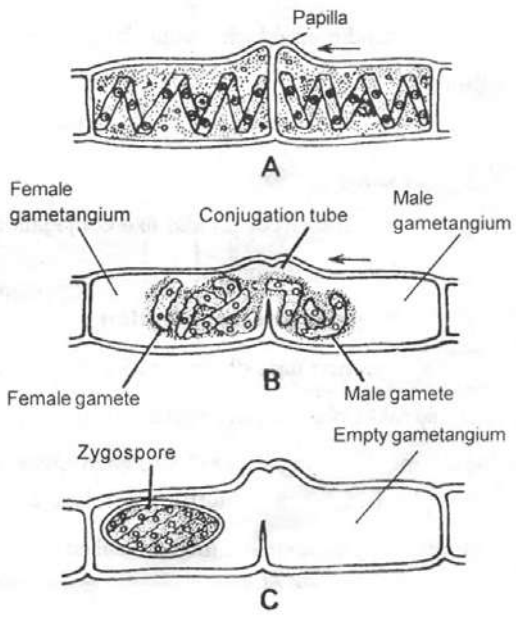
- It takes place between **adjacent cells** of the **same filament.**
- Lateral conjugation occurs in **homothallic species** of **Spirogyra.** Lateral conjugation is of **two types-**

(a) Indirect lateral conjugation

(b) Direct lateral conjugation

(a) Indirect lateral conjugation / chain conjugation-

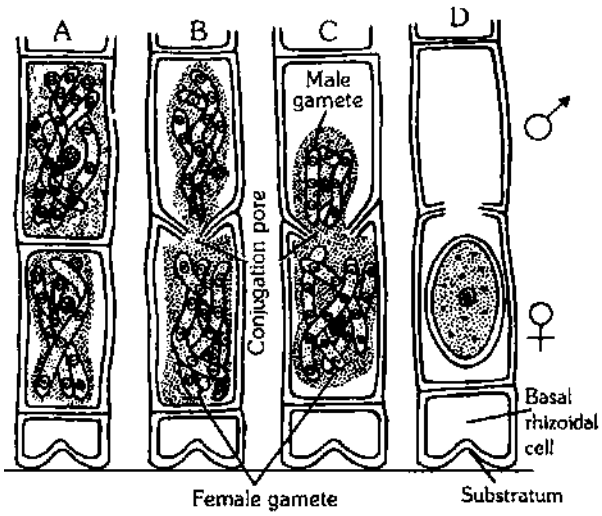
- Protoplast of cells constricts to form gametes.
- Male and female gametes are formed in **adjacent cells** of a filament.
- Each cell form **tubular/papilla-like out growth** in their lateral wall.
- Out growth of two cells fuse to form **conjugation tube.**
- Male gamete migrates through conjugation tube and fuses with female gamete to form zygospore.
- After the completion of conjugation the filament contains empty and zygospore containing cells in alternate manner.
  Ex.: ***S. affinis.***



Spirogyra affinis - Indirect lateral Conjugation/chain conjugaton

(b) Direct lateral conjugation-

- This type of conjugation was studied by **M.O.P. Iyengar** (Father of Indian phycology/Algology) is ***Spirogyra jogensis.***
- Male gamete migrates to adjacent cell through a **conjugation pore** in transverse wall between two cells.
- Male gamete fuses with female gamete to form a **diploid zygote.**



STRUCTURE OF ZYGOSPORE ::

- Wall of zygospore is three layered-

(i) Exosporium – Thin layer of **cellulose** (Mainly) or pectose.

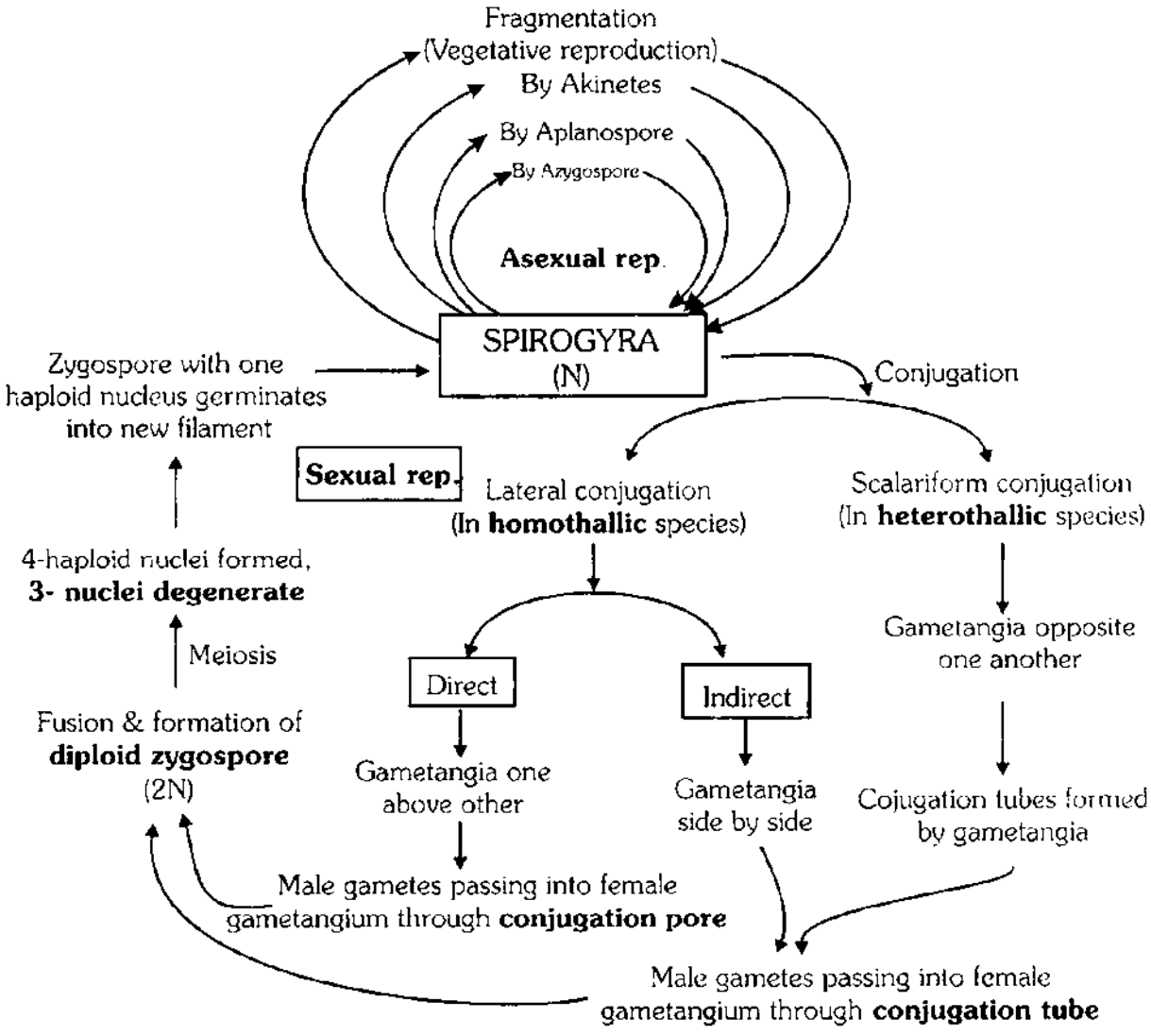
(ii) Mesosporium – Brown, thick ornamented and **chitinised.**

(iii) Endosporium – Thin & made up of cellulose.

- **Germination of Zygospore**
  - Germination takes place in **favourable conditions.**
  - Four haploid nuclei are formed inside the zygospore as a result of **meiosis.**
  - **Three nuclei are degenerate** and only nucleus remains functional.
  - Now functional nucleus of zygospore undergoes repeated mitotic division to form a haploid filament of **Spirogyra.**
  - During germination of zygospore in spirogyra exosporium and mesosporium reptures and endosporium emerges in form of cylindrical tube.

LIFE CYCLE

- Life cycle of **Spirogyra** is **"haplontic type".**



LIFE CYCLE OF SPIROGYRA

RICCIA

SYSTEMATIC POSITION

Kingdom	:	Plantae
Sub kingdom	:	Embryophyta
Division	:	Bryophyta
Class	:	Hepaticopsida
Order	:	Marchantiales
Family	:	Ricciaceae
Genus	:	Riccia

HABIT AND HABITAT

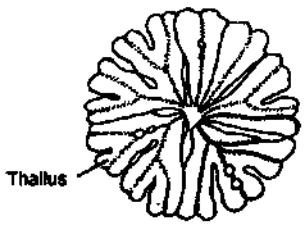
- **Riccia** was discovered by **F.F. Ricci**.
- Species of R iccia are generally found in moist land.
- The common Indian species are as follows :

i. **Riccia discolor/R.himalayensis**
ii. **R. glauca**
iii. **R. pathankotensis**
iv. **R. robusta**
v. **R. crystallina**

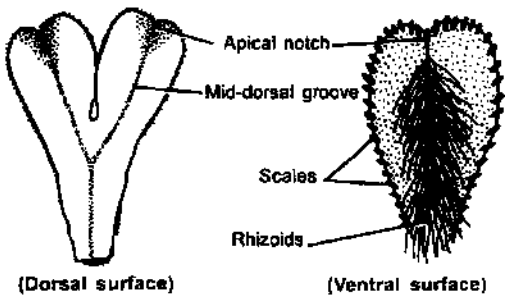
- **Riccia discolor** found in Rajasthan.
- Some species of Riccia are **aquatic**.
- Such as - **Riccia fluitans, R.abuensis, R.riella etc**.

• STRUCTURE

- The main plant of Riccia is **gametophyte** in the form of thallus.
- It is green, flat, dorsiventral and **dichotomously** branched. It grows **prostrate** on the soil.
- At the growing point of thallus a notch is present, at the apical end. It is known as **Apical notch**.
- At the base of apical notch a apical cell is present. It is **pyramidal** shape. The thallus grows by the activity of this apical cell.
- Each lobe of the thallus is thick in the middle and thin at their margins.
- On the **upper (dorsal) surface** of each lobe vein is present in the middle which extends from anterior to posterior. It is known as **longitudinal median vein**.



[Rosette form in terrestrial species] due to the presence of several dichotomies close to each othe



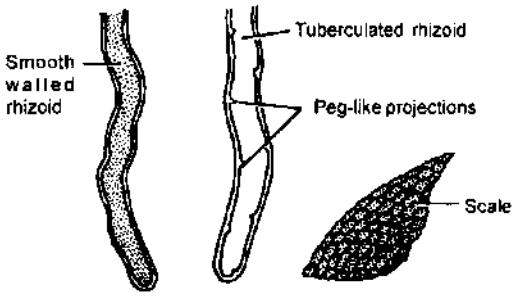
STRUCTURE OF RICCIA THALLUS

- A long groove is present in the rgion of median vein, is called **Median groove.**
- In this groove, sex organs are developed in **acropetal order** (New at apical notch old away from it) on the dorsal surface of thallus.

Note : The dorsal surface of the **Marchantia** thallus (Liver shaped) bears **gemma cups** along the mid rib.

(a) Rhizoid :

- Rhizoids are found in the mid rib region on the **ventral/Adaxial** surface of the Riccia thallus. (In scattered form).
- Rhizoids are **unicellular**, **unbranched**, **colourless** and **tubular**.



Two type of rhizoids are found in Riccia

1. **Smooth walled :**

- Outer and inner walls of rhizoids are smooth & straight.

2. **Tuberculated :**

- Peg like ingrowths are present on the surface of inner wall.
- Tubercalated rhizoids are absent in **Riccia sanguinea**.

Note : Smooth walled & tuberculated rthizoids are also found in **Marchantia** & **Plagiochasma**.

- **Rhizoids are absent** in the aquatic species of Riccia. Such as **R.fluitans**.

  Function : The main function of the rhizoids are is **to fix the plant** with the substratum and it **absorbs** some amount of water and minerals.
- The whole ventral surface also absorbs water and minerals.

(b) Scales :

- Triangular, **multicellular** and **violet colour scales** are present on the margin of **ventral surface** of thallus.
- **Violet (Purple)** colour of the scales is due to presence of **anthocyanin** pigment in their **cell sap**.
- They are **ligulate**. The scales are single celled thick. **Maximum scales are found in apical notch**.
- Scales are absent or less developed in aquatic species of **Riccia.**
- Plant growing moist terrestrial habitats usually have small and ephemeral scales, whereas those of **dry habitats** have **large** and **persistent Scales**.

Note : In **Marchantia** scales are **appendiculate** & **ligulate**.

- In Riccia the half scales are found at margin of the thallus. **Complete scales are found in the apical notch**.

Function :

(1) The main function of the scales is the **protection of growing points**.

(2) Some amount of water also absorbed through the scales.

- Scales are formed by the activity of the apical cell and arranged in a single row, but as the thallus grows and widen, each scale splits into two halves along the median line, so that **two rows of scales** are seen, one row near each margin of the thallus.
- In terrestrial species e.g. **R.sanguinea, Riccia robusta etc. scales are completely absent**.

INTERNAL STRUCTURE

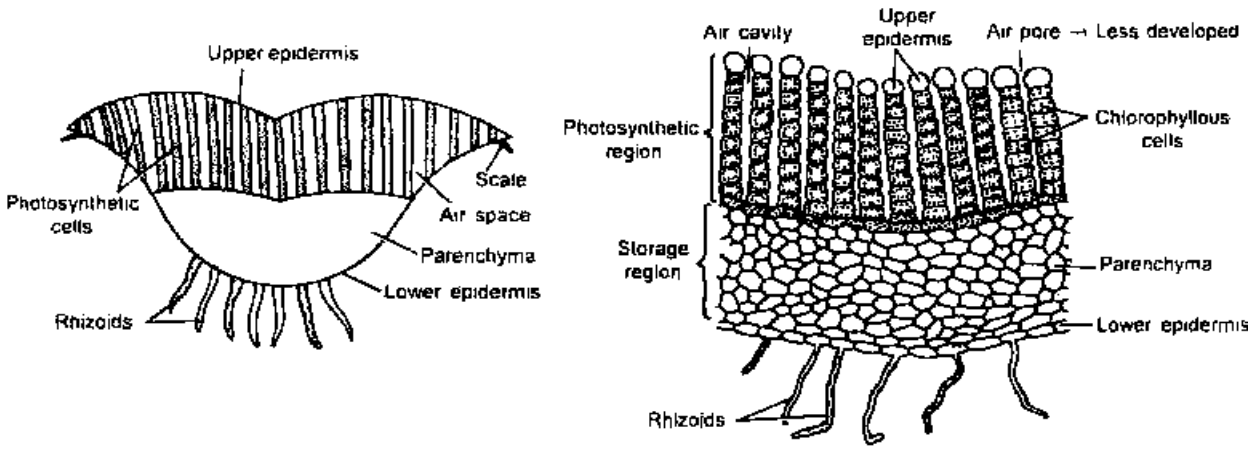
- Interally, the thallus is divided into **two** distinct zones or regions.

(i) Upper or dorsal : **Photosynthetic** or **assimilatory region.**

(ii) Lower or Ventral **: - Storage region**.

(i) Assimilatory Region or Photosynthetic region : -

- The cells of this region are **loosely** arranged and **parenchymatous**.
- Chloroplasts **(Discoid type)** are found in the cells of this region. So this region is able to carry the process of photosynthesis. Therefore it is known as **photosynthetic region**.



V.T.S. OF THALLUS

- The chlorophyllous cells are arranged in **vertical rows**.
- A narrow, deep space is found in between the vertical rows, called **air spac**e or **air canal**.
- Upper cell of each vertical row is **colourless**, larger in size & differentiated to form upper epidermis.
- Air canal opens at upper epidermis through the **pore** called **air pore**.
- Air canals are **schizogenous** in origin. It means it is formed by the **separation of cells.**
- The presence of air canal or air chamber is the ancestral feature. They shows **aquatic ancestral** Character.
- Food material synthesize in this region through the photosynthesis.

(ii) Storage Region : -

- The cells of this region are **colourless, compact, parenchymatous** and without intercellular spaces.
- The **starch** is stored by the cells of this region as food.
- The lower most layer of cells are arranged systematically to form a **lower epidermis.**

REPRODUCTION

- It reproduces by two different ways.

(1) Vegetative Reproduction (2) Sexual Reproduction

1. Vegetative Reproduction

- It is responsible for the **gregarious** (Growing close together but not matted) habit of the plant. It takes place by following methods :

(a) By progressive death and decay of older parts of thallus.

- It is normal method of vegetative reproduction. It takes place in **favourable** growth season (period).
- The older part of the plant body gradually becomes aged, die and ultimately decay.
- When this process of decay reaches up to **dichotomous point,** two branches get separated and each branch form a new thallus through the apical growth.

(b) By Rhizoidal tips.

- It has been reported by ***Fellener*** in ***R.glauca.***
- During this reproduction at the tips of **rhizoids,** a **multicellular mass of cells** is formed by segmentation and repeated division, which becomes green in colour and act as a **bud.** These buds separate from the rhizoids and grow into a new plant.

(c) By Adventitious branches.

- This method of reproduction is found in **aquatic species** of Riccia such as ***R.fluitans.***
- Special adventitious branches arise from the **ventral surface** of the thallus in the **mid rib region**. These branches are detached from the parent thallus and grow into a new plant.

(d) By tuber formation.

- In many species like ***R.discolor, R.perennis*** growing in dry habitat.
- When the **dry season starts,** the apical cell divide to form a **multicellular mass** of cells on the apex of each branch. This mass of cells of the lobes becomes thick due to **storage of food** material and develop a thick protective layer around it after degeneration of marginal cells. This thick structure is known as **tuber.**
- The **tubers** remains **dormant** in **dry season.** On the returns of favourable condition or moist season, each tuber resumes growth and give rise to new thallus. Tubers shows **"perennation".**

(e) By persistent apices/ By death of thallus in drought condition except growing region.

- This method found in region having prolonged dry season as in **Punjab** and **Rajasthan**.
  eg., ***R.discolor.***
- In the beginning of dry season entire body of the thallus becomes dry **except the apices.**
- The apices very often grow down into the soil and becomes thick due to the **storage of food** material.
- On the advent of favourable condition. (ie., rainy season) all the apices grow and form a new plant.

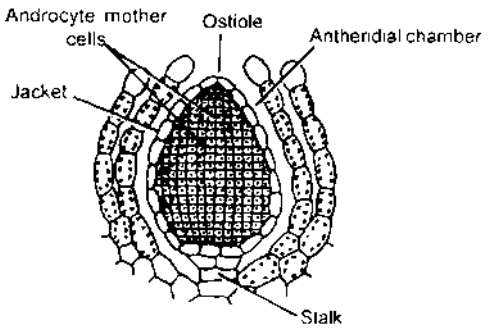
2. Sexual Reproduction

- The main plant of **Riccia** is gametophyte. It reproduces by **gamete formation.**
- It is oogamous type.
- Male sex organ called as **antheridium** and female sex organ called as **archegonium.**
- The sex organs of Riccia are borne on **dorsal surface** of the thallus in the median groove.
- The sex organs are develop singly, usually deeply in the tissues in **acropetal order.** (Youngest sex organ near the apex and oldest sex organ away from the apical notch.)
- For the development of sex organ, **low sun light** and **temperature** is required.
- The species of Riccia are **Monoecious** and **dioecious.** But most of the species of Riccia are **monoecious.**

(a) Monoecious species : Male and female sex organs lies on the same thallus. Such as : ***R.robusta, R.glauca, R.pathankotensis, R.gangetica etc.***

(b) Dioecious species : Male and femal sex organs are present on separate thallus such as : ***R.discolor / R himalayensis***

- Most of the species of Riccia are **homothallic** in nature, ie., fertilization takes place in between genetically identical gametes. But ***R.bischoffii*** and ***R.curtisi*** are **heterothallic.** i.e., Fertilisation takes place in genetically different gametes.



V.S. OF ANTHERIDIUM

[i] Antheridium :

- Each mature antheridium is some what elongated oval or **pear shaped** and **stalked** structure.
- Each antheridium enclosed in a cavity or chamber, known as **antheridial-Chamber.**
- Each antheridium has a short, **few celled stalk** by which it is attached with the base of antheridial chamber.
- The **jacket of the antheridium** is made up of **sterile cells.**
- Jacket is **single celled thick** and **multicellular.**
- Antheridium has large number of small cells, called **Androgonial cells.**

ANTHEROZOIDS

- An **oblique** or diagonal cell division takes place in each androgonial cell. Resulting, two **androcytes** or **antherozoid mother cells** (Sperm mother cells) are formed.
- Each **androcytes** converts into a **male gamete** (elongated nucleus present) or **antherozoids** by metamorphosis.
- These antherozoids are **motile** male gametes.
- The are **comma** like or **curve** shaped and ***biflagellate*.** (In **Marchantia** rod like and biflagellate.)

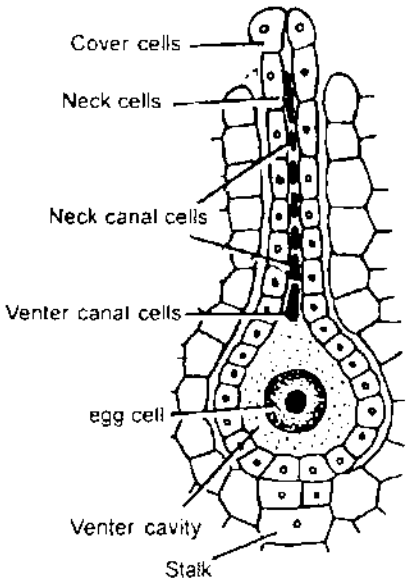
  Note : Most of the species of **Marchantia** are **dioecious** or **heterothallic.**
- At the maturation of antheridium **cell wall of the androcytes** dissolves during metamorphosis and mucilage is formed.
- It is **hygroscopic** in nature.
- The apical cells of **Antheridial Jacket** absorbs water by imbibition from the antheridial chamber Resulting, a pressure increase on the apical region of antheridium and the **Jacket bursts at the apex** then antherozoids come out with mucilage.
- On coming in contact with water, the **antherozoids swim freely** with the help of their flagella.

Dehiscence of antheridium takes place in the presence of high amount of water, is called **Hydrochasy.**

[ii] Archegonium :

- A mature archegonium is **flask shaped** structure and enclosed in **archegonial chamber.**
- It is attached with the base of archegonial chamber with the stalk.
- The basal swollen portion of archegonium is called **Venter.** The upper narrow tube like portion is termed **neck. (sterile cell)**
- The archegonium has a **single layered jacket.**

- The jacket in the neck region is composed of **six vertical rows** of cells. In each vertical row 6 to 9 **(mainly 6) neck cells** are present.
- Venter region contains **two cells.** A large cell which is termed **egg** or **oosphere** and above the oosphere is a small **venter canal cell.**
- The neck region has **4(mainly) – 6 neck canal cells.** (In **Marchantia** 4-8 N.C.C.)
- The **four** terminal cells of jacket of the neck of archegonium function as **cover-cells.**



V.S. OF ARCHEGONIUM

FERTILIZATION

- When archegonium is fully mature, the **neck canal cells** and **venter canal cells** of archegonium **degenerate.**
- Only one cell remains which is called **egg cell.**
- Disintegration of the cells give rise to **mucilaginous substance.**
- Mucilage is **hygroscopic** in nature. It absorbs water, results increase a pressure in archegonium and consequently the **cover cells of archegonium separate from each other** and forming funnel shaped opening and the mucilage oozes out.
- **Inorganic potassium salts** and **soluble protein** are present in mucilage which attracts the **antherozoids**.
- Antherozoid shows **chemotactic** movement.
- Due to this chemotactic response many **antherozoids** enter into the neck of archegonium. But eventually only **one antherozoid** fuses with the **egg cell** and other perish.
- Now fertilized egg cell is called **Zygote** which is **diploid** structure.

DEVELOPMENT OF SPOROPHYTE

- Development of zygote takes place **only inside archegonium.**
- Zygote is the **first cell of sporophytic generation.**
- The first division is **transverse** in zygote and second one is perpendicular to the first one while the third division is vertical which give rise to **8-celled-embryo [octant].**
- Subsequent division occur in all **possible planes** until a mass of 20-40 cells is formed.
- The superficial cells of this mass now undergo **periclinal division,** resulting in an **outer amphithecium** layer and a **central** mass of cells, the **endothecium.**
- The cells **amphithecium** divides again and again **anticlinically** to form the **wall of sporogonium.** It is **single layered.**
- **Endothecium** acts as a **archesporium.**
- The cells of **endothecium** divides in all planes, resulting, a mass of cells **(sporogenous tissue)** is formed. It has two types of cells.

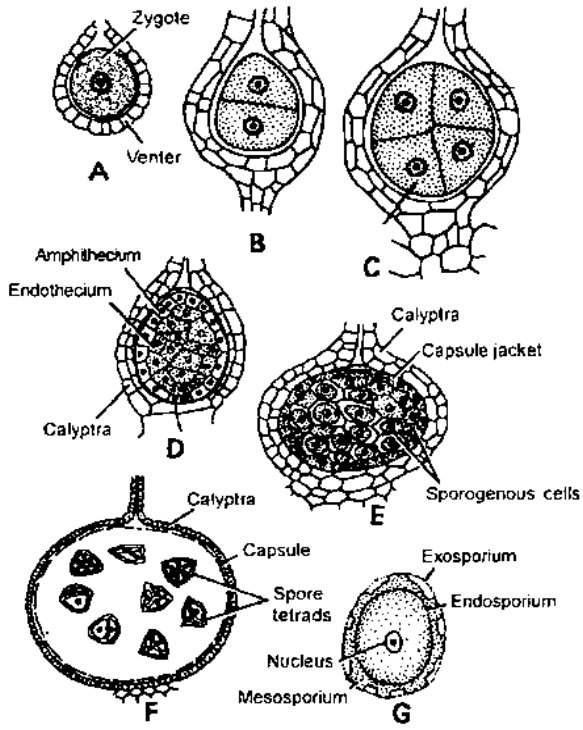
(i) **Sporocytes** or **spore mother** cells and

(ii) **Nutritive cells** or **Nurse cells. (Prestructure of elaters)**

Note : In **Marchantia** nurse cells are transform into **elaters (2N).** Elaters are hygroscopic in nature and help in dispersal of spores.

- The nurse cells provide nutrition to the sporophytes. (In **Riccia**)

- One **periclinal division** takes place in the cells of **venter region** during the development.
- Due to this bilayered covering is formed around the **sporogonium.** It is termed **calyptra.**
- Calyptra is **haploid.** Because, it is formed by venter region of archegonium.
- The cell wall of sporogonium and sporocytes or spore mother cells are diploid.
- Now, **meiotic** cell division takes place in spore mother cells, results, **haploid spores** are formed.
- Now wall of sporogonium disintegrates, to provide nutrition to the spores.
- Later inner most layer (wall) of Calyptra also breaks down to provide additional nourishment.
- In mature sporophyte spore **tetrads** lie in a cavity enclosed by a **single layered calyptra.**
- All the structures in capsule are haploid (n) at the mature stage.



DEVELOPMENT OF SPOROPHYTE

A-E. Successive stages in the development of sporophyte, F. V.S.of mature sporophyte with spore tetrads G. Spore

- The sporophyte of Riccia is simplest in **Bryophyta**. It is made up of **only capsule**.
- The sporophyte is **devoid of foot** and **seta.**
- In ***Marchantia*** sporophyte is differentiated into Foot, Seta and Capsule.

DEHISCENCE OF CAPSULE / DEHISCENCE OF SPORE SAC

- There is no special means of dehiscence of capsule of **Riccia.**
- The liberation of the spores is brought about **by the death and decay of capsule and thallus**.

STRUCTURE OF SPORE

- Spore is the **first cell** of the **gametophytic generation.**
- The spores are arranged in **tetrahedral tetrad.**
- The spores of Riccia are **uninucleate, pyramidal** and **rough.** Their diameter is 0.05 mm to 0.12 mm.
- The spore wall is tri-layered.

(i) Outer layer or Exospore or Exosporium : It is **thick** and **spiny.** It is made up of **callose** and **cutin**.

(ii) Middle layer or Mesospore or Mesosporium : It is thick and solid. It is composed of **Cutin.**

(iii) Innermost layer of Endospore or Endosporium : It is **thin** and **elastic.**
It is composed of **pecto-cellulose.** These layer are developed in centripetal order.

- The spores germinate when there is **enough water** in the soil and **new thallus** is formed.

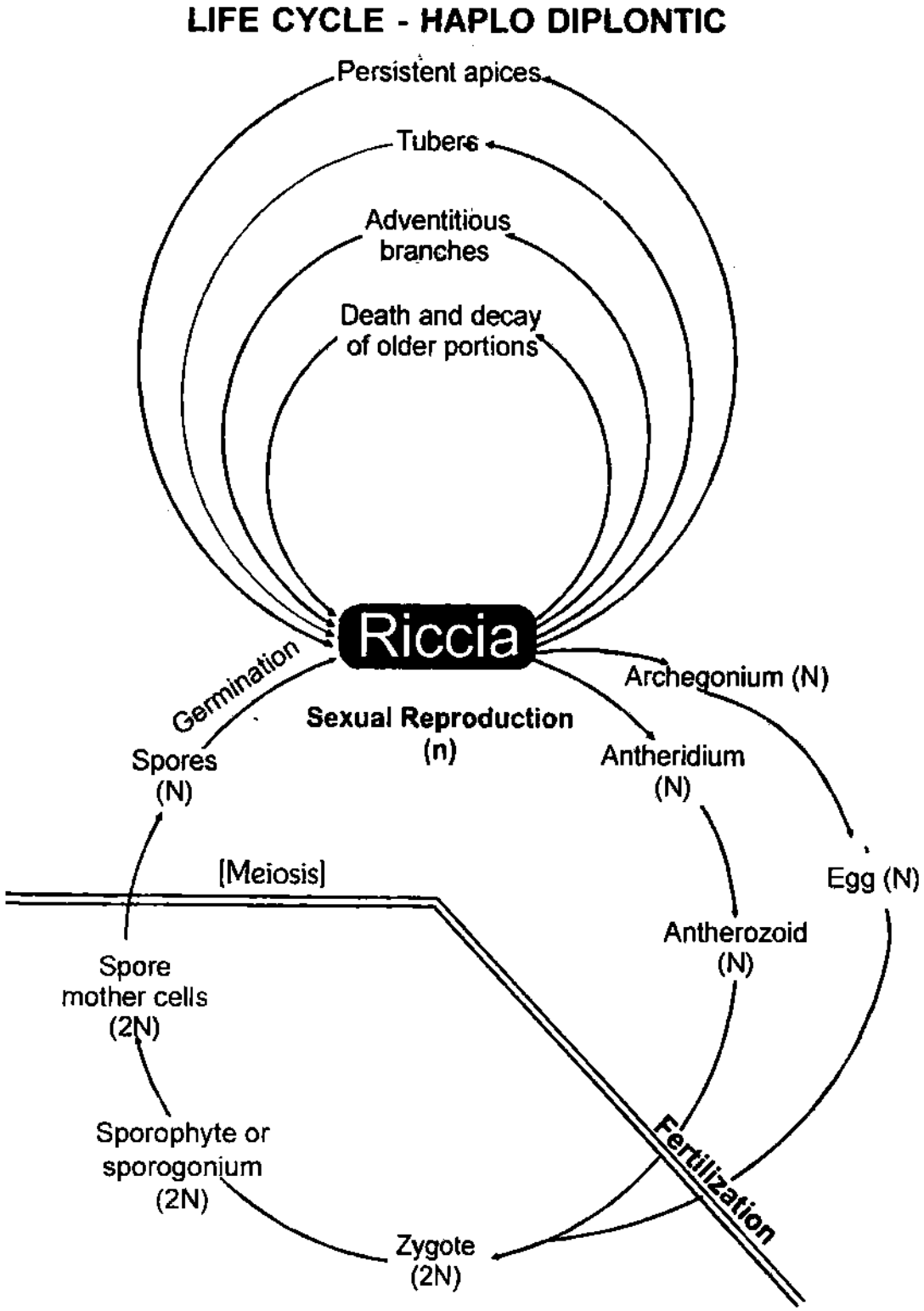
LIFE CYCLE

- **Haplo-diplotic** type alternation of generation is found in **Riccia.**

- **Sporophyte of riccia** completely depend upon **gametophyte for nutrition** and **shelter.**

Note : [In **haplo-diplontic** alternation of generation a **dominant**, **independent**, **photosynthetic**, **thalloid** or erect phase is represented by a **haploid gametophyte** and it alternates with the **short, lived** multicellular **sporophyte** which is totally (eg., Riccia) or partially dependent (eg., Funaria) on the gametophyte for its **anchorage and nutrition.**]

- Haplo-diplontic type of alternation of generation is found Bryophytes.



FUNARIA

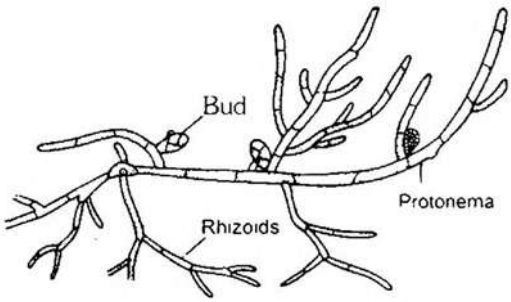
[Green moss or cord moss or rope moss]

SYSTEMATIC POSITION

Division	:	Bryophyta
Class	:	Bryopsida
Order	:	*Funariales*
Family	:	*Funariaceae*
Genus	:	*Funaria*
Species	:	***Funaria hygrometrica***

DISTRIBUTION & HABITAT

- **Funaria hygrometrica** is a cosmopolitan species.
- The plants **(mosses)** are found in **damp** and **shady** localities.
- **Tallest moss** is ***Dawsonia.***
- The adult plant body of moss represents **Gametophytic phase.**



MATURE PROTONEMA

GAMETOPHYTIC PHASE

- It is found in two forms :

(a) Protonema : Prostrate, Creeping filament, Ephemeral, Multicellular and filamentous algae like – [Juvenile stage]

(b) Gametophore : [Erect and Foliose]

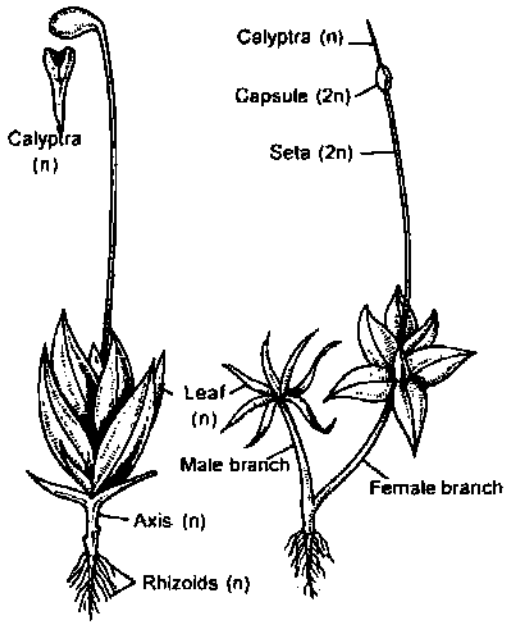
- Gametophore is an actual gametophytic plant which measures 1-3 cms and distinguished into three parts- (i) Rhizoids (ii) Axis (iii) Leaves

(i) Rhizoids :

- Rhizoids are **brownish** in colour.
- **Branched, Cylindrical, Multicellular** and **Oblique septate** structure.

Function :

- They help to **fix** the plant and in **absorption of water** and **minerals.**



FUNARIA HYGROMETRICA

A. A female branch of leafy gametophore with sporophyte B. A leafy gametophore with a male branch and a female branch with young sporophyte.

(ii) Axis :

- It is green in colour, erect, soft and branched.
- Their branches are **extra axillary** in origin. It means branches are developed from below the leaves, not from their axis.
- Stem (axis) and branches bear bright green leaves.

(iii) Leaves :

- Leaves are small, membranous, **sessile** and oval shaped and a **distinct mid-rib is present.**
- They are arranged **(3/8 phyllotaxy)** spirally on the axis. In leaves, **lateral vein are absent.**
- **3/8 phyllotaxy i.e., in three complete spirals there are eight leaves.**

Note : A **pyramidal shape** apical cell is responsible for growth of apex of axis.

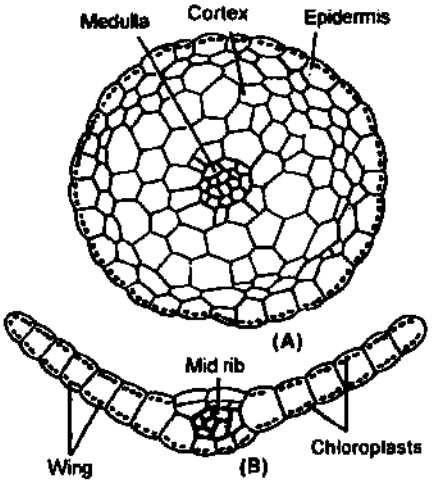
INTERNAL STRUCTURE

1. Axis or stem : A transverse section of the mature axis shows three distinct regions.

(a) Epidermis : It is the outermost layer, composed of tangentially elongated **chlrophyllous cells.** It has **no stomata** and **cuticle.**

(b) Cortex : It is multilayered **parenchymatous** region. The cells of outer layers are thick walled and the cells of inner layers are thin walled.

(c) Central Cylinder : It is composed of long, colourless and thin walled cells. These cells are **dead and lack protoplasm.** They help in the conduction of **water and nutrients.**



A. TRANSVERSE SECTION OF AXIS
B. VERTICAL SECTION OF LEAF

2. Leaf : In the V.S. of leaf lamina one multilayered median vein is found and its both side having single layered **wings.**

- The multilayered median vein is the main part. The central part of median vein formed by narrow parenchymatous cells.
- Wing region of leaf lamina made up of thin layered cells in which **many chloroplasts** are present.
- **Stomata are absent in the leaf.**

REPRODUCTION

- Reproduction in gametophyte of Funaria is of two type-
  (1) Vegetative
  (2) Sexual

1. Vegetative Reproduction

It is responsible for **gregarious habit.**

- Vegetative propagation in *Funaria* takes place by the following method.

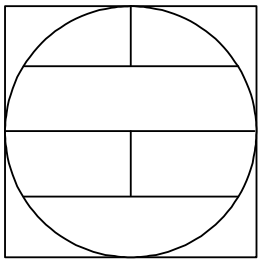
(i) Fragmentation of primary protonema

- On germination the **spore** gives rise to a branched filamentous structure, known as **primary protonema.**
- Sometimes it breaks into small fragments. The fragments **bear buds** and each bud develops into an **erect gametophore.**

(ii) Secondary protonema

- Under favourable conditions. Secondary protonema may be formed by the cells of injured **rhizoids, stems, leaves** or **reproductive** structures.
- Like primary protonema, it bears buds which are capable of growing into erect gametophores.

(iii) Gemmae



- During **unfavourable** period, the **terminal cells** of the protonema form **multicellular green** bodies, called **gammae.**
- Gammae are both, **vertically** and **transversely** septate and has **10-30** cells.
- On return of favourable conditions, it is detached from the parent plant and germinates to form an erect gametophore.
- Under certain condition, gemmae may also develop on the leaf and on the axis of the gametophore.

(iv) Bulbils

- They develop on **rhizoids** and **devoid of chloroplast.** The bulbil grows into a new plant when detached from the parent plant.

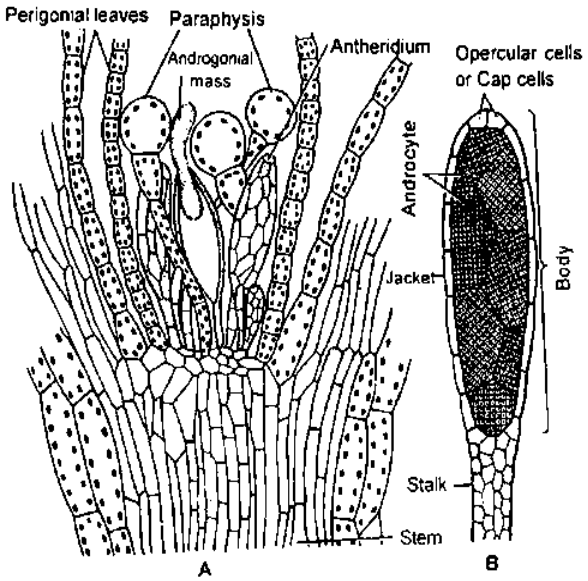
2. Sexual Reproduction

- Sexual reproduction in Funaria is **oogamous** type.
- Funaria is **monoecious** and **autocious plant.**
- Male and female sex organs are called **antheridia** and **archegonia** respectively and are borne in clusters at the tips of different branches.
- **Antheridia** develops at the apex of **main branch** of plant where as **archegonia** develops at the apex of **lateral branch.**
- These are covered by **involucral** leaves.

[Note : Autocious means when two different sex organs are born on different head of the **same plant.]**

ATHERIDIUM

- Antheridium of Funaria is **club shaped** structure.
- It has short multicellular **stalk.**
- It has **single layer jacket.**
- In Antheridium many androcytes are present. Each androcyte forms long, **spirally coiled, biflagellated** antherozoids by **metamorphosis.**
- **Chloroplast** is present in jacket cells of young antheridium due to which they are green but **orange colour of jacket of mature antheridium** is due to presence of **chromoplast.**
- At the apex of jacket **two** colourless cells are present called as **opercular cells** or **cap cells.**
- In between the antheridia, **paraphysis** are present which are **green,** upright and multicellular **capitate hairs.**

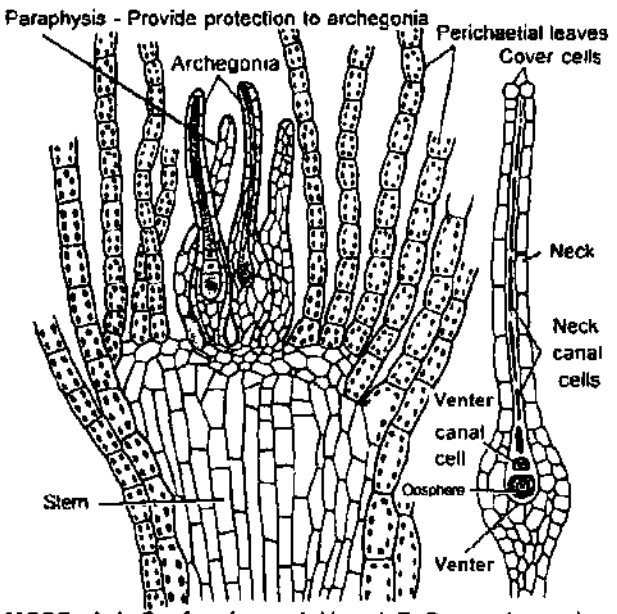


MOSS : A. L. S. of antheridial head, B. L. S. of one antheridium (young stage)

- Antheridia and paraphysis are surrounded by **perigonial leaves.**
- **Function of paraphysis :** Provide protection to antheridia and **water secretion.**

ARCHEGONIUM

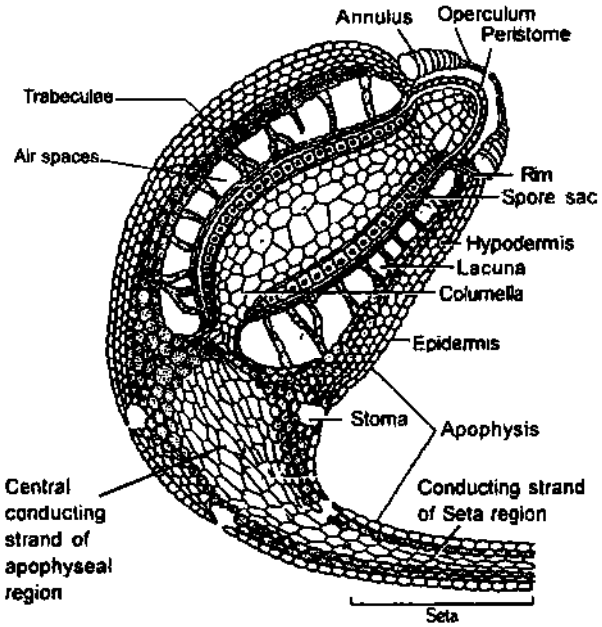
- Archegonium of Funaria develops from an apical cell at the **archegonial branch.**
- A mature archegonium is **flask shaped** structure **paraphysis** are also present between archegonia which are **not capitate.** They are surrounded by **perichaetial leaves.**
- Archegonium is distinguished into **stalk, venter** and **neck.**
- A swollen **double layered** venter contain an **egg** and a **venter canal** cell.
- Neck contain **six** or **more** (6-10) **neck canal cells.** It is capped by **four cover cells.**
- Jacket of neck is single layered and made of **six** vertical rows of **neck cells**.
- In each vertical row **6 to 9 neck cells** are present.



MOSS : A. L. S. of archegonial head, B. One archegonium

FERTILIZATION

- **Water medium** is essential for fertilization and the apical cells of the antheridium Jacket which forms **operculum absorbs water** and bursts.
- The **spirally coiled biflagellate antherozoids** escape from the antheridium.
- The **neck canal cells** and venter canal cells also degenerate to form a **mucilaginous substance** which absorb water to exert a pressure so **cover cells** become separated from each other and to form a passage for antherozoids.
- The antherozoids are attracted towards the neck of the archegonium by some **chemotactic substance,** possibly **sugar,** produced by archegonium.
- An antherozoids fused with egg of archegonium to form a diploid **zygote.**



FUNARIA : L.S. OF MATURE SPOROPHYTE SHOWING SETA AND CAPSULE

SPOROPHYTIC PHASE

- Diploid zygote divides to produce **sporophyte of Funaria.**
- The mature sporophyte distinguished into three parts : **Foot, seta and capsule.**

(i) Foot : Foot is very small and formed by **parenchymatous** cells. It **absorbs water and nutrients from the gametophyte.**

(ii) Seta : Seta is a thick and **thread** like structure. It is **hygroscopic** in nature.

Function :

- Conducts water and nutrients.
- Helps in dispersal of spores.

(iii) Capsule :

- It is pear shaped, the capsule is distinguished into three regions.
- Development of capsule takes place by upper apical cell of embryo.

(i) Upper → **Opercular region** < Annulus, Rim, Peristome

(ii) Middle → **Theca region** < Fertile → Spore sac; Sterile → Collumella

(iii) Lower → **Apophyseal region** ➡ Stoma

(i) Opercular region :

- The opercular region comparises operculum which covers **peristome**.
- The **peristomial teeth** are present in peristome. They are curved and **triangular** in shaped.
- They are arranged in **two whorls-outer** and **inner** whorls.
- Outer whorls bear **16 teeth** which are **thick, large** and **well developed** & **red.**
- **Inner teeth** are also **16** in number but they are **thin** and **delicate & colourless.**
- Total 32 peristomial teeth are present.
- These teeth are help in dispersal of spores.
- The teeth are simply the strips of **cuticle** and they are **acellular.**
- Opercular region is separated by theca region, by two rings.

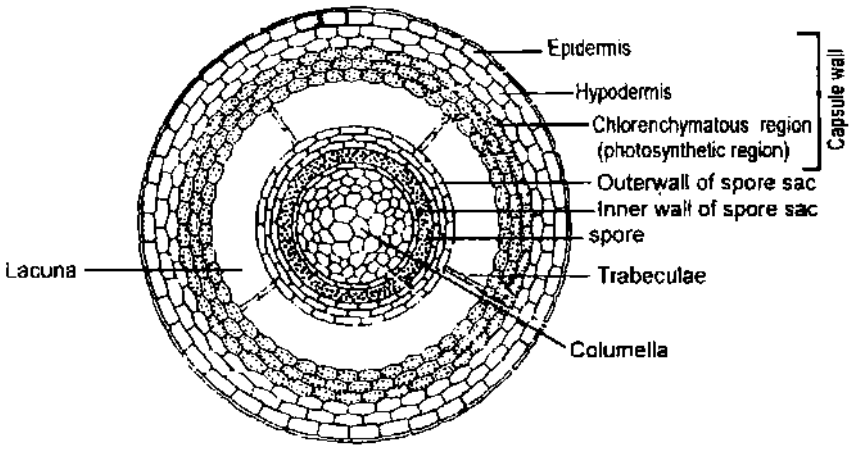
(a) Rim or **Diaphragm** (lower) **(b) Annulus** (upper)

(ii) Theca region :

- The middle theca region is distinguishable into **epidermis, hypodermis, chlorenchymatous** region (2-3 layered), filamentous **trabeculae** with large **air spaces**, two layered **spore sacs** and central **sterile** region is **columella.**
- **Elaters** are absent in **spore sac.**

Function of columella : It provides water and food to developing spores in spore sac.

Function of trabeculae : It connects the inner most layer of capsule wall to outer most layer of outer wall of spore sac.



T.S. OF FUNARIA CAPSULE THROUGH THECA REGION

(iii) Apophyseal region :

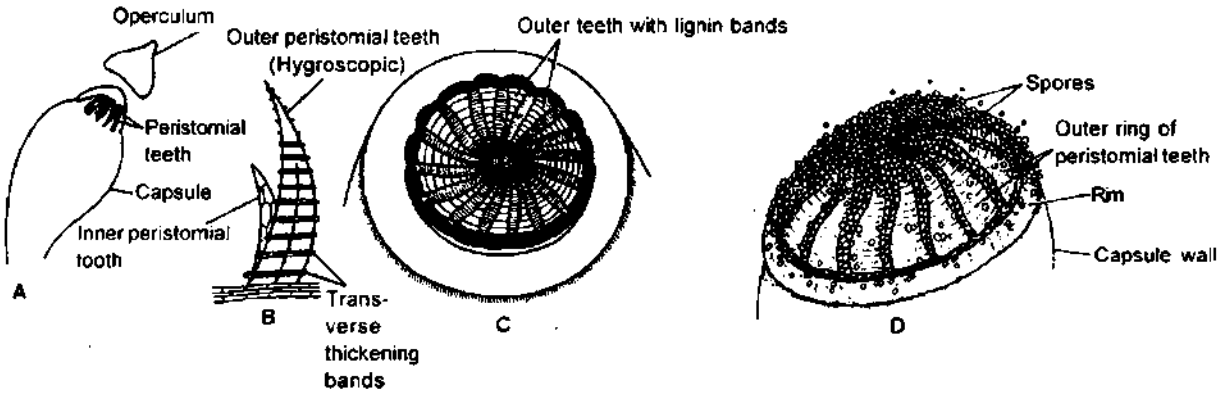
- The apophyseal region is the lower most part of the capsule which has **conducting strand** and attached with seta**.**
- This is surrounded by **chlorenchymatous** cells with prominent **intercellular spaces.**
- The epidermis has **stomatal aperture** which is guarded by two **guard cells.**
- In mature stomata stomatal aperture is guarded by **single ring like guard cell.**

Note :

- The **endothecium** forms the **central parenchymatous** cells in the opercular region.
- **Columella, Inner wall of spore sacs, archesporium** in the fertile region, **central conducting** strand in the **apophyseal region** and central conducting strand in seta region.
- The **rest of the tissues** arises from the **amphithecium.**
- Archesporial cells divide and redivide, to form a mass of **sporogenous tissues.**
- Sporogenous cells behave like **spore mother cells.**
- These cells are divided by **meiosis** and to form **haploid tetrahedral tetrad** of spores.

DEHISCENCE OF CAPSULE AND DISPERSAL OF SPORES

- ***Funaria*** is a **stegocarpous moss**.
- **Stegocarpous** means the dehiscence of capsule always along a predetermined line.
- As the capsule matures, the thin walled cells including **columella** dries up.



(A) CAPSULE WITH PERISTOMIAL TEETH, (B) OUTER & INNER PERISTOMIAL TOOTH, (C) THE STRUCTURE OF CAPSULE AFTER THE SEPERATION OF OPERCULUM (D) DISPERSAL OF SPORES

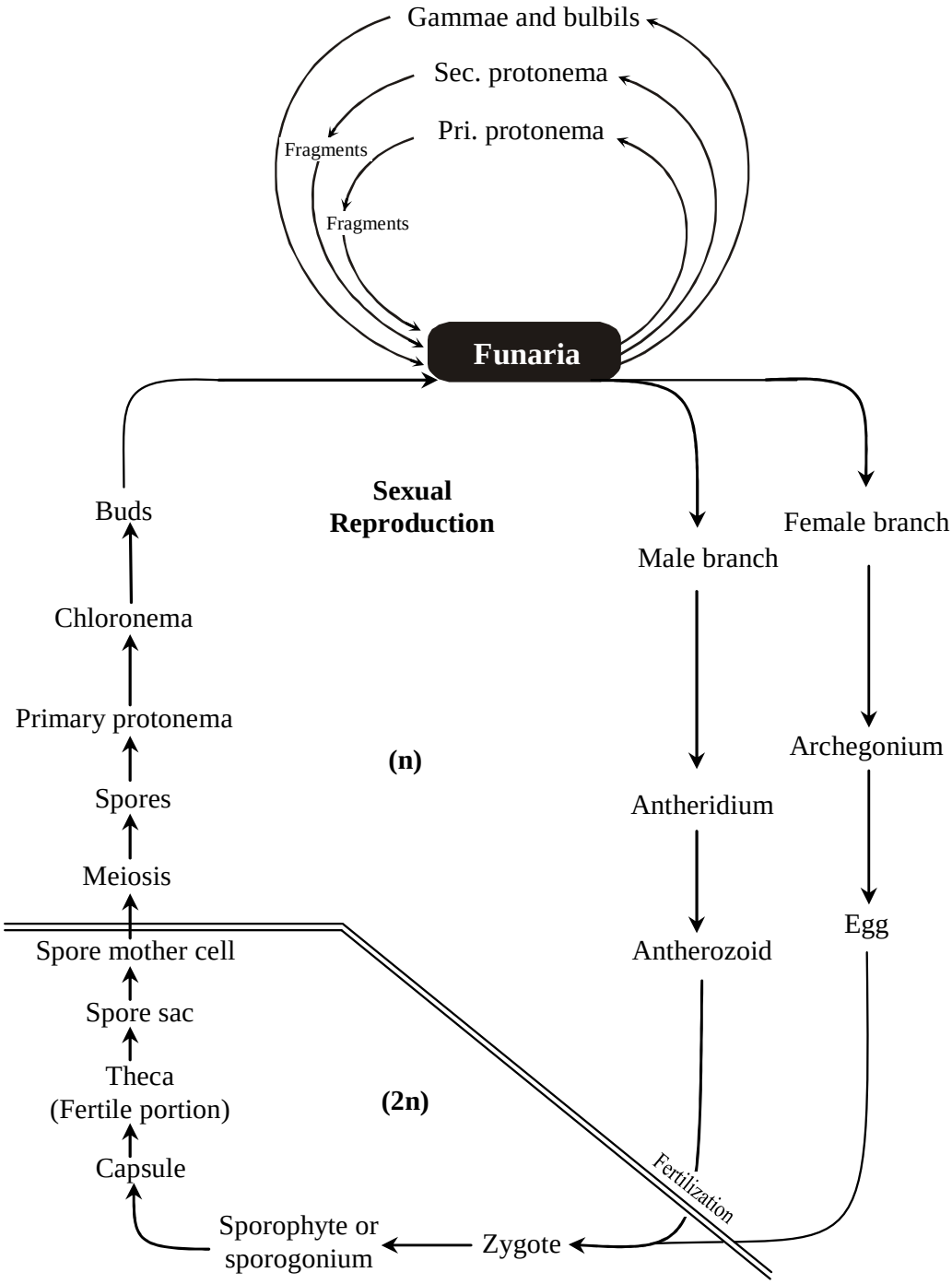
- The thin walled cells of **annulus** break away and thus **operculum separated** along the annulus and **exposing** the **peristome.**
- The **hygroscopic** nature of **outer peristomial teeth** (Open out in only in dry weather) helps in **dispersal of spores.**
- The inner peristomial teeth check sudden dispersal of spores.
- They reach at far places through the medium of **air.**
- In moss capsule, spore dispersal takes place by **censor mechanism.**
- Peristome teeth- They shows **xerochasy.**

STRUCTURE OF SPORES AND GERMINATION OF SPORES

- **Spore** is the **first cell** of gametophytic generation. Spores are spherical in shape and 12-20μm in diameter and **double layered.**

- The outer **wall-exosporium** is much thicker and inner wall **endosporium** is thin.
- Spores have **oil droplets** and **chloroplast.**
- The spore germinates to form the **primary protonema.**
- Protonema grows in **two directions.** The green prostrate branches growing on the surface called as **chloronema** or **chloronemal** branches and **colourless** branches grow into soil are called **rhizoidal branches.**
- The chloronemal branches give rise to many buds and each bud grows into an erect leafy gametophore.

Life cycle : Halpo-diplontic



LIFE CYCLE OF ***FUNARIA***

SPECIAL POINTS

- *Funaria* is a **protoandrous** moss.
- Internal structure of *Sphagnum* stem is differentiated into **central medulla,** cortex and epidermis.
- **Medulla** has **hadrome. Hadrome** is **water conducting tissue** and it is made up of **parenchyma.**
- *Sphagnum* has two types of cell, *hyaline* (water absorbing cells) and ***chlorophyllous*** in leaves.
- In **Anthoceros** and **Notothyllus.** (Specifically cynophycean algae found in thallus as symbiosis.)
- Stem of **Sphagnum** contain special type of water storage cells are called **"retort cells"**(Star shape or bottle neck like cells.).
- Upper region of capsule is covered by membranous structure called **calyptra.** Calyptra is formed by venter of archegonium. So it is **gametophytic tissue** or **paternal tissue (n).**
- The sterile tissue of **capsule** can be divided into four regions.

(i) The sterile cells constituting the **apophysis.**
(ii) The sterile cells forming thick **capsule wall.**
(iii) The sterile cells forming **columella.**
(iv) The sterile cells constituting the **operculum** and **peristome.**

Polytrichum : (Hair cap moss)

(i) **Dioecious**
(ii) Vegetative reproduction – by **bulbils** (Which develop on rhizoids) and fragmentation of underground) rhizome.
(iii) **Neck canal cells – Ten**
(iv) **Annulus absent.**
(v) In **Polytrichum,** peristome teeth (32 or 64) are **not hygroscopic.**
(vi) Common name – **Hair cap moss.**

- **Sphagnum –** Peat moss / Bog moss / Turf moss.

MUCOR & RHIZOPUS

↓ ↓

(Pin mold) **(Common bread mold)**

or

Black mold of bread

SYSTEMATIC POSITION

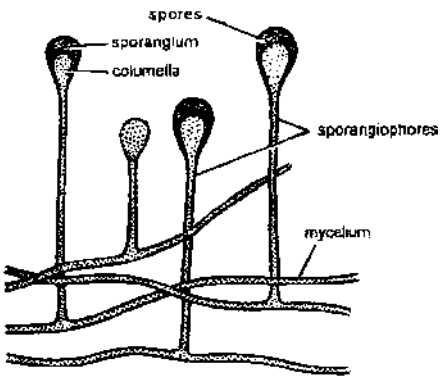
Division	:	Eumycophyta
Class	:	Phycomycetes
Sub. Class	:	zygomycetes
Order	:	mucorales
Family	:	mucoraceae
Genus	:	**Mucor/Rhizopus**

HABIT AND HABITAT

- Rhizopus and Mucor are **saprophytic** fungi and in laboratory can be obtained on moist bread.
- Rhizopus and Mucor are also called as **bread mold**.

STRUCTURE OF MYCELIUM

- It is branched, **coenocytic, aseptate** and vacuolated.
- The hyphal wall is made up of **chitin.**
- Some amount of glucosamine, galactose, protein, lipid, **Mg** and **Ca** are also present in the cell wall.
- In cytoplasm, storage food is present in the form of **oil droplets** and **glycogen bodies**.



STRUCTURE OF MUCOR MYCELIUM WITH SPORANGIOPHORE

REPRODUCTION

(1) Vegetative reproduction
(2) Asexual reproduction
(3) Sexual reproduction

1. Vegetative Reproduction

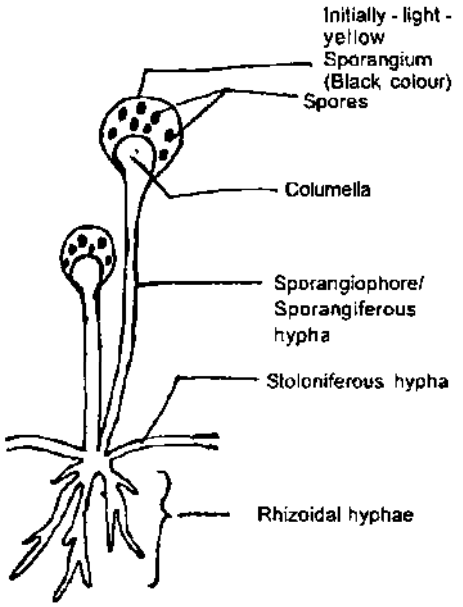
- It takes place by fragmentation.

2. Asexual Reproduction

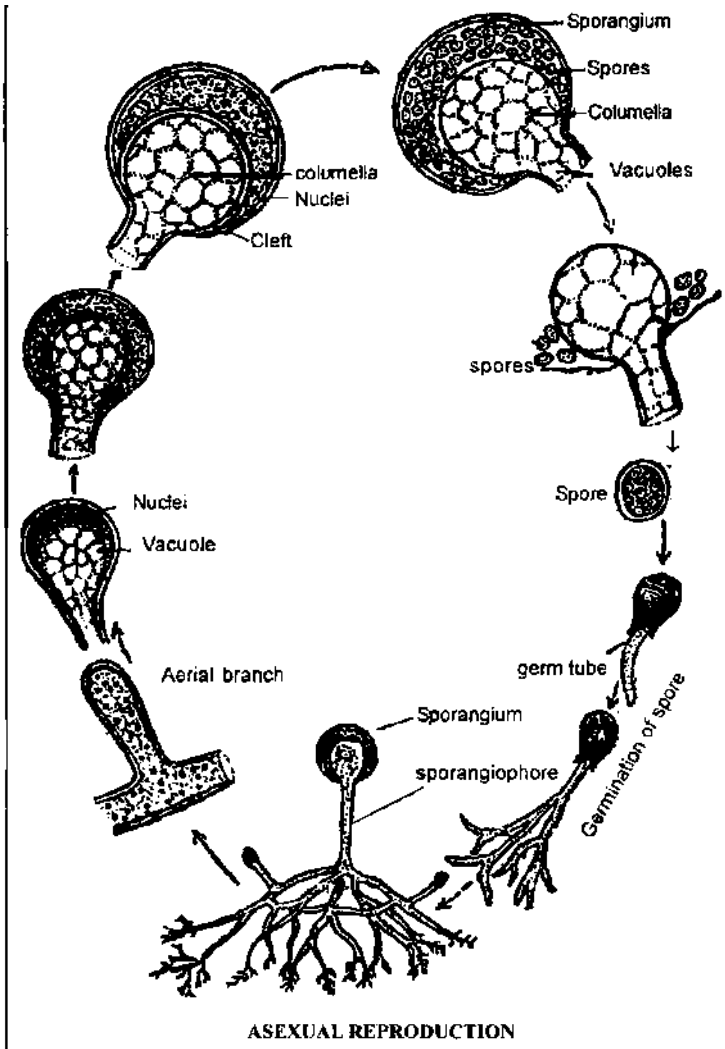
By aplanospore formation –

- Sporangia are **aseptate** and **aerial**.
- Sporangium develops on sporangiophores.

- Sporangiophores are branched **(Mucor mucedo)** or unbranched **(M.jenevensis).**
- Sporangiophores come out from mycelium and their **distal ends** swell up.
- The swollen apices accumulate cytoplasm, nuclei and food. Now it is called **sporangium** (plural-sporangia).
- In this stage protoplast of sporangium is differentiated into a **peripheral dense multinucleated region** and **central** region with **small flattened vacuole**.
- Nucleus are arranged in peripheral region. The peripheral region of sporangium is **fertile**.
- Central vacuolated region is **sterile.** It is hemispherical or club shaped which is called **columella**.
- At the stage of spore formation protoplast of peripheral region of sporangium get divided into many **multinucleated** segments (**2-10 nuclei** in each segment).
- Each segment secretes a wall around itself and form **aplanospores.**
- When they mature outer wall of sporangium ruptures to release the spores in air.
- These spores germinate in **favourable conditions** and form new mycelium.



STRUCTURE OF RHIZOPUS MYCELIUM WITH SPORANGIOPHORE

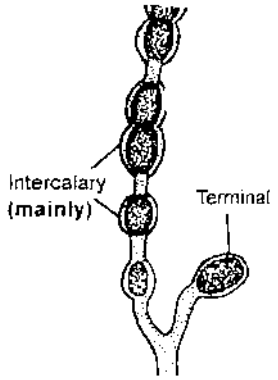


ASEXUAL REPRODUCTION

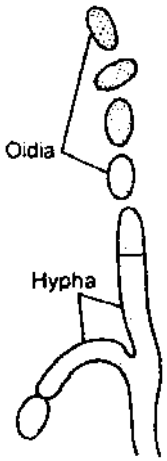
By Chlamydospores –

- Asexual reproduction also takes place by **chlamydospores**.

- When unfavourable condition comes, mycelium becomes **septate**.
- Protoplast of each cell aggregates, to become spherical and secretes a **thick wall** around itself.
- Chlamydospores are may be **intercalary** (mainly) and **terminal** in origin.
- These are **perennating** structure which can survive in **unfavourable conditions**.
- In favourable conditions these spores germinate and form new mycelium.



CHLAMYDOSPORES



OIDIA

Oidia –

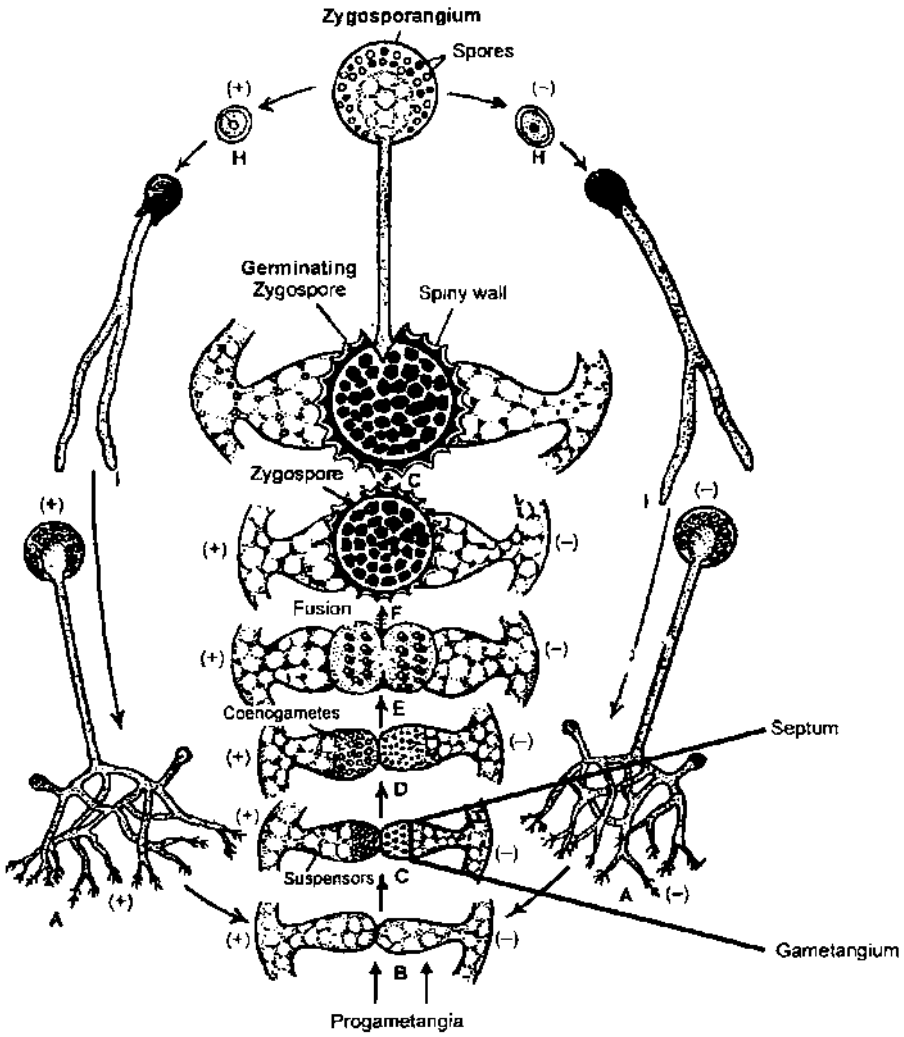
- When mycelium gorws in a **liquid medium** then it becomes septate and **thin-walled**. These cells are called **oidia**.
- Oidia are similar to buds of **yeast**.
- **Fermentation** takes place by oidia in **sugar solution** and **alcohol** is formed.
- Oidia are formed in a chain. This stage is called **torula stage**.

SEXUAL REPRODUCTION → **Isogamous type**

- It takes place during the **absence of nutrient susbstances**.
- In this process **gametangial copulation** takes place between **two gametangia**.
- Both **homothallic** and **heterothallic** species are occur in these fungi. But most of the species are **heterothallic**.
- In **homothallic** species fungal hyphae which participate in sexual reproduction are of same strains i.e. either (+) strains or (-) strains.
- In **heterothallic** species fungal hyhae which participate in sexual reproduction are of different strains.
- In **heterothallic species** sexual reproduction **always takes place between hyphae** of different strains i.e.(+) and (-).

Mucor mucedo (Dung mold)	**–**	**heterothallic**
R.stolonifer	**–**	**heterothallic**
Rhizopus nigricans	**–**	**heterothallic**
R. sexualis	**–**	**homothallic** (species found as obligate parasite in higher plant)

M.hiemalis – homothallic



SEXUAL REPRODUCTION

- When two fungal hyphae which are respectively (+) and (–) strains come close to each other, then these fungal hyphae produce some outgrowths. These outgrowths are called **"progametangia"**.
- Anterior parts of progametangia are filled with **cytoplasm** and **nuclei**. Now these progametangia **(which are different in strains),** come in contact and a **septum** is formed just behind the contact place.
- Now the terminal part is called **gametangium** & long basal part is called **suspensor**, which is **vacuolated**.
- The **multinucleate** undifferentiated protoplast of each gametangium is termed as **coenogamete** or **aplanogamete**.
- In mature gametangium at the place of contact, walls of gametangia are dissolved and fuse together and then **zygospore** is formed.
- In zygospore **diploid nuclei** are formed while haploid nuclei are degenerate.
- A black coloured, thick and ornamented coat is formed around the zygospore [Dormant stage approximately **6 months (In Rhizopus)**]. Which germinate in favourable condition.

GERMINATION OF ZYGOSPORE

- During germination outer wall of zygospore get ruptured.
- A germ tube protrudes out from this ruptured place, it is called **promycelium**/Promycelial Hypha.

- At the apex of promycelium, a sporangium is formed which is called **germsporangium** or **zygosporangium**.
- In **Rhizopus**, at the time of germination **Meiotic division** takes place in zygospore (delayed) whereas in **Mucor, meiotic division** takes place in zygospore **soon after karyogamy**.
- Each nucleus is converted into spore.
- In **Homothallic** species, only one type of (+ or –) spores are formed in the germsporangium whereas in **heterothallic** species both types of spores (+ & –) are formed.
- These spores germinate to form fungal hypha.

HETEROTHALLISM

- **"Blakeslee"** discovered heterothallism first in **Mucor mucedo.**
- In which copulating aplanogametangia are similar externally but are different physiologically i.e., they are of (+) and (–) type.
- According to **Blakeslee** two types of species are found in order mucorales which are called respectively **homothallic** and **heterothallic** species.
- When zygospore is formed by the fusion of two hyphae of same mycelium derived from single type of spore (+ or – strain) then such species are called **homothallic e.g. M.hiemalis**.
- In **heterothallic** species the sexual reproduction takes place between hyphae of **genetically different strains.** i.e. (+) and (–) strains. (In heterothallic species genetically similar strain are **inter-sterile**)
  e.g. **M.mucedo and R.Stolonifer**.
- According to **Blakeslee** in **heterothallic** species, **seperately growing** (+) and (–) strains do not form zygospore, only **sporangia** are formed.
- In heterothallic species (+) and (–) strains grow **together**, they fused and **zygospore** is formed. According to some scientists(+) and (–) strains fungal hyphae are **morphologically similar** but functionally dissimilar.

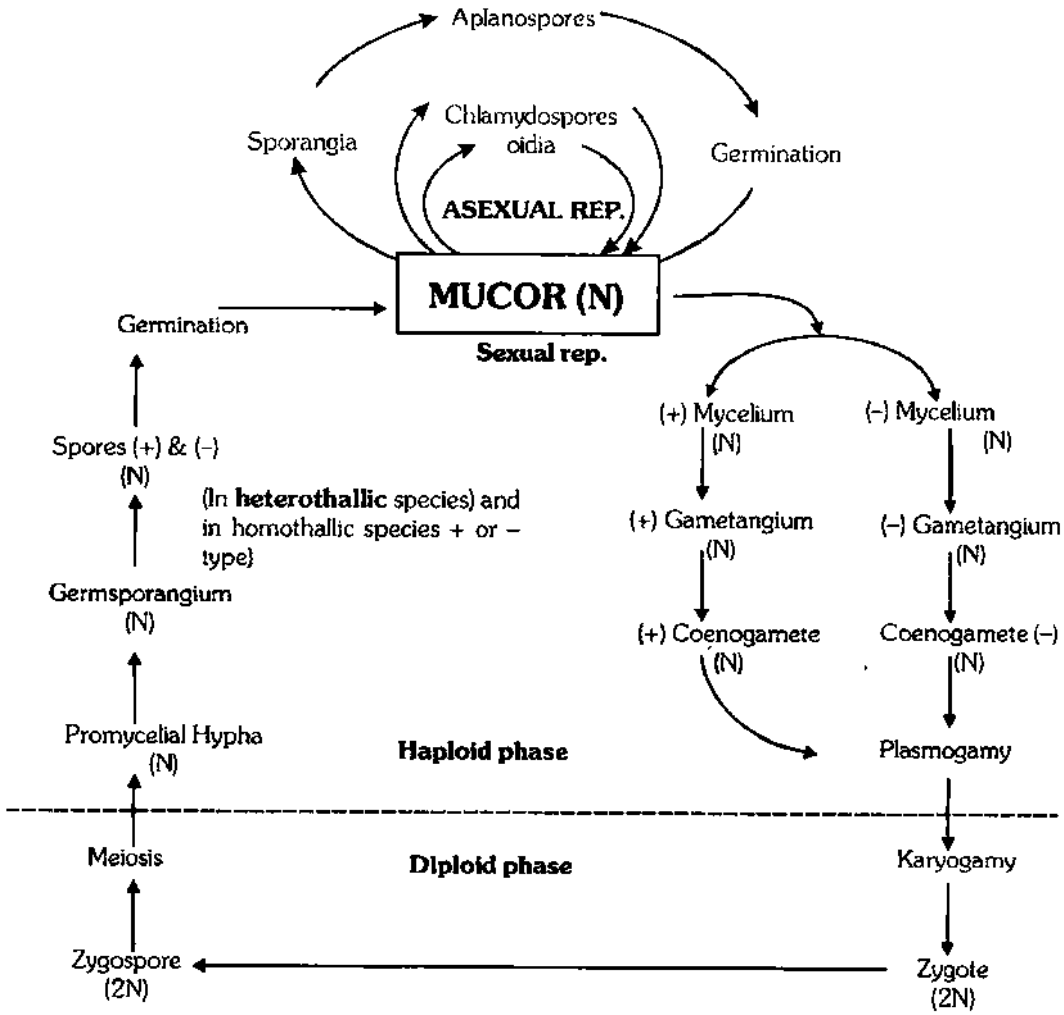
DISEASES

Rhizopus stolonifer – causes soft rot disease of vegetable crops./ **Soft rot** disease of sweat potato.
M.pusilus – infects genitalia of human beings
Rhizopus arrhizus – Causes fruit rot of apple.
R.artocarpi – fruit drop of Jack fruits.

DIFFERENCE BETWEEN RHIZOPUS & MUCOR

Rhizopus	Mucor
1. Mycelium is differentiated into three kind of hyphae-**stolons, rhizoids** and **sporangiophores.**	Mycelium is undifferentiated, i.e. it has only one kind of hyphae**.**
2. **Rhizoids present**.	**Rhizoids absent**.
3. Food material is absorbed mainly by rhizoids.	Food is absorbed by the entire mycelial surface.
4. Sporangiophores occur in tufts from the stolons opposite the rhizoids.	Sporangiophores usually occur singly from any point on the mycelium.
5. Spores easily disseminated by wind.	Spores remain **adhered to columella** and thus spores are not easily disseminated.

LIFE CYCLE – HAPLONTIC



LIFE CYCLE OF *MUCOR*

ALBUGO OR CYSTOPUS

Albugo name proposed by – De berry

SYSTEMATIC POSITION

Division	:	Eumycophyta
Class	:	Phycomycetes
Order	:	Pernosporales
Family	:	Albuginaceae
Genus	:	**Albugo or Cystopus**

Note: Albuginaceae is a **monotypic** family. It includes only single genera **Albugo**.

- It is an **obligate, inter cellular parasite**.
- It can not be grown on culture medium. It causes **"White-rust disease** in the plants of family **cruciferae** or **brassicaceae**. It shows specificity towards the host.

Etiology : - Study of causes of disease in body is called etiology.

Characteristics of White-rust diesase :

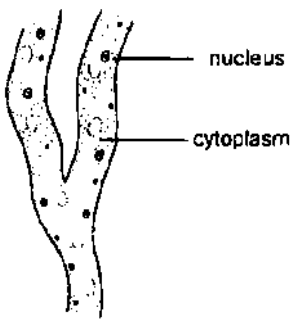
- **White pustules/white blisters** → They are usually present on **lower surface** of leaves which may also spread on the upper surface of the leaves & stems.
- The infected parts of the host become abnormal & the abnormality may be in the form of **hypertrophy**, **fleshyness** or **distortion**.

Note :

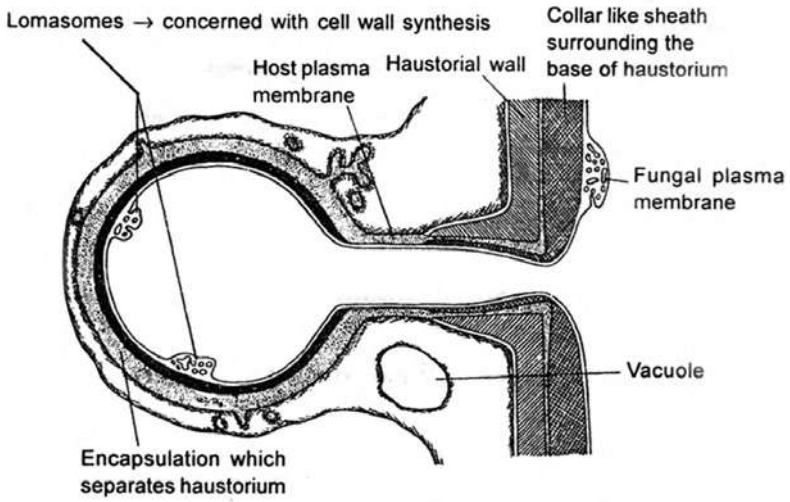
1. The main reason of hypertrophy is the formation of sex organs in the intercellular sapces of host.
2. In the presence of **less** temperature and **high moisture** white rust disease spreads vigorously. The study of sperad of disease is called **Epidemiology**.

STRUCTURE

- Mycelium is **branched, aseptate, coenocytic**. **(Septa** are only formed in mycelium **during reproduction)**.
- The hyphal wall is made up of **cellulose**.
- Reserve food material is present in the form of **glycogen and oil globules**.
- Hyphal network is found in the **inter cellular** spaces of the **host**.
- Round, **button** shaped or **knob** like and stalked **haustoria** are found in Albugo.
- With the help of haustoria it absorbs nutrients from the host cells.
- In the **apical region of haustorium** dense cytoplasm, found but **nuclei** are absent.
- The shape of haustorium have taxonomic importance.
- It's mycelium is stained by **cotton blue** and mounted by **lactophenol**.



STRUCUCTURE OF HYPHA



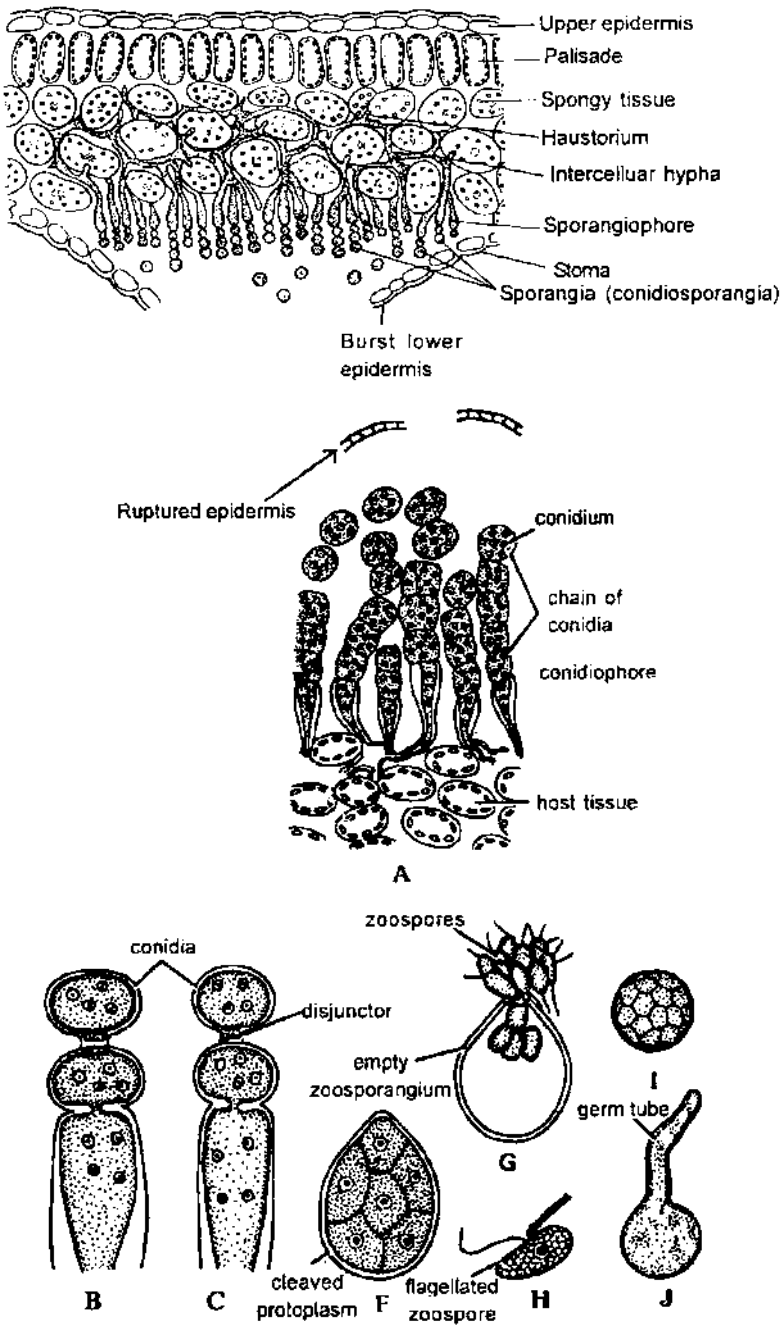
STRUCTURE OF HAUSTORIUM

REPRODUCTION

- **Holocarpic fungus : -** Where whole mycelium is utilized in the formation of reproductive structures. e.g. **Yeast.**
- **Eucarpic fungus : -** Where whole mycelium is not utilized in the formation of reproductive structure. Only few part of mycelium used for the formation of reproductive structures. Example : - **Albugo, Rhizopus, Mucor**
- **Reproduction methods**
  (1) Asexual reproduction
  (2) Sexual reproduction

1. Asexual reproduction

- It takes place by **Conidia** formation**.**
- It is a type of sporangium or zoosporangium.
- Conidium is a smooth colourless, spherical, thin walled and **multinucleated structure,** in which **3-8** nuclei are present.
- The mycelium gives rise to **erect branching**. They are usually formed towards **lower epidermis**. They are called **Conidiophore**.
- Conidiophores are **unbranched** and **club shaped** structure. Thier cell wall of the apical region is thin.
- The thin walled apical region forms the chains of conidia by **constriction technique**.
- Conidia are developed in **basipetal** sequence. It means **newly** formed conidia are present at the **base of chain** and **old** large conidia are present at the **end** of the chain.
- A **gelatinous disc** is present in between the two conidia. It is called **disjunctor.**
- This disc helps, conidia to remain in a chain. The chains of conidia grow and press the lower **epidermis**.
- This causes epidermis to **bulge out** and appears in the form of **blisters**.
- Due to more pressure, the epidermis bursts. And these conidia are spread in the form of **white powder** on the surface of leaf.



ASEXUAL REPRODUCTION

A part of vertical section of infected leaf, B-C conidium, F. A conidium with cleaves protoplasm, G. Liberation of zoospores from sporangium, H. A zoospore, I-J Germination of zoospore.

DISPERSAL & GERMINATION

- Conidia are dispersed by **air**.
- Two different types of germination takes place in favourable conditions.

(i) Direct germination :

- It takes place at **high temperature** and **low humidity** in environment. eg. **Albugo bliti**
- Conidium absorbs some water which is present on the surface of the leaf. A **germ tube** comes out fom the conidium. This tube enters inside host tissues through stomata and form **intercellular mycelium.**

(ii) Indirect Germination :

- In the presence of **less temperature** approximately **10-15ºC** and **high moisture** in atmosphere, condium germinates by (After 2-3 hours of their dispersal) **zoospores** formation.
- Conidium absorbs more water and swell up and forms **3-8 zoospores**. These zoospores are enveloped by **vesicle**.
- These enveloped zoospores are ooze out then the vesicle dissolves and zoospores become free.
- Free zoospores swim in water for few minute and finally they reaches on the surface of host, then after withdraw their flagella and round off and secretes a wall around itself.
- Deflagellated zoospores with wall germinates through the germ tube. This germ tube enter into the host tissue through **stomata** or through the **teared epidermis** and form mycelium.

STRUCTURE OF ZOOSPORES

- Zoospores of Albugo are **uninucleated, reniform** or **bean shaped** and **biflagellated.**
- Flagella are located on the **lateral side** of zoospore which are **unequal** in length.
- Out of them small the hairy flagellum is called **Tinsel or Pantonematic or Flimmergersal**.
- Another long and smooth flagellum is called **whiplash or Acronematic or peitgersal flagellum.**

(i) Monoplanetic Generation : - Only primary zoospores are formed.

(ii) Polyplanetic Generation : - In which many generation of zoospores are formed, like primary, secondary and tertiary zoospores are formed. (during high availability of water)

2. Sexual reproduction

- Sexual reproduction is **oogamous** type.
- Male and female sex organs are known as **antheridium** and **oogonium** respectively.
- In **A. candida** the sex organs are generally formed towards the **end of the growing season** of the host.
- Reproductive organs are **endogenous**. They develop in intercellular spaces, quite deep into the host tissues.
- Their presence is externally indicated by **hypertrophy** and **deformation** of the organ.

(i) Antheridium : -

- The antheridium is an elongated, **club shaped** and **multinucleated** structure.
- A transverse septum is present in its basal region. It develop on male hypha which is placed very close to the oogonium.
- There are many **(6-12)** nuclei present in a young antheridium but mature antheridium has only one **functional nucleus.**

(ii) Oogonium :

- Oogonium is **globular** in shape. The cytoplasm of oogonium differentiated into two distinct regions.

(a) Peripheral cytoplasm or Outer cytoplasm : -

It is vacuolated, spongy and diffused. It is called **periplasm**.

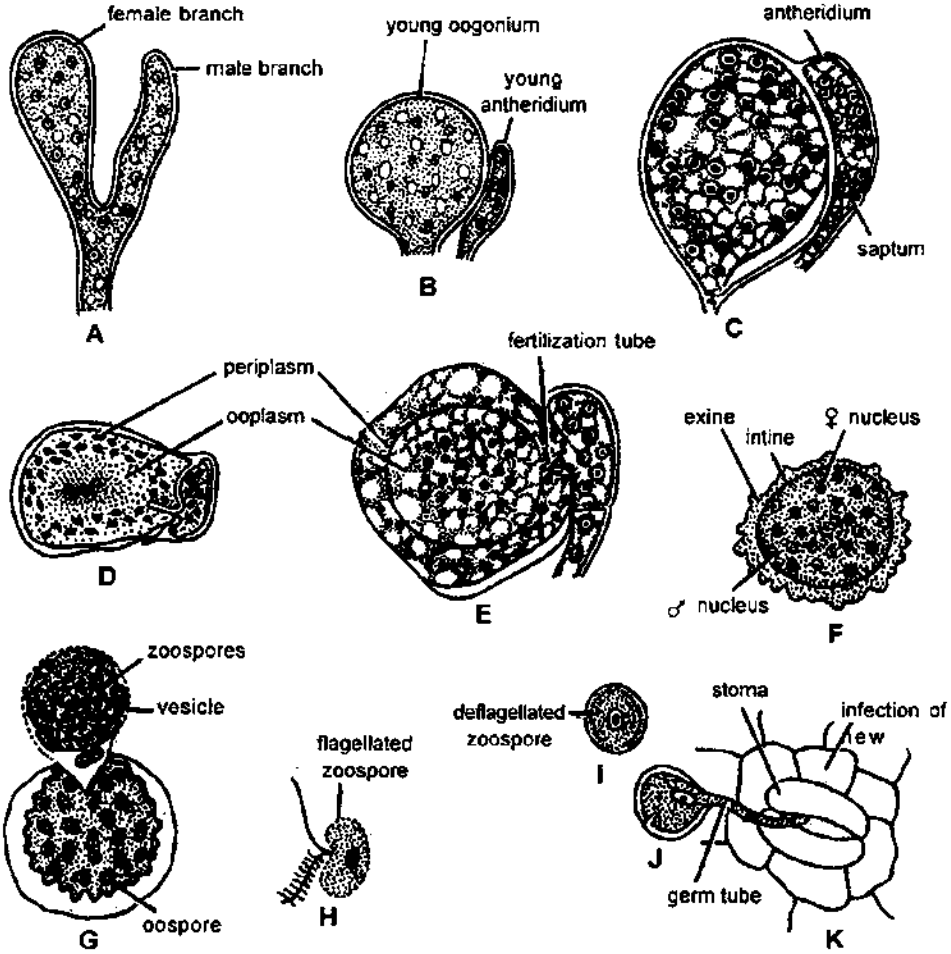
(b) Central cytoplasm : -

- It is dense. It is known as **ooplasm**.
- Both Ooplasm and periplasm are **multinucleated** in the begining but only a **single nucleus** remains in the **ooplasm at maturity** and rest of nuclei are transfered into the periplasm.

- However, some workers believe that all nuclei in the ooplasm except one disintegrate.
- A single nucleus present in the ooplasm is called **female nucleus** or **oosphere.**
- The oogonium of **A.bliti, A.portulacae** contains many female nuclei or oospheres.

Note :

- Antheridium and oogonium develops very close in the mycelium.



SEXUAL REPRODUCTION

A-C. Development of antheridium and oogonium, D-E. Fertilization,
F. Oospore, G. Gemination of oospore, H. Zoospores, I-K. Germination of zoospore.

FERTILIZATION

- A samll **protuberance** develpos from oogonium towards the antheridium. The wall of the antheridium and oogonium become thin at the region of their contact.
- This out growth stimulate the antheridium for fertilization. The inner wall of stimulated antheridium produces **fertilization tube** which enter into the oogonium and grows until reaches the oosphere.
- The terminal end of fertilization tube burst and introduces a **single nucleus** along with some cytoplasm.
- Male nucleus fuses with the female nucleus and results in the formation of **diploid nucleus**. Now it is known as **zygote**.
- Prior to fertilization a mass of protoplast is found in ooplasm. It is called **coenocentrum.** Which is formed by granular cytoplasm.

- After the fertilization, zygote secretes a thick **tri layered** wall around it self and now it is called **oospore** (2N).
- In oospore there occur **free nuclear divisions** and **32-nuclei** are formed in oospore (According to modern mycologists).
- According to **old mycologists,** the diploid nucleus of the oospore divide first by a **meiotic** division, followed by several **mitotic divisions** resulting in the formation of about **32 nuclei** in oospore.
- Oospore with **32 nuclei** is the resting stage of **Albugo**.
- In this stage it lives on dry branches in the absence of host.
- On returns of favourable conditions the 32 nuclei of oospore undergoes repeated divisions to form 100 or more nuclei.
- 100 or more zoospores are formed from these nuclei. The zoospores are released/liberated with vesicle by the rupturing of outer thick wall of oospore (formed by inner wall of oospore).
- These zoospores are coming in contact with a **suitable host** (seedling plants) settle down on the host and infect them.
- The initial stage of the disease during the growth period is called **primary infection** and it takes place through the **soil born oospores**.

POINT TO BE REMEMBERED

- According to **Stevens** all the structures of Albugo are **diploid except gamete.**
- According to **Sansome** and **Sansome** meiosis division takes place at the time of gamete formation i.e. **gametic meiosis** found in Albugo. In Albugo meiosis not takes place in **oospore.**

CONTROL OF WHITE-RUST DISEASE

1. **By crop rotation : -** Primary infection can be checked through the growing of crops one after another crops. This is the best method to control the white – rust.
2. By removal of infected plants from the field. Through this it can be eradicated.
3. **By application of fungicides –** Such as – **Bordeaux** mixture. It is composed of

   $CuSO_4$ + Lime water

   (1 : 1)

- Through the **sulphur dust** etc.
- In the absence of host **Albugo** grows on another plant **(Cleome viscosa)**. This plant grows as weeds.

Some species of Albugo : -

- **Albugo oxidental –** Infects Spinach
- **ipomoeae –** Infects sweet potato
- **bliti –** Infects Amanranthaceae family plants.
- **portulacae –** Infects portulaca plant.
- **tregopogosis –** Infects compositae family plants. eg. **Eclipta alba**

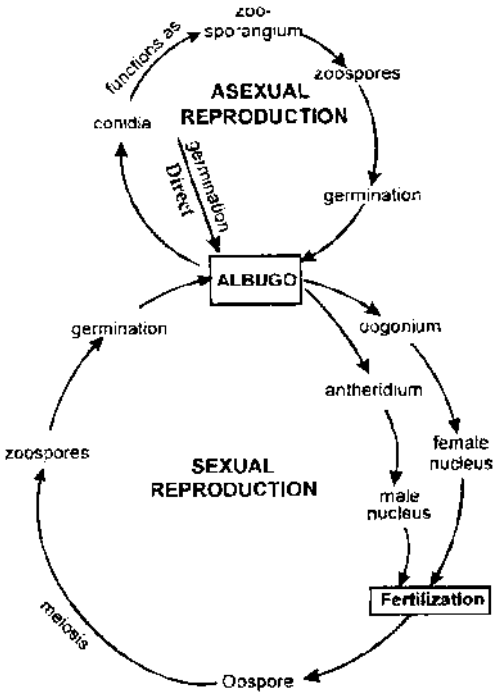
Note :

- Albugo never infects the undergound parts of the plants such as roots.
- It infects only aerial parts of the plants.

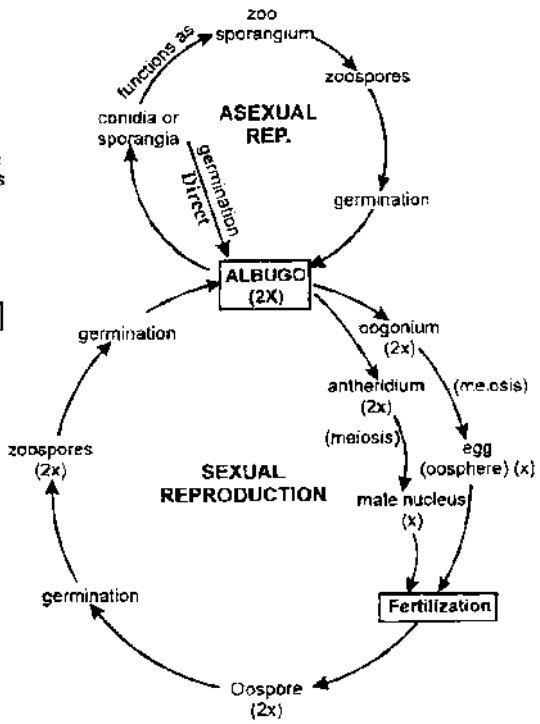
- An excessive enlargement of diseased organ due to an **excessive enlargement of cells,** called **hypertrophy.**
- **Albugo** is **autoecious** fungus. It means its whole life cycle complete in **single host**.
- **Heteroecious fungus :** - Fungus which complete their life cycle in **two different hosts**.
  Example : - **Puccinia, Primary host** – Wheat, **Secondary host** – Berberis

LIFE CYCLE

Diplontic type (according to **modern mycologists**)/ **Haplontic** (According to **old mycologists**)



LIFE CYCLE OF ALBUGO
(ACCORDING TO OLD MYCOLOGISTS)



LIFE CYCLE OF ALBUGO
(ACCORDING TO MODERN MYCOLOGISTS)

SELAGINELLA

SYSTEMATIC POSITION

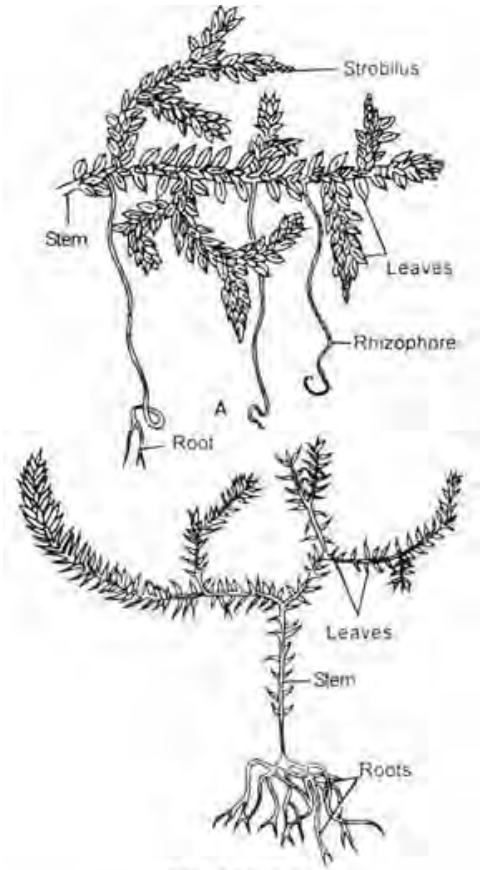
Kingdom	–	Plantae
Subkingdom	–	Embryophyta
Division	–	Tracheophyta
Sub Division	–	Ligulopsida
Class	–	Lycopsida/Lycopodineae
Order	–	Selaginellales
Family	–	Selaginellaceae
Genus	–	Selaginella

Note : Common name – [Little club moss or **spike moss]**

HABITAT & HABIT

- Mostly species are found in tropical rain forest
- The common Indian species are ***Selaginella kraussina, S. pallidissima*** and ***S.oregana*** etc.
- About 70 species are present in India.
- ***S. Oregana*** occurs on the **tree trunk** as **epiphyte**.
- ***S. pilifera, S. rupesteris*** and ***S. lepidophylla*** are the common **xerophytic species** and are called **resurrection plant.**

Note : Xerophytic species of selaginella show cespitose habit. They become ball like during dry season and again become green and fresh when moisture is available. So these are called resurrection plants. ***Selaginella bryopteris*** is known as **"Sanjivani Plant".**



SELAGINELLA
(A) S. Kraussiana, (B) S. Selaginoides

EXTERNAL MORPHOLOGY

- The selaginella is a **evergreen** delicate generally **perennial herb** (annual species **eg. *S. pygmea*** and ***S. gracilima***)
- Main plant body is sporophyte.
- Plant body is distinguished into three parts **Root, Stem and Leaves. Rhizophore** also found in some species.
- **Climber : *S. alligans*** (They possess special **discoid pads** on their **rhizophore for** climbing)

ROOT :

Primary root are **ephemeral** and the adult plant has **adventitious roots. Root hairs are unicellular.**

- These are branched with root hairs.

STEM :

Stem is green and cylindrical. Stem is prostrate and laterally branched (in some species) and **erect** and **dichotomously branched**.

- **Adventitious roots** arise from the **stem** and stem is covered by leaves.

- A structure arise from the dichotomous [bifurcation] point of stem which is colourless without chlorophyll, cylindrical, rootcap less and elongated is called **Rhizophore**

Morphological nature of Rhizophore :

- Rhizophore arises from the **dichotomous point** of stem. It is **Non-chlorophyllous colourless,** long **cylindrical** and **thread like** structure. Rhizophore term given by **Nageli.**
- It grows toward the soil and it is bifurcated. It provides **support** to the plant and help in **absorption** of **water** and **minerals.**
- Morphological nature of the Rhizophore of selaginella is still in question. The following three views about its possible nature are–

(a) Rhizophore is a Root cap less root - According to **Van Tieghem, Harvey Gibson** "rhizophore is a root cap less root" because-

(1) It is **positively geotropic** in nature
(2) It is leafless
(3) Rhizophore is monosteleic like root.

(b) Rhizophore is leafless shoot – **Pfeffer , Treub** and **Cusick, Bruchmann** etc regards rhizophore a leafless shoot because-

(1) Absence of root cap
(2) Absence of root hair
(3) It arises from bifurcation point of stem
(4) It is **exogenous** in origin

(c) Rhizophore is a newly formed organ – According to **Goebel** and **Bowe**r the rhizophore is neither shoot nor a root but organ **sui-generies.**

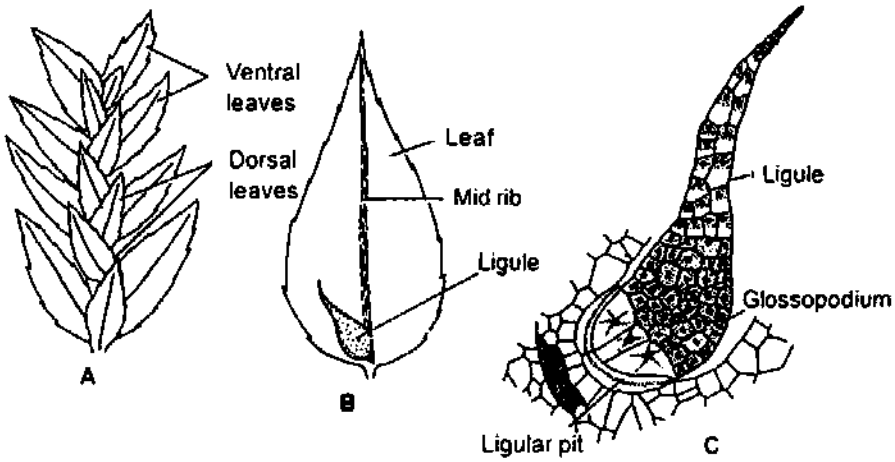
LEAVES :

The leaves of selaginella are **microphyllous**, **sessile** and **simple**. Their shape varies from ovate to lanceolate. The leaves are mostly **Amphistomatic** (Exception ***S. martensii*-Hypostomatic**)

- The vegetative leaf as well as sporophyll has a small, membranous projection on its **adaxial (upper)** surface, close to the base. This projection is known as **ligule**.
- The basal part of the ligule has a distinct **hemispherical** foot-like structure, called **glossopodium**. The ligule is embedded at the base of the leaf in a **pit-like structure** known as **ligular pit**.
- Leaves are **dimorphic** or **Heterophyllum**. The **megaphylls** are develop from **ventral/Abaxial/ lower surface** of the stem and **microphylls** develop from **dorsal/adaxial/upper surface** of the stem.
- *S.spinulosa, S.rupestris, S.pygmea* and *S.oregana* have monomorphic leaves.

Function of ligule :

- According to some scientists ligules are **associated** with water **absorption** and **secretion** and thus prevent **dessication of the shoot**.
- Ligules are concerned with **upward movement of inorganic solutes.**

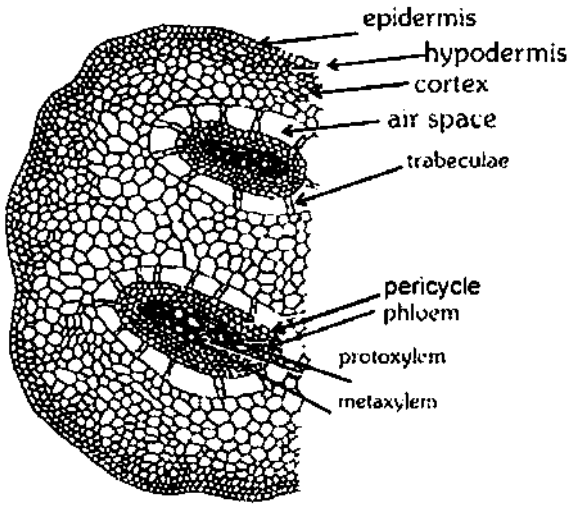


SELAGINELLA

A. Branch B. Leaf with Ligule, C. L.S. of Ligule

Special Point :

1. In ***Selaginella selaginoides*** stem protostele (haplostele) is present & mesarch condition found in vascular bundles
2. In **selaginella** stem, the metaxylem tracheids show **sclariform thickenings** and the protoxylem tracheids have **annular** thickenings.
3. A distinctive feature of selaginella stem is the presence of radially elongated endodermal cells, called trabeculae. Between these cells large intercellular spaces are present.
4. **Trabeculae** are absent in the **stem of xerophytic** species of selaginella.
5. In selaginella stem xylem usually **monarch** (*S. kraussina*) or **diarch** (*S.chrysocaulos, S. oregana*) and **exarch** (mesarch in *S. selaginoides*)



T.S OF SELAGINELLA STEM

REPRODUCTION

- The sporophyte of Selaginella reproduces **vegetatively** and by **spores**.

1. Vegetative Reproduction : It is rare in selaginella. Its occurs by following method.

1. Fragmentation
2. Resting Bud
3. Tuber
4. Apogamy

1. **Fragmentation :** It occur during moist condition.
   In ***S. rupestris***, prostrate branches produce roots during favourable conditions. These root bearing prostrate branches separate from the parent plant and grow in to new sporophytes.
2. **Resting Bud :** Terminal leaves overlapped to each other and become fleshy.
   They form resting bud. They are formed for vegetative reproduction. eg., ***Selaginella chrysocaulos.***
3. **By Tuber :** Subterranean branches of ***S.chrysorhizos*** enters in substratum. Their terminal and swollen end form tuber. During favourable condition they form new plant.

- In S. chrysocaulos aerial branch form tuber.

4. **Apogamy :** Sometime gametophyte directly develops in sporophyte. These sporophyte are haploid.

- In ***S.chrysocaulos*** and ***S.chrysorhizos,*** vegetative reproduction is occur through bulbils also.

2. Reproduction by spores

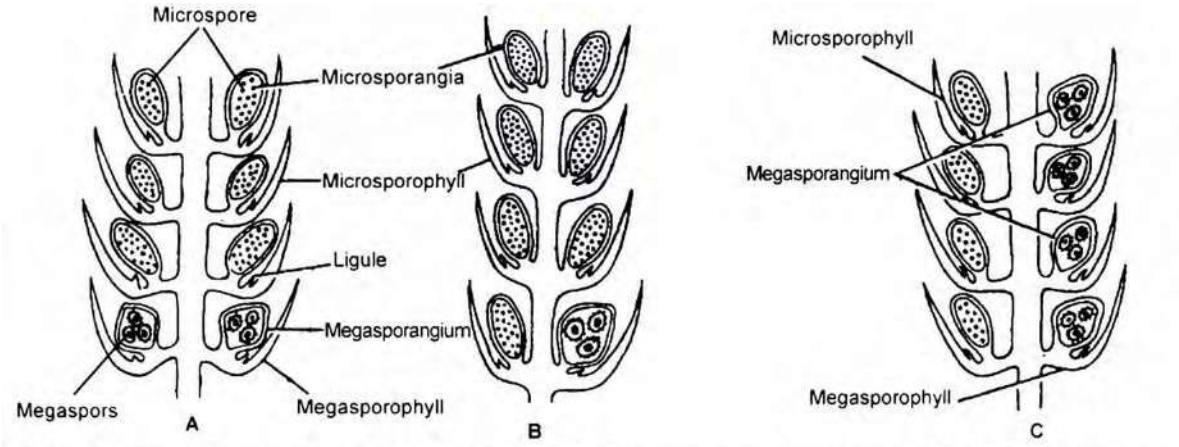
- Selaginella is a **heterosporous** Plant. It produces two types of spores – **megaspores** and **microspores**.

(i) Strobilus or cone –

- In most of the species of Selaginella sporophylls are aggregated at the apex of the main stem or lateral branch and forms compact cones, called **strobili. (Singular - strobilus)**
- The sporophylls are spirally arranged around a central axis.
- The sporangia are borne singly in the axils of **sporophylls.** The sporophyll bearing micro-sporangium is called **microsporophyll.**
- The sporangia are strictly **dimorphic.**
- There are many microspores in a microsporangium but a megasporangium usually has 4 megaspores.
- The **megaspores** form **female gametophytes** on germination and the **microspores** give rise to **male gametophytes.**

(ii) Distribution of micro and megasporangia in strobilus

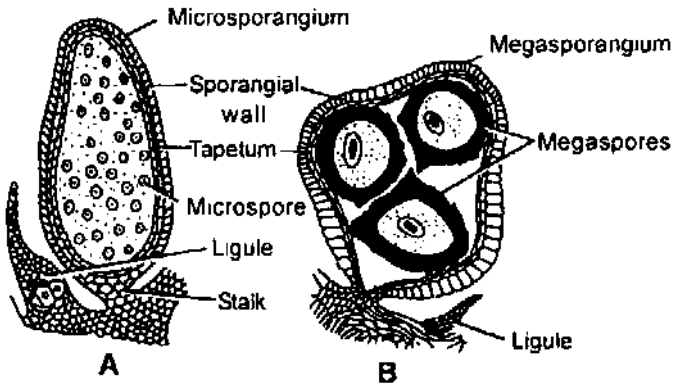
- In most of the species of Selaginella both micro and megasporangia are found within the same strobilus.



A-C. L.S of Selaginella Strobilus : Distribution of Sporophyll in different species of Selaginella
(A) S.rupestris, S. selaginoides and S. helvatica (B) S. kraussiana (C) S. inaequalifolia

- **DEVELOPMENT OF SPORANGIUM** (Eusporangiate type)

(a) Microsporogenesis : Each microspore mother cell divide meiotically to form haploid tetrad sproes in large numbers [**128 or 256**]



A. V.S. Microsporangium,
B. V.S Megasporangium

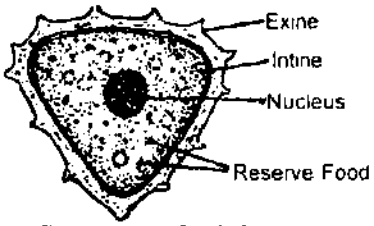
(b) Megasporogenesis:

- All the cells of megasporangium are degenerate except only one **sporocyte**.
- This functional cells is called **megaspore mother cell**. This cell divide meiotically to form **four megaspores**.
- ***S. monospora*** & ***S. rupestris*** bears only **single megaspore** in megasporangium.

• MICROSPORES AND DEVELOPMENT OF MALE GAMETOPHYTE:

1. Microspore :

- The microspores are small spherical structures, ranging **0.015-0.06 mm** in **diameter**. A microspore is surrounded by a thick ornamented exine and a relatively thin **intine**.
- The spore has a single **haploid nucleus** and **granular cytoplasm,** rich in fatty substances (about **35 %**) and **chlorophyll** absent.



Structure of a Microspore

2. Development of male gametophyte :

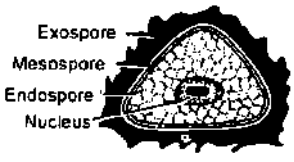
- The microspore germinate **inside the microsporangium** and shed from the microsporangium at **13-celled stage.**
- The first division of the microspore is **asymmetrical** and as a result a small lenticular **prothallial cell** and a large **antheridial initial** is established. The prothallial cell does not divide further.
- The first division of the antheridial initial is nearly at right angles to the prothallial cell. It result in the formation of two **antheridial cells** of almost equal size. Both these cells divide by a vertical wall (at right angles to the first vertical division). Thus, at this stage the gametophyte consists of five cells (**four cells** derived from the antheridial initial and **a prothallial cell**). The two basal cells, derived from the antheridial initial, do not divide further, whereas the upper two daughter cells divide repeatedly and form ten cells. At this stage the gametophytes has **13 cells**. Of these, four central cells function as **primary androgonial cells** and eight peripheral cells function as **jacket cells.**
- The male gametophyte **shed** from the microsporangium at **13-celled** stage. (**1**- prothallial cell, **4**- primary androgonial cells and **8**- jacket cells)
- The **four** central primary androgonial cells of the male gametophyte divide repeatedly forming a mass of **128-256 antherozoid mother cells** or **androcytes.** Each androcyte by **metamorphosis** converts into **a spindle-shaped/comma shaped biflagellate** antherozoid.
- With the formation of antherozoids, the jacket cells decompose and form a **mucilaginous** substance. The antherozoids float in this substance. Until this stage the male gametophyte is completely enclosed within the wall of the microspore. **The gametophyte is not set free and is dependent on the parent sporophyte for nutrition.**

Note :

1. Unlike other pteridophytes, vegetative prothallus are not formed in selaginella.
2. The **antherozoids of Selaginella** are the **smallest among the vascular plant.**
3. Development of gametophyte from spore start before dehiscence of spore, thus it is known as Precocious or In situ germination.

• MEGASPORE AND DEVELOPMENT OF FEMALE GAMETOPHYTE

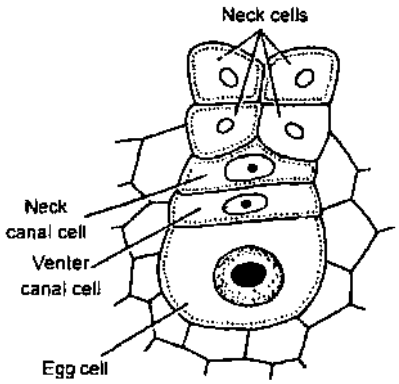
- Their diameter varies from **0.15** to **0.5** mm
- The megaspores are arranged in **tetrahedral tetrads.**
- The wall of the megaspore is differentiated into three distinct layer – the outer **exospore**, the middle **mesospore** and the inner **endospore**.
- The megaspore has a single haploid nucleus, surrounded by granular cytoplasm rich in fatty substances (about 48 %)



Megaspore

- The development of **female gametophyte** starts even when the megaspore remain present in the **megasporangium.**
- By repeated **free nuclear division** followed by cell wall formation female gametophyte is differentiated into upper region called **female prothallus** and lower region called **storage region** which are separated **by diaphragm**.
- A functional cell of the female prothallus acts as **archegonial initial.**

  Note : The mature archegonium of Selaginella has long neck (consisting of eight cells, in two tiers of four cell each), **a neck canal cell, a venter canal cell** and **an egg.**



V.S. of Mature Archegonium

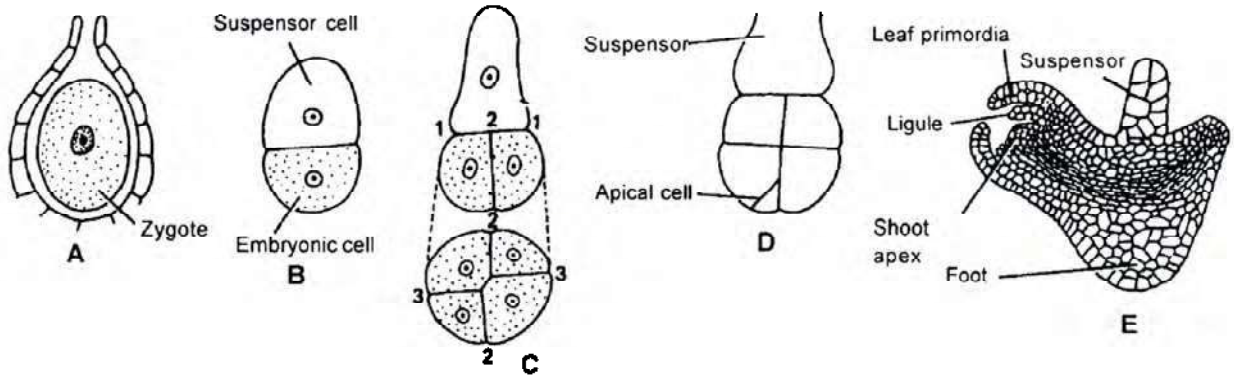
FERTILIZATION

- Fertilization usually takes after the female gametophyte has fallen in the soil but in some species (e.g. ***S. rupestris***) it may occur while the female gametophyte is still with in mega sporangium.
- **Water** is essential for fertilization. Just before the fertilization the neck and ventral canal cell disorganize and to form a **mucilage** which contain some **chemotactic** substances.
- Many **biflagellated antherozoids** enter into the neck of archegonium by chemotactic movement and one antherozoid fuse with the egg, resulting in the formation of **zygote**.

Note : In few species like ***S. rupestris*** archegonia are fertilized when enclosed in the **megasporangium** which is attached with spike hence approach towards the **seed habit** of Angiosperm. **Heterospory** is a **pre-requisite** condition for the **seed habit.**

EMBRYO DEVELOPMENT

- The diploid zygote is the mother cell of the sporophytic generation.
- It divides transversely, establishing an **epibasal** (upper) **suspensor cell** and a **hypobasal** (lower) **embryonic cell.** As development proceeds, the suspensor cell repeatedly divides to form a **suspensor,** which pushes the developing embryo **deep into the female gametophyte.**
- The rest of the embryo develops from the **embryonic** cell. It divides by **two vertical wall** at right angles to each other and thus a **four-celled** embryo is formed. In these, one cell divides by an **oblique vertical** wall and thus an **apical cell** with three **cutting faces** is established. This eventually functions as the **apical** cell of the **embryonic** shoot.

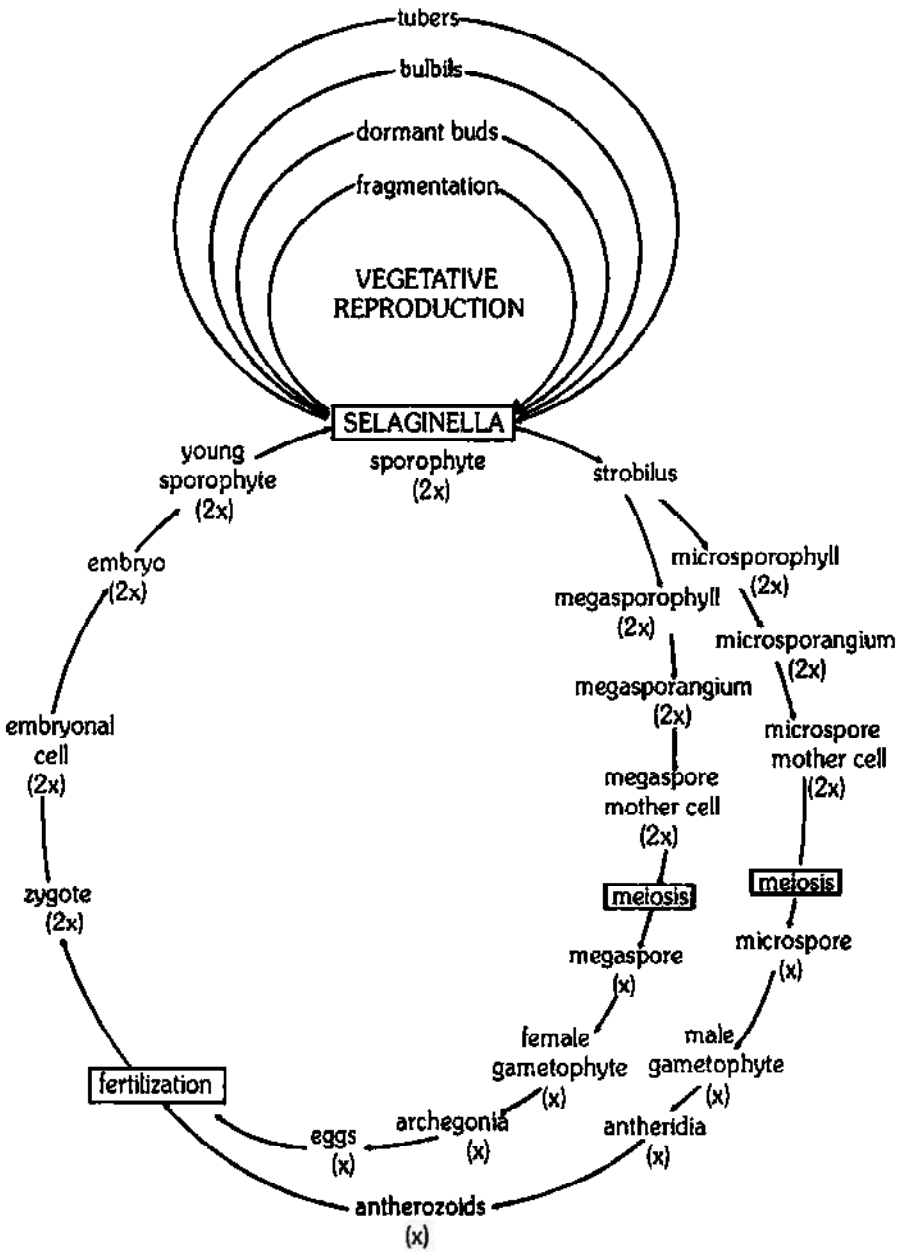


Stages in Embryo Development

- The remaining three cells of the 4-celled embryo and the **sister cell** of **the apical cell** divide **transversely** to form **two tiers** of four cells each.
- The cells of both the tiers divide irregularly, forming a multicellular embryo. Usually the cells of the lower tier divide more rapidly than the upper tier.

- The derivatives of the lower tier form the foot. The foot acts as a **haustorial organ;** its main function is to **absorb nutrition** for the **developing sporophyte** from the **female gametophyte**.
- Two cells of upper tier acts as apical cell of cotyledon and forms two ligulated cotyledon.
- The part of the embryo posterior to cotyledons develops into **hypocotyledonary part** of the stem. The stem grows with the help of the apical cell of the embryo.
- After the formation of **cotyledons** and **stem,** the apical cell of the root differentiates on the lateral surface of the foot. The derivatives of this cell develop into a root-like structure, called **rhizophore.** Roots, infact, develop at the apex of the rhizophore.
- In **early stages of development** the **young sporophyte** is attached to the **megaspore** and derives its food from the female gametophyte with the help of its foot. But after the establishment of root and stem, the sporophyte becomes **independent.**

LIFE CYCLE : DIPLO-HAPLONTIC



Life Cycle (Schematic Representation)

Note :

1. Selaginella is the only living genus in selaginellaceae family.
2. In ***S.intermedia***, microspore is not formed, embryo develops **parthenogenetically.**
3. Stele of Rhizophore and root is **monarch** and **exarch**
4. **Distele** is found in stem of ***S.christina***
5. **Meroblastic development** takes place in embryo of selaginella
6. Lycopodium is called **"Botanical snakes"** or **snakes of plant kingdom.**
7. **Cyathea, Dicksonia** & **Alsophila** are peculiar fern having tree habit.
8. **Rhynia** is a **fossil pteridophyte**
9. **Telome theory** for origin of plant body in pteridophyte was proposed by **Zimmerman**
10. Ovule absent in all Pteridophyte.
11. **Adiantum** is called **"Walking fern"** or **"Maiden hair fern"** and **chelanthum** is called **"Silver fern"**
12. Development of sporangium of selaginella is **"eusporangiate"**
13. Xerophytic species of **Selaginella** (e.g. **S. rupestris**) called as "Bird's nest moss".
14. When two different sex organs are born in different group but on the same head this condition is called **paroicous**.
15. In ***S. selaginoides*** the **parenchymatous** cells of the **cortex** show **mycorrhizal association.**
16. In **Rhizophore** of ***S.Kraussiana*** the xylem is **centrifugal.**
17. In leaves of selaginella stomata are distributed mostly in the **midrib region**. A **mesophyll cell** has **1-8 cup shaped chloroplast,** which have many **spindle shaped pyrenoid** like bodies.
18. Selaginella, Marsillia, Isoetes, Salvinia, Azolla etc. are heterosporous plant.

PTERIDIUM (MONOTYPIC GENUS)

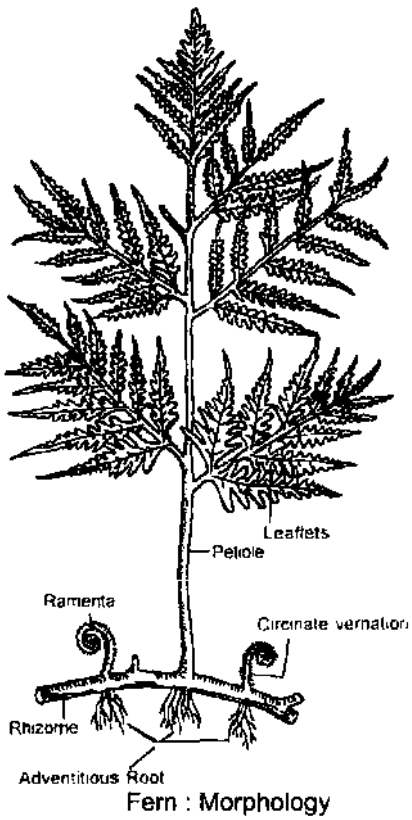
SYSTEMATIC POSITION

Kingdom	–	Plantae
Sub Kingdom	–	Embryophyta
Division	–	Tracheophyta
Class	–	Pteropsida
Sub Class	–	Filicineae
Order	–	Filicales
Family	–	Polypodiaceae
Genus	–	Pteridium
Species	–	Aquilinum

Common name – " Sun Fern" or "Bracken Fern"

HABIT AND HABITAT

- Ferns are commonly grow in **moist** and **shady** places. This is present throughout world except South America and Antarctica.
- They shows '**gregarious**' habit. This habit is due to **vegetative reproduction.**
- It can be grown in the presence of **less moisture** and **high light,** so it is called **"Sun fern**". It is xerophytic plant. It is pioneer plant after forest fire.



Fern : Morphology

EXTERNAL MORPHOLOGY

- The plant body of Pteridium is **sporophytic** and it is differentiated in **root, stem** and **leaves**. Root and stem are underground and leaves are aerial. Plants are **perennial.**

I. ROOT :

- The primary root is short lived. It is soon replaced by **adventitious** roots which develop from the **rhizome** in **Acropetal** manner.
- The adventitious root are thin, small, soft and less branched.
- They are endogenous in origin

II. STEM (Rhizome)

- The stem of fern is **underground rhizome**.
- Rhizome grows **horizontally** in the soil. The main stem is **dichotomously** branched.
- The young rhizome particularly covered by multicellular brown hairs called as **ramenta.**

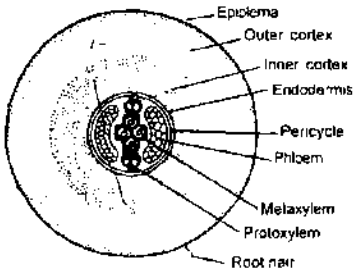
III. LEAVES :

- Pteridium is a **megaphyllous** plant. It's large leaf is known as '**frond**'. leaves are borne only on small branches

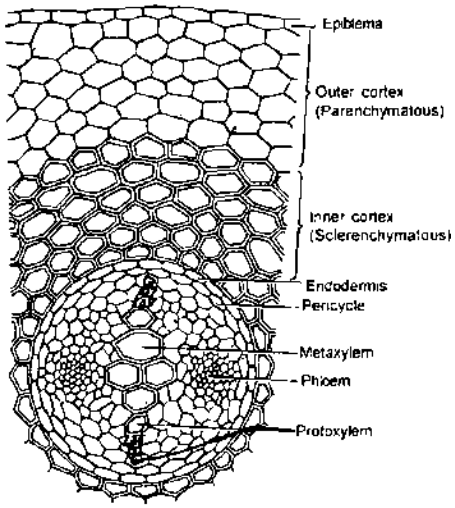
- The leaves may be 2-12 feet long (height) and in each leaf, the petiole and lamina are almost equal in length. They are developed on rhizome in **alternate** manner.
- Leaf lamina is divided into number of **leaflets.** The leaves are **compound, bipinnate and imparipinnate.**
- The young leaf shows typically **open furcate venation.** (The bifurcation of veinlets without attachment, at the anterior end is called open furcate venation).
- In these leves, the young leaves of Pteridium are curled. **Circinate ptyxis"** is found. Each young leaf open from the base to apex. Ramenta are also present on young leaves.

INTERNAL STRUCTURE OF ROOT

- In the transverse section the root appears approximately like a dicotyledons root.
- The outermost layer is called **epiblema.** It possesses unicellular root hairs.
- Below the epiblema there is broad cortex is present which is differentiated into two zones.
- **Outer cortex** which is made up of **parenchymatous** cells.
- **Inner cortex** which is composed of **Sclerenchymatous** cells.
- In the centre a stele is present which is surrounded by single layered **endodermis**. Below the endodermis **pericycle** is present which is **one** or **two** layered and medeup of thin walled **parenchymatous** cells.
- The **stele** is **diarch** with two xylem bundles alternating with two pholem bundles.
  The xylem is **exarch** in position. The xylem is without vessels and phloem lacks **companion cells.**
  Secondary growth is absent in fern roots.



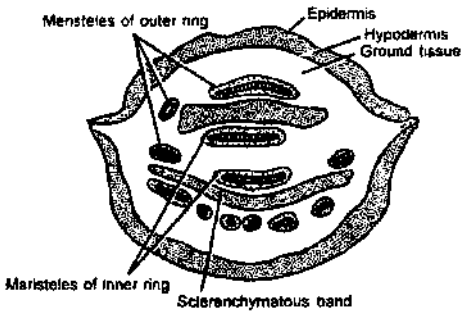
(Pteridium : T.S. of Root Internal Structure)



(Pteridium : T.S. of Root-Out line diagram)

INTERNAL STRUCTURE OF RHIZOME :

- In a transverse section the rhizome of **Pteridium** appears somewhat **oblong** being flattened dorsiventrally
- The outer layer is termed as **epidermis**. Inside the epidermis, three-four layers of **sclerenchymatous hypodermis** is present. which is **broken** at **two** ends (Points). At these points, the parenchymatous cells of ground tissues reaches directly up to the epidermis.
- Hypodermis is followed by parenchymatous **ground tissues** in which two rings of **meristeles** are present. The stele is **polycylic dictyostele** or **polystele** or Dictyostele type.
- Both the rings of meristele are separated by **two plates** of **sclerenchyma** in dorsiventral position.



T.S. of Rhizome

- The meristeles of outer ring are smaller in size and more in number, while there are two or three large meristeles are present in inner ring .

MERISTELE :

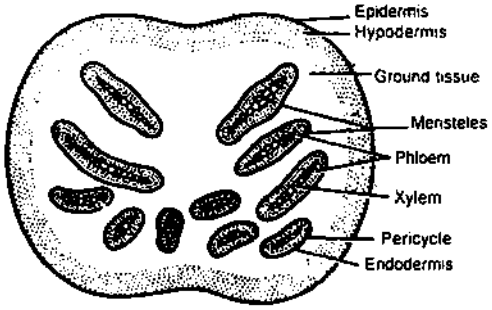
- Each meristele is surrounded by a single layered endodermis.
- Below the endodermis one or two layered parenchymatous pericycle is present.
- Xylem forms the central core of the meristele, which is **Mesarch** in position i.e. protoxylem is surrounded by metaxylem.
- Vessels in xylem and companion cells in phloem are absent.
- In meristeles vascular bundles are **concentric** and **amphicribral** or **hadrocentric type.**
- Pseudo vessels are formed due to disintegration of septum from meta xylem tracheids.
- Meristele is a complete stele because it has its own pericycle, endodermis, Xylem and phloem.
- **Secondary growth is absent in rhizome due to absence of vascular cambium.**

INTERNAL STRUCTURE OF LEAF :

It is differentiated into rachis and leaflet (pinnules).

(1) Rachis : In a transverse section the young rachis is hemispherical in shape.

- The outermost layer is **epidermis.**
- Below the epidermis a few layers of thick walled cells forms the **sclerenchymatous** hypodermis.
- Many meristele are arranged in the mature rachis of **Pteridium** in **horse-shoe shaped**.

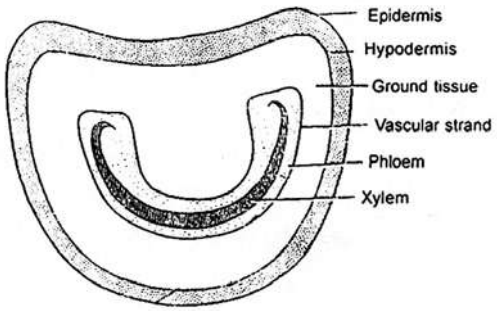


Internal Structure of Mature Rachis

- In each meristeles vascular bundles are **concentric, amphicribral** and **mesarch.**

(2) Leaflet pinnules :

- Mesophyll is present between two epidermal layers and mesophyll differentiated into palisade and spongy tissue.
- The stomata are present on lower epidermis.
- The epidermal cells of leaflet also bears **chloroplast. Concentric** vascular bundles are present in **Pteridium** leaflets.



T.S. OF YOUNG RACHIS

Note :

1. In **Dryopteris leaf,** mesophyll is not differentiated into palisade and spongy tissue.
2. In **Dryopteris** leaf **bicollateral** vascular bundle are found in **large veins** where as in **small veins collateral** vascular bundle are present.

REPRODUCTION

- Three different type of reproduction – **Vegetative, by spore formation and sexual,** are found in Pteridium.
- The main plant body represents sporophytic phase and reproduces by **vegetative** and **by spore formation.**
- **Sexual reproduction** only takes place in **gametophytic phase** i.e. in the **prothallus.**

1. VEGETATIVE REPRODUCTION :

(1) By death and decay method :

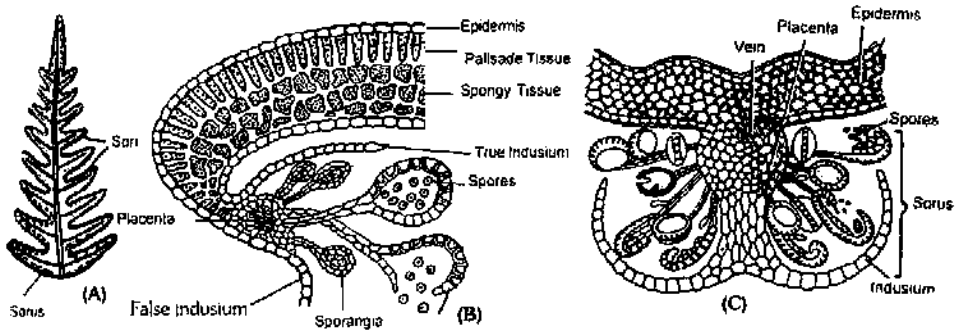
- Vegetative reproduction takes place through **rhizome in Pteridium and Dryopteris.**
- The rhizome is **dichotomously** branched and grows indefinitely. When the death and decay of rhizome reaches upto the point of dichotomy, both the branches are separate and each grows into a new plant.
- This method is responsible for the **gregarious habit** of plant.

(2) By adventitious buds : Sometimes a **bud** is formed in the axis of **persistent leaf base.** These buds separate and grow into a new plants

(3) By spore formation :

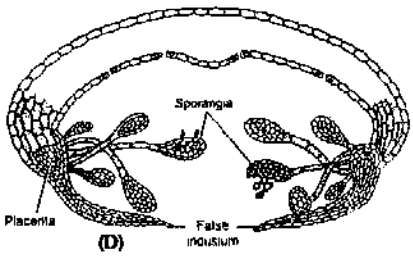
- The main plant body of **Pteridium** is **sporophytic** and **reproduces** by the **formation of spores.**
- The spores of pteridium are of one type and this condition is termed as **homospory**.
- **Leaflet / fronds** at maturity bears small, rounded, reniform, brown or black coloured spots called **sori**. Sori bearing fronds are called as **sporophyll.** The sporophylls of **Pteridium** are **photosynthetic** in nature.
- **Each Sorus** is protected by a covering sheath called **indusium** (bilipped) which may be true or false on the basis of origin.
- A **true indusium** (Inner and small) arise from the **placenta** whereas **false indusium** (outer and large) does not arise from the placenta but it is formed by **curved margin** of the **sporophyll.**
- The main function of **indusium** → Provide protection to sori (Singular – sorus).
- Each sorus bears large number of sporangia and each sporangium produce many spores.

Position and Form of Sori :



(B) V.S. of *Pteridium* Sporophyll Through sorus region

(C) V.S. of *Dryopteris* Sporophyll Through sorus region



(D) V.S. of *Pteris* Sporophyll Through sorus region

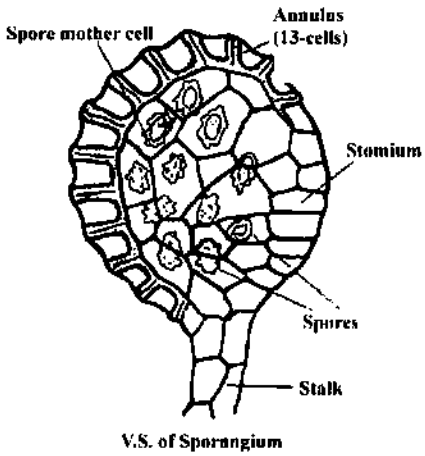
- Each sporangium develop on the **abaxial (Lower)** surface of the leaves
- These sporangia arises in the groups i.e. in the form of **sori.**
- These **sorus** develops continuous, linearly arranged along under the margin of leaves is termed as **continous linear sorus** or **coenosorus**
- Those sorus lies on the margin of sporophylls termed as **"marginal sorus"**

- Inner indusium is small and true and it is arises from the placenta.

Note :

1. First of all **Bower** studied the development of **sorus.**
2. Pteridum is a **laptosporangiate** type fern. It means each sporangium develops from a single initial cell.
3. In **Adiantum, Pteridium & Pteris** sori are marginal but in **Dryopteris** and **Nephrolepis,** sori are arranged in two rows, one of either side of mid rib/vein
4. In **Adiantum** and **Pteris** false indusium is found whereas in **Dryopteris** and **Nephrolepis**, true indusium is found

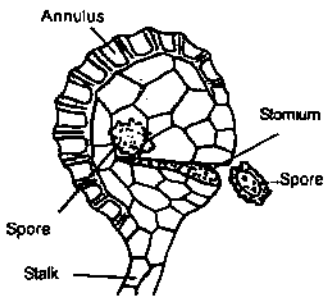
STRUCTURE OF SPORANGIUM



V.S. of Sporangium

- A sporangium has a long narrow, slender, multicellular **stalk** usually composed of **three vertical rows** of cells and a sporangial body or **capsule.**
- The capsule is **oval** or **biconvex (generally)**.
- The radial and inner walls of the cells of specialised row of jacket becomes heavily thickened while their outer tangential wall remains thin.
- These cells constitute the **"annulus"**. It starts from the base of the capsule on one side, run upwards curve on the other side and ceases almost near the middle.
- Annulus covers **3/4 part of the sporangium.** Below this, the cells of marginal row are thin walled and parenchymatous, consititute the **stomium**.
- The annulus and stomium together help in dispersal of spores and dehiscence of sporangium. Sporangium break at the place of stomium during dehiscence of sporangium.
- The cavity of capsule contain **8 or 16 spore mother cells** or **sporocyte** which is **diploid**.
- Spore mother cells divide meiotically to produce **32** or **64** haploid spores.

Dehiscence of sporangium :



Dehiscence of Sporangium

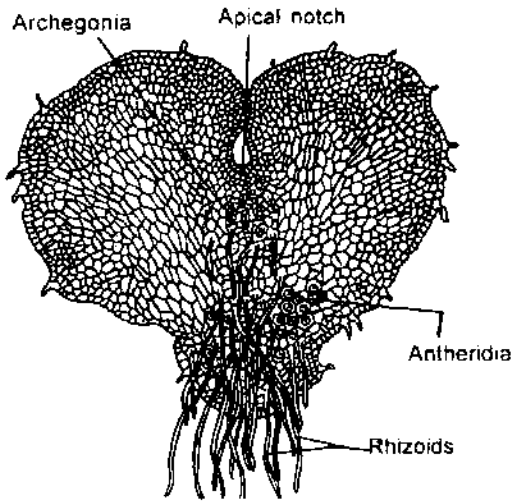
- Dehiscence of sporangium takes place in **dry season**. When the sporangium mature, the indusium dries and shrivels exposing the sporangia to dry air.
- In dry weather, the annulus Cells of the sporangial wall loose moisture, dries up and **shrink.** The radial and tangential walls of annulus are thick so they do not shrink or bend easily. But **outer wall** of **annulus** is mainly **thin** which curve **inwards** and becomes **concave**. This inwards curving of the thin walls exerts pulling force on **annulus** cells.
- Due to this **pulling force** (tension) thin cells of stomium tear up. So that a **fissure** once started from region of stomium and ultimately reaches up to the base of annulus on the opposite side of stomium.
- Due to the pulling force the **entire annulus** turns into the back side. Along the annulus most of the spores are attached. The space which is created by loss of water is filled **by air** and saturate. Because of this **pulling force** suddenly released from the annulus and annulus immediately comes in original position with a great force. The spores are attached on annulus, during this time, are thrown away. Dispersal of spores in **Pteridium** by **"Catapult mechanism"** (By annulus).

SPORES

- The gametophytic phage begins with the formation of spores which are **tetrahedral.**
- The spore wall or coat is usually two layered. **The outer layer** which is brown in colour called **exosporium** or **exine.** It is thick and ornamented. The inner layer is thin and delicate. It is termed as **endosporium** or **intine**.

Prothallus :

- Under the favourable conditions of moisture and temperature the spores germinates.
- A gametophyte plant prothallus is produced by germination of spore. Prothallus is a **heart shaped** structure
- The prothallus is thin, delicate flat short lived and **dorsiventral** structure. Initialy prothallus is uniseriate thick but later on maturity it become multiseriate.
- It is **independent** and **autotrophic**. It is free from the sporophytic generation. It is **unbranched**. Diameter of adult prothallus is **3-8 mm**.
- It grows prostrate on the soil. The middle region of the prothallus is thick and, thin towards the marginal side. An apical notch is present at the anterior end.



Ventral Surface of Pteridium Prothallus

- A apical cell is present in the apical notch, by which growth takes place in the prothallus. It is **nonvascular.** Unicellular and unbranched **rhizoids** are located on the ventral surface of the **prothallus.**
- They fix the prothallus with the substratum (soil). Sex-organs are developed on the ventral surface of the prothallus. Prothallus is **monoecious** which bears both sex organs –**Antheridia** and **Archegonia**
- Archegonia borne on prothallus near the apical notch, while the antheridia are developed in the posterior region in between the rhizoids.

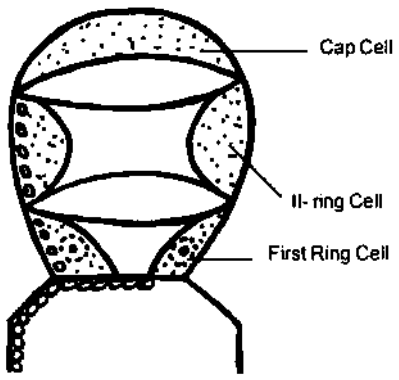
Main point

(i) Antheridia matures before the archegonia ie, prothallus is **protandrous.**

(ii) Always, cross fertilization takes place in **Pteridium (Heterothallism).**

ANTHERIDIUM :

- Antheridium of **Pteridium** is simpler than **Riccia**. The presence of antheridium is the primitive character.
- Antheridium of **Pteridium** is a small **sessile** spherical structure.
- The jacket of the antheridium is composed of three cells. The two cells of the jacket lying one above and the other forming the base.
- The lowest and middle cells are called **I-ring cell** and **II-ring cell,** respectively. The upper or apical cell is called **cap cell** or **operculum** forming the top portion of the jacket.



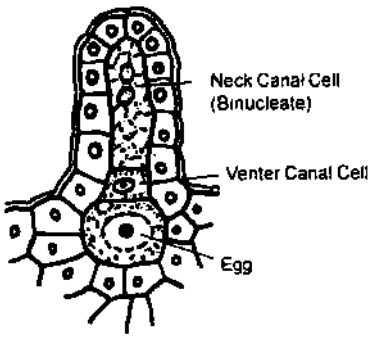
V.S. of Antheridium

- Inside the antheridium there are **20-50 androcytes** or **antherozoid mother cells** are present which are responsible to form **spirally coiled multiflagellate antherozoids.**

- Dehiscence of antheridium takes place in the presence of **water.**
- When the antheridium fully mature and water is available, its mucilage which is present in the cavity of antheridium, absorb moisture and swells up, resulting, the opening of the lid like cell at the top.
- The antherozoids liberated and after coming in contact with water, they swim freely.

Archegonium :

- Archegonium is a **flask-shaped sessile** structure. Its swollen venter embedded in the tissue of prothallus and short curved neck projecting above the prothallus. Jacket is only found in neck region. Jacket of neck region is made up of **four vertical rows** of neck cells.
- The venter has a large **ovum** or **egg** and a small **venter canal cell.**
- In the cavity of the neck there is a **single long neck canal cell** which is usually **binucleated**. **Cover cells are absent** at the apex of neck.



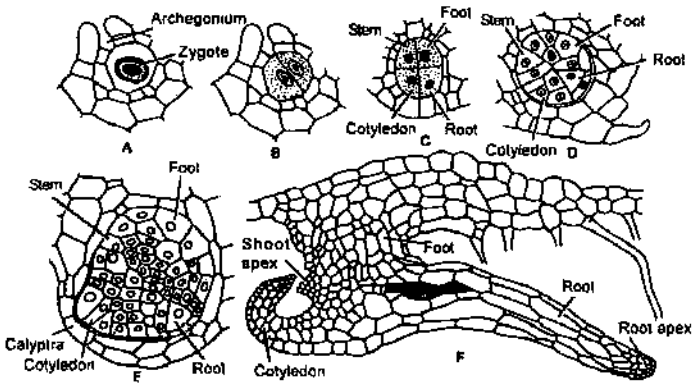
V.S. of Archegonium of Pteridium

FERTILIZATION

- Fertilization takes place in the **presence of water.**
- Just before the fertilization the **venter canal cell** and **neck canal cell** of the archegonium disintegrate forming a mucilagenous substance which absorbs moisture, resulting the opening of mouth of the neck.
- Some of the mucilage oozes out at the tip of the archegonium and attracts the antherozoids on account of certain organic substance like **malic acid** present in it.
- As a result of **chemotactic** response and lashing movement of cilia, some of the antherozoids enter the archegonium and ultimately one of them fuse with the egg. This fertilized egg is termed **oospore** or **zygote**.

Embryo and its development :

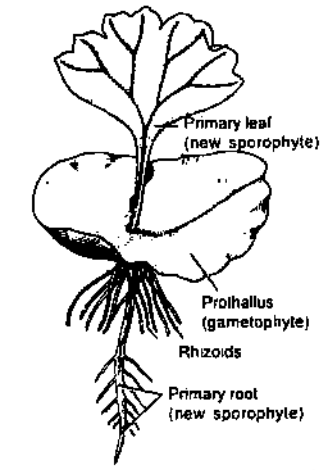
- Zygote (oospore) is the first cell of the sporophytic generation.
- The oospore **first divide** by a **vertical** division nearly parallel to the long axis of the archegonium, which divide the oospore into two half an **Anterior** or **epibasal** cell (lying the notch of prothallus) and posterior cell or hypobasal cell (lying towards the posterior end). Second division is also vertical but right angle to first one so that four-celled embryo is formed.



A. ZYGOTE, B-F STAGES IN THE DEVELOPMENT OF EMBRYO

- There are **two epibasal** or **anterior cells** and **two hypobasal** or **posterior** cells. This stage known as **quadrate stage.**
- Third division is **transverse** and therefore eight cells are formed. This is known as **octant stage.** Therefore, two **inferior hypobasal cells**, two **inferior epibasal** cells, two **superior epibasal cells** and two **superior hypobasal cells** are formed.

- The superior epibasal cells gives rise to **apical bud** of the stem.
- Both **inferior epibasal cells** give rise to **cotyledon.**
- Both the **superior hypobasal cells** giving rise to the **foot**. Foot is embedded in the prothallus and help in providing nourishment to the embryo. The young sporophyte depends upon **gametophyte**.
- Both the **inferior hypobasal** cells gives rise to radicle. The radicle grows first and pierce into the soil and form the **primary root.** Firstly, the primary root comes out from the prothallus but it is short lived. It soon dies and is replaced by **adventitious root** developed from the stem.
- The cotyledons and apical bud of stem comes out in air from the lower surface of the gametophyte. Plumule grows immediately to form an underground **rhizome.** Foot and prothallus dies later on.

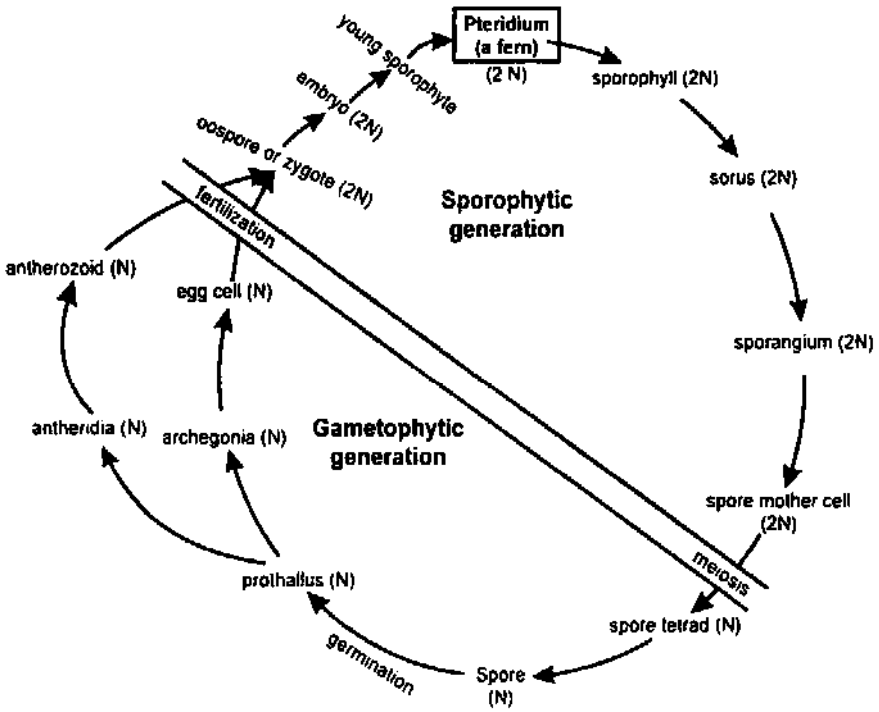


YOUNG SPOROPHYTE DEPENDS UPON GAMETOPHYTE

Note :

- **Lateral polarity** is exhibited by the embryo of **Pteridium.**
- The venter of the archegonium forms a protective covering, called calyptra, around the developing embryo. Its is haploid and part of gametophyte.
- **Primary leaves** are simple and lives for one year and later it dies off. Later on special leaves arises from the rhizome. New leaves are developed each year, new leaves are compound and pinnate.
- Old leaves left the **leaf base.** If **10** leaf base are present in **Dryopteris** then the age will be **11 years.** Because in first year plant bears simple leaves.

ALTERNATION OF GENERATION



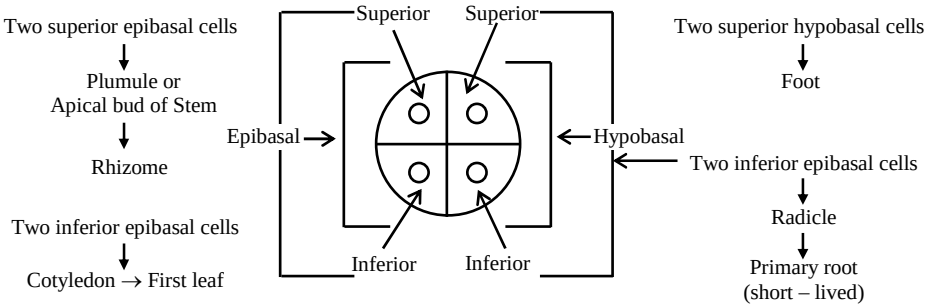
LIFE CYCLE OF PTERIDIUM

- Independent alternation of generation is found in **Pteridium.**
- In its life cycle two independent phases are present. Out of them one is main plant which is sporophyte. This reproduce through spore formation.
- A haploid gametophyte plant body **prothallus** develops from the germination of spore.
- Gametophytic generation begins from the spores till the formation of the gametes.
- Sporophytic generation begins with **zygote or oospore** formation. Spore mother cells are last cell of sporophytic generation. Spore is the first cell of gametophytic generation.
- The life cycle of **Pteridium** is known as **Diplo-haplontic type.**

IMPORTANT POINTS

- **Dryopteris filix – mas :** Male shield fern / Beech fern / Hay scented fern.
- Sympodial branching found in **Pteridium** rhizome
  Branches are three types in pteridium.
  Long shoots, Short shoots, Intermediate shoot. Short shoots bear fronds.
- In **pteridium**, at the base of each leaf let a **nectary** is present
- Main feature of ferns :

1. Presentce of ramenta on young leaf and rhizome
2. Circinate ptyxis of young leaf.

- In Zygote / oospore of Pteridium and Dryopteris : Ist and IInd division are vertical but IIIrd is transverse.
- In **Dryopteris** & **Pteridium** roots are **Diarch**.
- In **Dryopteris** rhizome meristeles are arranged in **one ring** whereas in **Pteridium** rhizome meristeles are arranged in **two rings**.
- **Pteridium, Dryopteris, Psilotum, Equisetum** and **Nephrolepis** are **homosporous** plant.
- **Heteromorphic alternation of generation** is found in **Pteridium, Funaria** and **Dryopteris** etc.
- **Pteridium, Adiantum, Nephrolepis** (Sword fern) & **Dryopteris** etc are **leptosporangiate** fern.
- 

- **Megaphyllous pteridophytes** – With large pinnatified leaves having a complex series of vein. They form prominent leaf gaps in the stem stele.
  eg. **Pteris, Pteridium and Dryopteris.**
- Tapetum cells are present in sporangium of pteridium which provide nutrition to sporogenous mother cell. It is Diploid.

CYCAS

SYSTEMATIC POSITION

Kingdom	→	Plantae
Sub kingdom	→	Embryophyta
Division	→	Tracheophyta
Class	→	Gymnospermae
Subclass	→	Cycadophyta
Order	→	Cycadales
Family	→	Cycadaceae
Genus	→	**Cycas**

Common name : **Sago palm** or **palm fern.**

- Cycas is the most widely distributed genus of the order Cycadales. There are about 20 species which occur in wild state in China, Japan, Australia, Africa, Nepal, Bangladesh, Burma and India. Four species of Cycas – ***C. circinalis, C. pectinata, C. rumphii and C. beddomei*** – occur in natural state in India, chiefly in Assam, Orissa, Meghalaya, Andaman and Nicobar Islands, Karnataka and Tamil Nadu. ***C. revoluta*** and ***C. siamensis*** are widely grown in gardens.
- ***C. rumphii* –** This species occurs in Andaman and Nicobar Islands.

ECONOMIC IMPORTANCE

- The juice of young leaves of ***C. circinalis*** is used as remedy for disorders of stomach, flatulence, blood vomiting and skin diseases.
- Decoction of young seeds of ***C. circinalis*** is purgative and emetic.
- Pollen grains of some species of Cycas are strongly narcotic, and microsporophylls of ***C. rumphii*** and ***C. circinalis*** are used as painkiller.
- A tincture prepared from the seeds of ***C. revoluta*** is used to relieve headache, giddiness and sore throat.
- A hair wash prepared from the pounded and crushed stems of ***C. pectinata*** is used in Assam for the treatment of diseased hair roots
- Leaves of ***C. revoluta*** are rich in nitrogen and they are used as green manure for rice, sweet potato and sugarcane.
- The starch of stem cortex & pith (usually) of ***C. revoluta*** is utilized for the production of **sago.**

SPOROPHYTE

[I] External morphology :

Cycas is an evergreen slow-growing **palm-like** small tree with an average height of 1.5-3m. It is commonly found in **xerophytic habitats**. It also grows well under cultivation in gardens. The sporophytic plant body is differentiated into roots, stem and leaves.

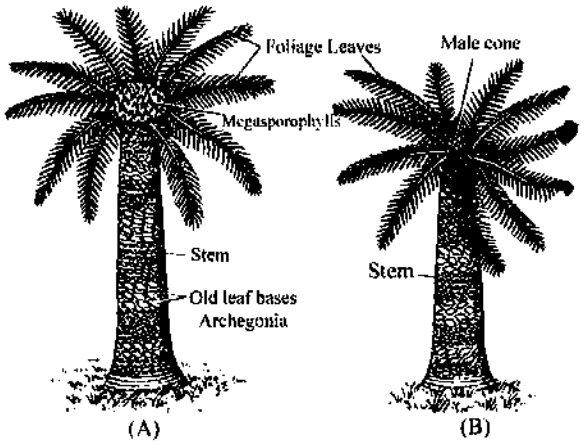
1. **Root :** There are two types of roots in Cycas :
   (a) Normal tap roots (b) Coralloid roots.

(a) Normal tap roots : These roots are **positively geotropic** and their main function is anchorage and absorption of water and mineral nutrients.

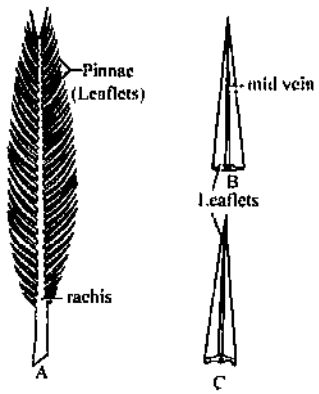
(b) Coralloid roots : These are speciallised **apogeotropic** roots which grow on the surface of the soil. They are repeatedly dichotomously branched and appear as coralline masses. They are more frequent on young plants. The coralloid roots possess **lenticels**, which help in **respiration**.

2. Stem : In mature plants, the stem becomes thick, columnar and woody. It is covered with **persistent and woody leaf bases**.

- The stem is **usually unbranched**, but sometimes due to injury shoot apical meristem is divided into two parts and the stem appears as **dichotomously branched**.



Cycas :- (A) Female Plant, (B) Male plant



(A) A foliage leaf, (B) A part of leaflet of *C. rumphii*, (C) A part of leaflet of *C. revoluta*

3. Leaves : Cycas has **dimorphic** leaves : (i) Foliage or Assimilatory leaves and (ii) Scale leaves.

(i) Foliage or Assimilatory leaves : Large, **pinnately compound** foliage leaves form a crown at the top of stem. Each leaf has 80-100 pairs of leaflets which are arranged on both sides of the rachis in opposite or alternate manner. The leaflets are sessile, elongated and ovate or lanceolate with flat (***C, rumphii***) or revolute (***C. revoluta***), margins. The apex is acute or spiny. The leaflet has a **single mid vein**, lateral veins are absent. Young leaves covered with **ramenta**.

- **Circinate vernation** is found in young leaf let.

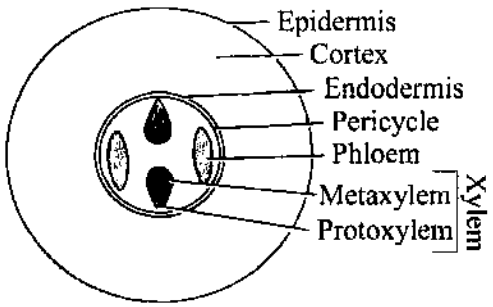
(ii) Scale leaves : The scale are small, rough, dry and **triangular**. They are thickly covered with ramenta. They are incapable of carbon assimilation and their **main function** is to protect **apical meristem** and other **aerial parts**.

- The foliage and scale are arranged in close alternate whorls at the stem. Usually a single crown of leaves is formed in a year.

[II] Internal Anatomy :

(a) Internal Structure of Normal Tap Root :

- Some cells of epiblema give rise to root hairs and root hairs are ephemeral.
- Cortex are filled with **starch**. Some **tannin cells** and **mucilage cells** are also present in this region.
- Vascular tissue forms a central **diarch** stele. The xylem is **exarch** and tracheids of the protoxylem have **spiral thickenings** and metaxylem tracheids have **sclariform thickenings**.
- The mature normal root shows secondary growth.



T.S. of young root. (Out line diagram)

(b) Internal structure of Coralloid root : Coralloid roots'cortex is differentiated in to three distinct regions.

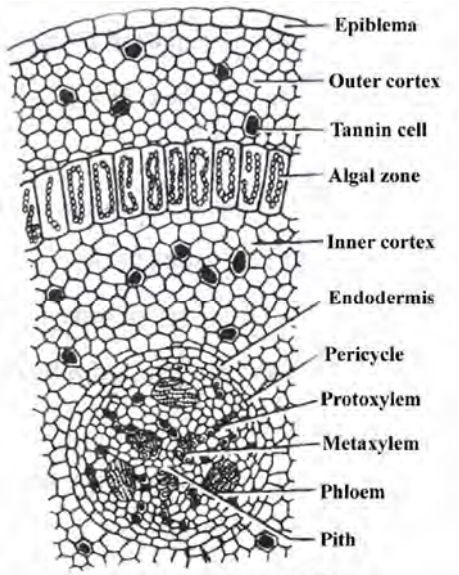
(i) Outer cortex ⟶ Composed of compact polygonal cells

(ii) Inner cortex ⟶ Thin walled parenchymatous cells.

(iii) Middle cortex ⟶ It has algal zone.

The algal zone consists of a single layer of lossely connected thin

walled and **radially elongated cells**. In the algal zone blue-green algae, such as ***Anabaena cycadae, Nostoc punctiforme*** and ***Oscillatoria spp.*** occur which live symbiotically. These help in nitrogen fixation. Pericycle is present inside inner cortex.

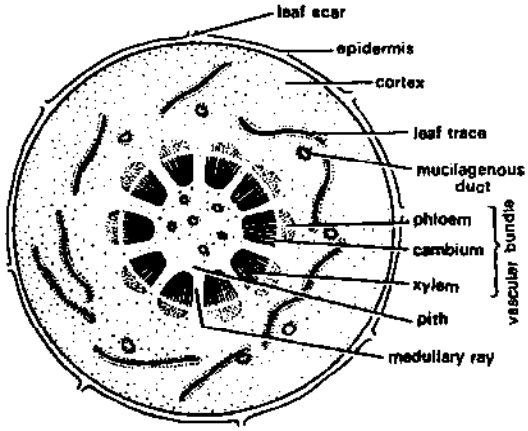


Internal structure of coralloid roots

- **Vascular Bundle :** coralloid roots are **triarch** and **exarch**. Root hair and root cap absent in coralloid roots

(c) Internal structure of Stem : Its internal structure is similar to that of a dicotyledonous stem.

- Epidermis is usually discontinous due to the presence of persistent leaf bases.
- Cortex composed of parenchymatous cells, rich in starch grains. The cortex is also traversed by several **mucilagenous** canals and many **leaf traces**.
- Endodermis and pericycle both are indistinct.
- There are several vascular bundles arranged in a ring forming an **ectophloic siphonostele**.
- The vascular bundles are conjoint, collateral, endarch and open.



Diagrammatic representation of transverse section of young stem

- The individual bundles are separated by parenchymatous medullary rays.
- The xylem is composed of tracheids and xylem parenchyma only, **vessels are absent**.
- The phloem is composed of **seive tubes** and phloem parenchyma, **companion cells are absent**.
- In a transverse section of stem, numerous leaf traces can be seen in the cortical region. They are vascular strands which supply the leaves.
- Each leaf receives four leaf traces. (**Two direct** & **Two girdle traces**)
- There is a parenchymatous pith in the centre of stem. The pith cells are rich in starch and several pith cells also contain tannin and mucilagenous substances.
- The stem of **Cycas** shows normal secondary growth in early stages, similar to that of dicotyledonous stem.

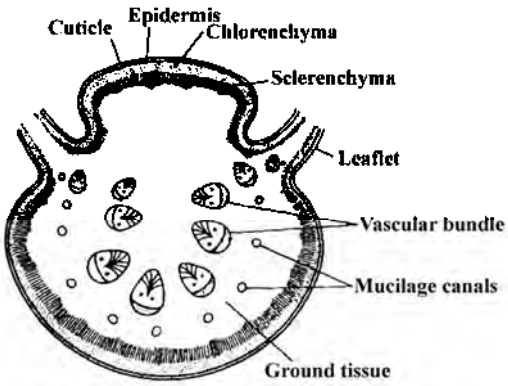
Note : Young stem of **Cycas** which is **monoxylic** earlier becomes **polyxylic** later on.

(d) Internal structure of leaf : -

(i) Rachis : - In a transverse section rachis is **circular** in outline. It has two rows of leaflets inserted on the adaxial side.

- Epidermis is outer most and parenchymatous. Scleranchymatous hypodermis is present below it.
- Ground tissue containing mucus canals present below hypodermis.

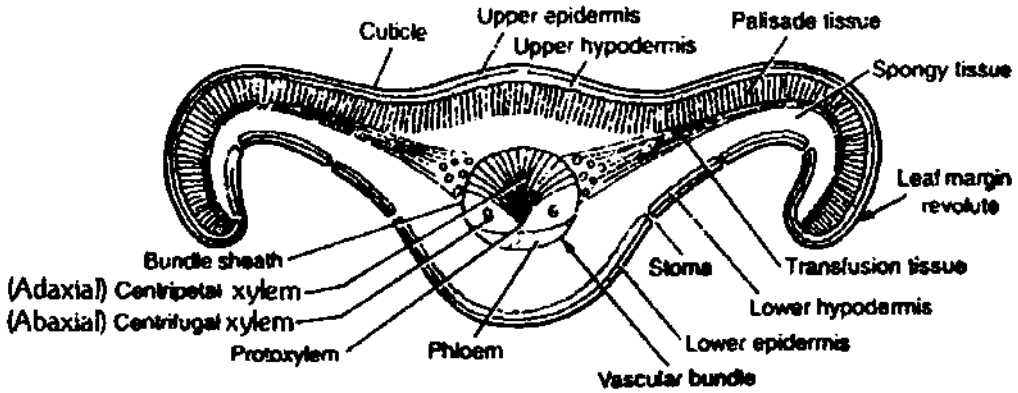
- There are several vascular bundles in the ground tissue and they are arranged in a typical inverted **omega-like** arc.
- The vascular bundles are conjoint, collateral and open, and each is surrounded by a single layered bundle sheath.
- Xylem is diploxylic in V.B. i.e. centrifugal & centripetal xylem present. Centrifugal xylem is more at basal part of rachis while centripetal xlyem is more towards tip.



T.S. of Cycas Rachis

(ii) Leaflet : - There is a single midrib in the leaflet, lateral veins are absent. The leaflet is swollen in the mid rib region.

- Upper and lower epidermis is present. stomata are present only at lower epidermis .
- The margins of the wings are revolute in ***C.revoluta*** and ***C.beddomei*** and straight in ***C.circinalis***, ***C.pectinata*** and ***C.rumphii***.
- Leaf mesophyll is modified in pallisade and spongy tissue.
- There are groups of tracheid-like cells on the lateral sides of the vascular xylem in the mid-rib region. These cells have reticulate thickenings and **bordered pits** on their walls. They represent **transfusion tissue**.



V.S. of Cycas Leaf Let

- In the wing region long colourless and transversely elongated parenchyma cells are present in between palisade and spongy parenchyma. They represent **secondary** or **accessory transfusion tissue**.
- Accessory transfusion tissue helps in lateral conduction of water and nutrients because lateral veins are lacking in cycas.
- A **single vascular bundle** is present in the **midrib region**. The vascular bundle is conjoint collateral, open and xlyem is **diploxylic**.
- It has a large and **triangular centripetal** xylem (Adaxial in position) and two small groups of **centrifugal xylem** (**Abaxial in position**).
- A thin layer of cambium is present between the xylem and phloem.

REPRODUCTION

- Cycas reproduces by vegetative and sexual means.

I. Vegetative reproduction :

- Vegetative propagation takes place by resting **adventitious buds or bulbils**. They develop in the basal part of the stem from parenchymatous cells of the cortex, in the crevices between persistent leaf bases.
- It is a common method of propagation in ***C.revoluta***, as **male plants** of this species usually do not occur in **Northern India** and in their absence sexual reproduction is not possible. Bulbils formed on male plants give rise to male plant and those developed on female plants form female plants.
- In ***C.circinalis***, vegetative propagation takes place by **suckers** which develop from the roots. They grow horizontally at the ground for some distance and then form new plants.

II. Sexual reproduction : -

- Species of **Cycas** are strictly **dioecious**.

1. **Male strobilus :** The strobilus (cone) develops at the apex of the stem in between the crown of foliage leaves. In its development apical meristem of the stem is utilised and as a result the future stem becomes **sympodial**.

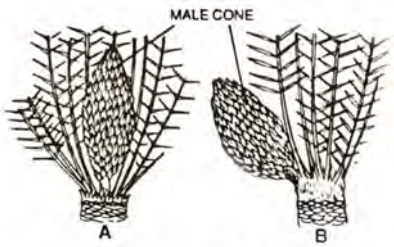
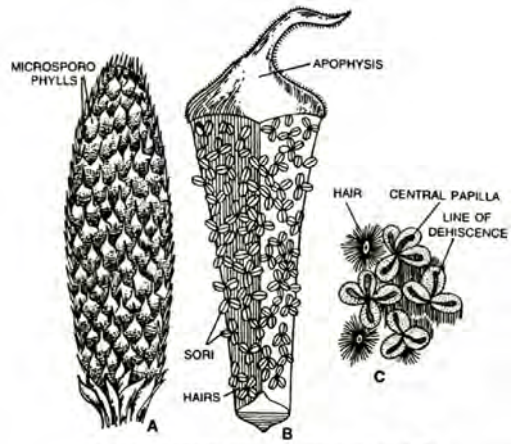


Fig.: Cycas Male Strobilus

- The male cone is shortly stalked, compact, oval or conical woody structure.It is **40-80** cm in length, the **largest among the plant kingdom**.
- The male cone consists of several microsporophylls which are arranged spirally around a central cone axis.
- The microsporophyll is a woody, more or less horizontally flattened and nearly triangular structure. It is differentiated into a proximal **wedge-shaped fertile** part which expands distally from a narrow point of attachement and a distal sterile part, tapering into an upcurved **apophysis**. The upper (adaxial) surface of the fertile part of the microsporophyll is sterile, while on the lower (abaxial) surface there are **700-1000** microsporangia, arranged in definite groups, known as **sori**. (Singular - Sorus). Each microsporangium is globular and sac like structure. The wall of microsporangium is trilayered.



Cycas : (A) Male cone, (B) Microsporophyll
(C) Microsporangium

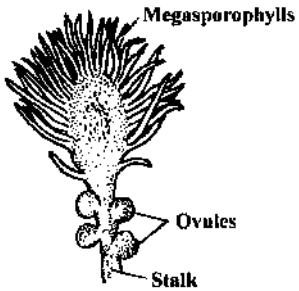
Exothecium
Endothecium
Tapetum

- Tapetum is inner most and it covered sporogenous tissue
- Types of development of microsporangium → Eusporangiate type.

Microsporogenesis : Microsporogenus cell $\xrightarrow{\text{mitosis}}$ **microsporemother cell** $\xrightarrow{\text{meiosis}}$ **microspore**

FEMALE REPRODUCTIVE STRUCTURE

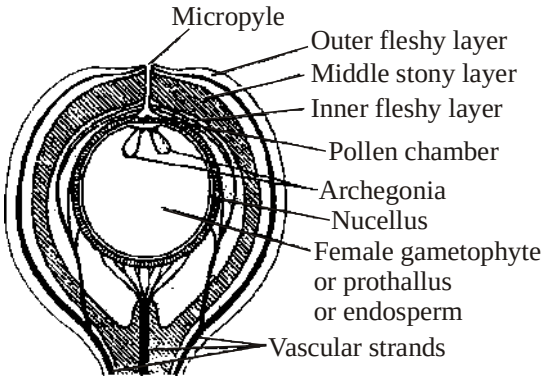
- The **megasporophylls** of Cycas are not organised into cones and instead they occur in close spirals in **acropetal** succession around the stem apex of the female plant. New megasporophylls are produced every year like the foliage leaves. The growth of the apical meristem of the female plants is **monopodial**, the axis countinues to grow as it produced foliage leaves and megasporophylls.
- The megasporophylls are considered to be **modified leaves**. They are flat and dorsiventral structures, measuring **15-30 cm** in length. A megasporophyll is differentiated into a basal stalk and an upper **pinnate** lamina. **Ovules are formed on the lateral sides of the stalk**.
- Largest ovule in plant kingdom is present in **Cycas thaursai**.



Cycas : Megasporophylls

Structure of Ovule :

- The ovule of Cycas is **orthotropous** and **unitegmic**. It is sessile or shortly, stalked and largest in the plant kingdom, about **6 cm** in length and **4 cm in diameter**. The ovule consists of a large nucellus surrounded by a single integument. The integument remains fused with the body of the ovule except at the apex of the nucellus, where it forms a **nucellar beak** and micropyle.
- The integument is very thick and is differentiated into **three distinct layers** – the outer and inner layers are fleshy, whereas the middle layer is hard and stony. The inner fleshy layer remains fused with the nucellus and it is **short-lived**. Mucilage canals and tannin cells are frequently present in the integument. Some cells of the nucellar beak dissolve to form a pollen chamber that lies in the central region of the beak. The young ovule is green and is covered by minute multicellular hairs. At maturity it becomes red or orange in colour and hairs disappear.
- The ovule is supplied by **three vascular strands** from megasporophyll.



L.S. of Cycas ovule

GAMETOPHYTE

- Cycas is **heterosporous**, it produces two types of spores – **microspores** and **megaspores**. The microspore develops into male gemetophyte and the megaspore in female gametophyte.

A. Male gametophyte :

The male gametophyte develops partially inside the micro sporangium before pollination and partially within the pollen chamber of the ovule after pollination.

1. Development of male gametophyte before polination : - The development of the male gametophyte before pollination takes place inside the **microsporangium**. The microspore divides by a transverse wall in to **two unequal** cells, a small prothallial cell and a large antherdial cell. The prothallial cell does not divide further. The antheridial cell divides to form a small generative cell (adjacent to the prothallial cell) and a

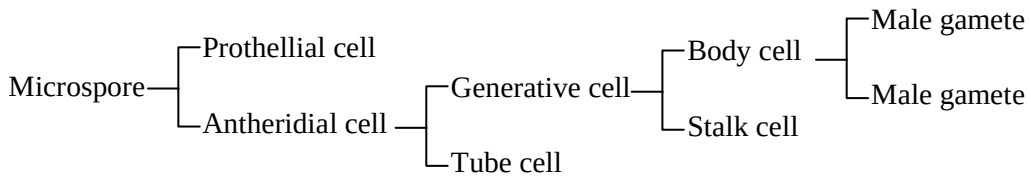
large tube cell. Thus the microspore becomes 3-celled. The **dispersal of microspores takes place** at the **3-celled stage**. Further development occurs in the pollen chamber of the ovule after pollination.

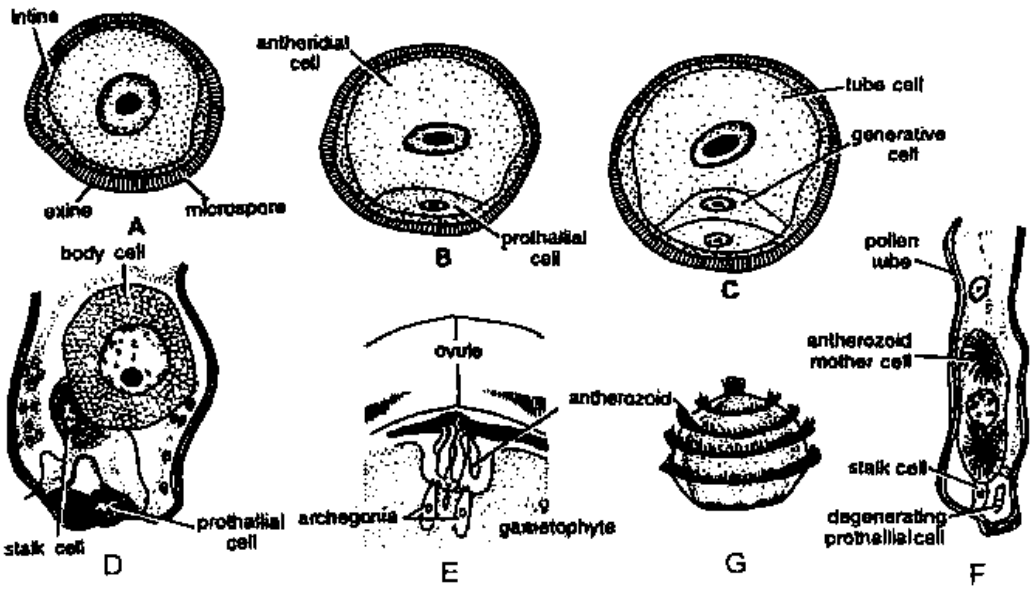
2. **Pollination :** The 3-celled microspores are shed in the air after the dehiscence of the sporangium. They are **very light in weight** and are carried by **air currents**.

- In **synchronization** with the time of dispersal of the microspores, some cells of the nucellar beak disorganise to form a **viscous fluid**. This fluid oozes out from the micropyle in the form of a pollen drop. Some of the microspores, carrieds by air current, are entangled in the pollen drop. As the pollen drop dries up, the microspores are sucked into the pollen chamber through the micropylar canal. As the result of drying of the viscous fluid, the micropylar canal of the pollinated ovules is plugged.

3. **Development of male gametophyte after pollination :** Further development of the 3-celled male gametophyte takes place within a week of pollination in the pollen chamber of the ovule. The generative cell divides to form a **stalk** cell and a **body** cell, about the same time, the exine ruptures and the intine protrudes out in the form of a pollen tube. The pollen tube penetrates the nucellar tissue and grows towards the female gametophyte. In **Cycas**, the **pollen tube is haustorial in nature**.

- The stalk cell does not divide, whereas the body cell divides to form two male gametes (antherozoids) just before fertilization. **(Mature male gametophyte of Cycas is 5-celled)** The antherozoids swim freely in the cytoplasm of the pollen tube. There is an interval of about four months between the pollination and fertilization.
- The male gametes are **naked, top-shaped** structures, measuring **180-210 µm** and **multi ciliated/ multiflagellated**.

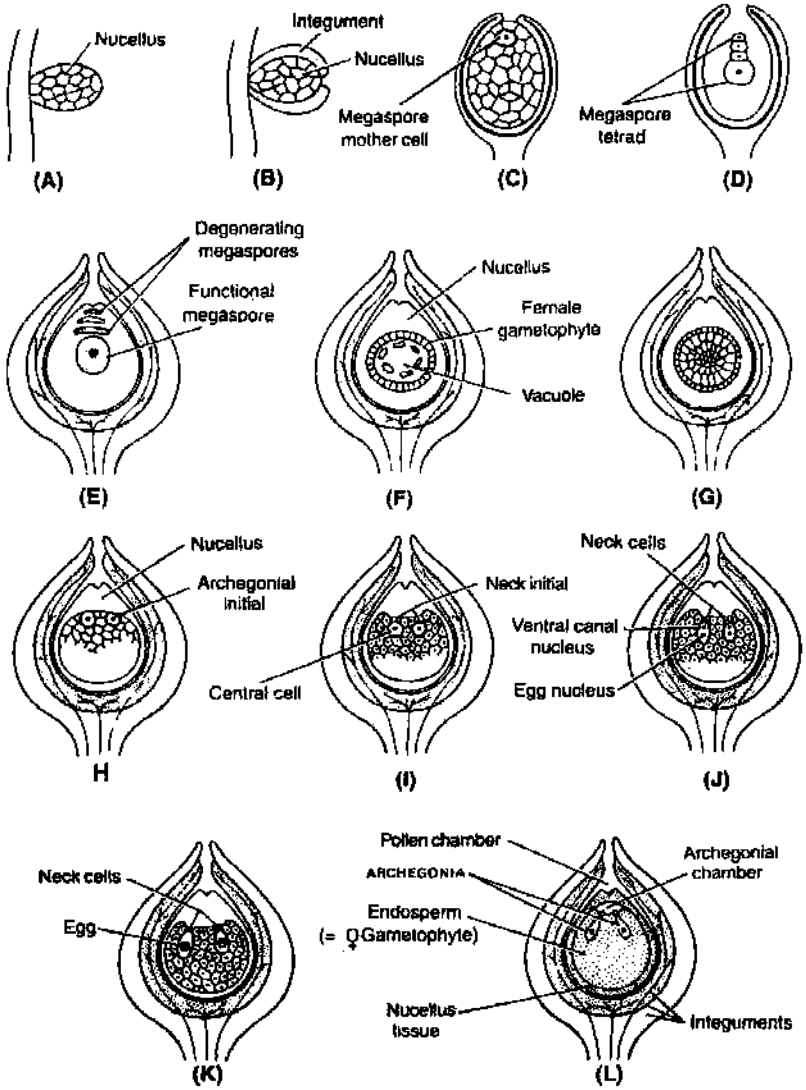




A-G Cycas : Development of male gametophyte;
A-C Stages before pollination, D-F. Stage after pollination, G. An antherozoid.

B. Development of Female Gametophyte :

- Four megaspore are formed by meiotic division in megaspore mother cell. Megaspore mother cell is originated from nucellus. Out of these four megaspore, three megaspore towards micropyle end degenerate and only one remain functional. Free nuclear division occur in functional megaspore. Cell wall formation occur and multicellular female gametophyte or endosperm is formed.
- Archegonia are formed from archegonial initial cell which is present toward micropyle.
- The mature archegonia consists of 2(generally)-4 neck cells and an egg. The venter is surrounded by a nutritive jacket of cells formed by the gametophyte cells. This jacket is called **archegonial jacket**. Neck canal cells are absent.
- **Note :** - The number of archegonia in an ovule varies in different species of cycas, for example, 3-6 in ***C. rumphii***, 3-8in ***C.circinalis*** and 2-8 in ***C.revoluta***.



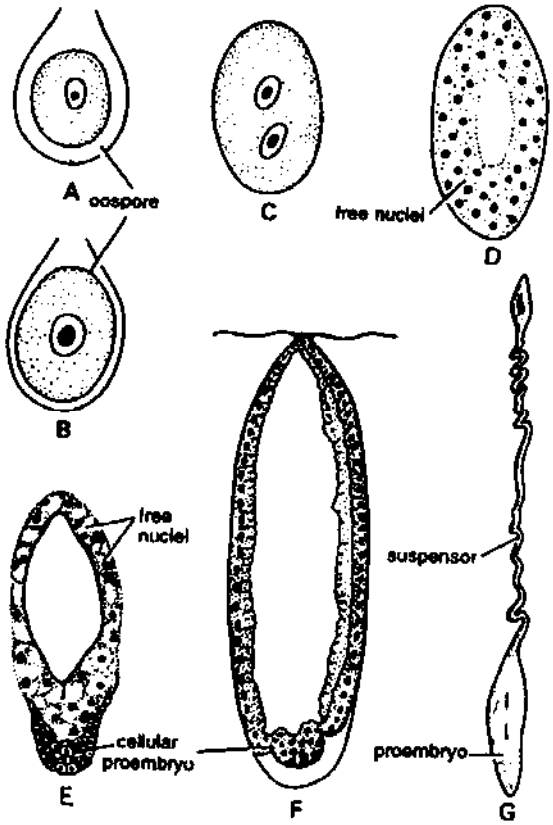
Different stages of the development of female gametophyte

[III] Fertilization – Zoodiosiphogamous type

Embryo development : Meroblastic and endoscopic

- The Cycas proembryo differentiated into three regions : (i) the uppermost **haustorial region** at the micropylar end, (ii) the middle **suspensor region**, and (ii) the basal **embryonal** region.
- The cells of the **haustorial region** absorb nutrients from the micropylar end and provide them to the developing embryo.

- The cells of the **suspensor** region are elongated and much coiled. They push the embryo deep into the female gametophyte (endosperm).
- The embryonal region forms the main part of the embryo. The embryo takes **about one year for its complete development**.
- Two cotyledon are present in embryo of cycas.



A-G Cycas : Stages in the development of embryo

SEED :

- The ovule is **transformed into seed after fertilization**. The inner fleshy layer of the ovule wall and the major part of the nucellus are consumed in providing nourishment to the developing embryo. Thus both these parts persist in the seed in the form of a thin layer.
- The mature seed is red, orange or dark brown in colour. It is surrounded by a fleshy seed coat formed by the three layers of the integument of the ovule. The outer fleshy layer of the integument forms **sacrotesta** and the middle stony layer **sclerotesta**, while the inner layer remains thin and papery. The seed coat has a sweet taste and pleasant odour. These provide attraction to birds and animals which help in dispersal of seeds. There is a straight embryo with **two unequal cotyledons** inside the seed coat.
- The seed of **Cycas** represents **three generation**. The seed coat, formed by the integument of the ovule, represents the first sporophytic stage, the endosperm is the gametophyte stage and the embryo is the next (new) sporophytic stage.

Germination of seed :

- The seed germinates without undergoing any rest period. It remains viable only for few months. The germination is **hypogeal**.

Species of Cycas	**No. of ovules in a megasporophyll**
Cycas circinalis	12

Cycas revoluta	2 – 4
Cycas pectinata	4 – 6
Cycas rumphii	6 – 10
Cycas siamensis	two

- **Age of Cycads** ⟶ Triassic period of mesozoic era
- Height of ***Cycas media*** ⟶ 20 meters
- In Cycas, the radicle is enclosed in a pod-like hard covering known as **Coleorrhiza**.
- Multiseriate bordered pits are present in **Cycas tracheids.**
- Two embryo are present in seed of ***cycas circinalis*** which are formed through two fertilized archegonia

Alternation of generation :

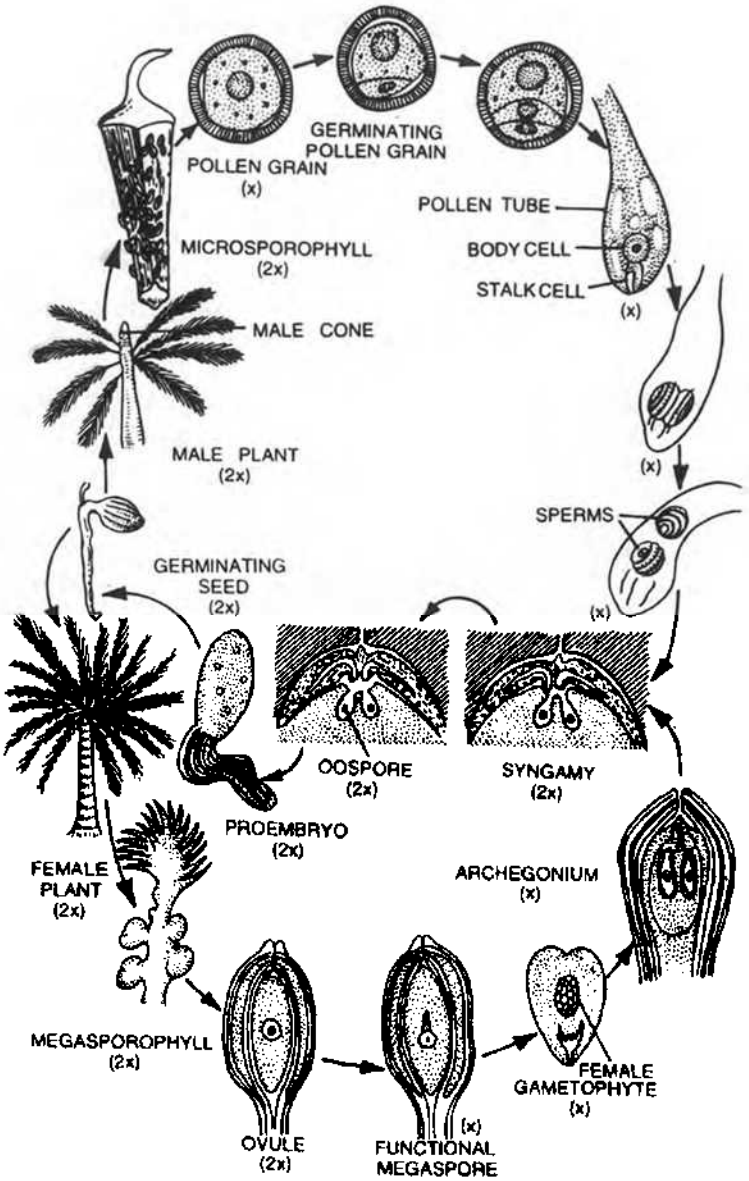


Fig.: Cycas : Alternation of Generation

PINUS

SYSTEMATIC POSITION

Kingdom		Plantae
Sub kingdom	→	Embryophyta
Division	→	Tracheophyta
Class	→	Gymnospermae
Subclass	→	Coniferophyta
Order	→	Coniferales
Family	→	Pinaceae/Abitaceae
Genus	→	Pinus

SPECIES OF PINUS

- There are six species of Pinus commonly found in India

(i) ***Pinus gerardiana*** **– (Chilgoza Pine)**

(ii) ***Pinus wallichiana Syn. Pinus excelsa*** **– (Blue Pine/Kail)**

(iii) ***Pinus roxburghii Syn. Pinus longifolia*** **– (Chir Pine)**

(iv) ***Pinus merkusii*** **(Teenasserim Pine) : Height-3 mt**

(v) ***Pinus insularis*** **Syn.** ***Pinus khasya*** **– (Khashi Pine)**

(vi) ***Pinus armandi*** **(Armandi's Pine)**

- Pinus is a **evergreen and perennial** tree with xerophytic adaptation which is growing on the slopes of hills in **temperate** climate. It is **conical** in **shape** due to **excurrent growth** of the plant i.e. both main axis and lateral branches grow continously to acquired **cone like** shape.

Note : The excurrent/conical habit of **Pinus** tree is caused by auxin effect on the growth of stem tip & axillary branches.

EXTERNAL MORPHOLOGY OF PINUS

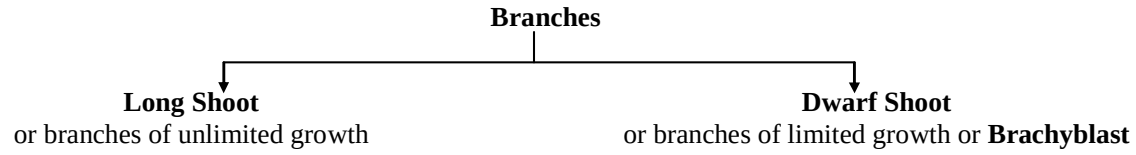
- Main plant body of **Pinus** is sporophytic and which is differentiated into root, stem and leaves.

1. Root : Well developed tap root system is found in **Pinus**. Root hairs are poorly developed. Ectomycorrhiza are present.

- Basidiomycetes fungus like ***Clavatia, Scleroderma, Amanita*** and ***Boletus*** etc. are present in mycorrhiza in the form of symbiont in root of pinus. They help in absorption of water and minerals.

2. Stem :

- Stem of the **Pinus** is erect/straight, cylindrical, long, woody and branched.
- Branches are **monopodial** and developed from the axis of scaly leaves which are present on the stem. Branching gives **conical** appearance to plant.
- Branches are Dimorphic.



(i) Long Shoot :

- These are developed in the axis of scaly leaves on stem after the growth of every year. In long shoot, apical bud is found. These are responsible for unlimited growth.
- These branches bear only **scaly leaves**.

(ii) Dwarf Shoot/Branches of limited growth or Brachyblast :

- They develop in the axis of scaly leaves on the long shoot and bear both **scaly** and **foliage** leaves.
- They possess foliage leaves at their apex.
- These branches do **not have apical bud** and hence show only limited growth.
- **A dwarf shoot with a group of needle like foliage leaves, called as foliar spur.**

3. Leaves :

- The leaves are **Dimorphic.**
  (i) Scaly leaves
  (ii) Foliage leaves/Photosynthetic leaves.

(i) Scaly leaves :

- The scaly leaves are dark brown, membranous, thin and small, and present on both long and dwarf shoots.
- They do not help in photosynthesis

Main function : protection of the young buds.

- They fall off as the branches are mature.
- The scaly leaves on the dwarf shoots have a distinct midrib and they are called **Cataphylls**.

(ii) Foliage leaves : (or photosynthetic leaves)

- They **develop** only on the **dwarf shoot** and present on their apex.
- The foliage leaves are green & needle like.

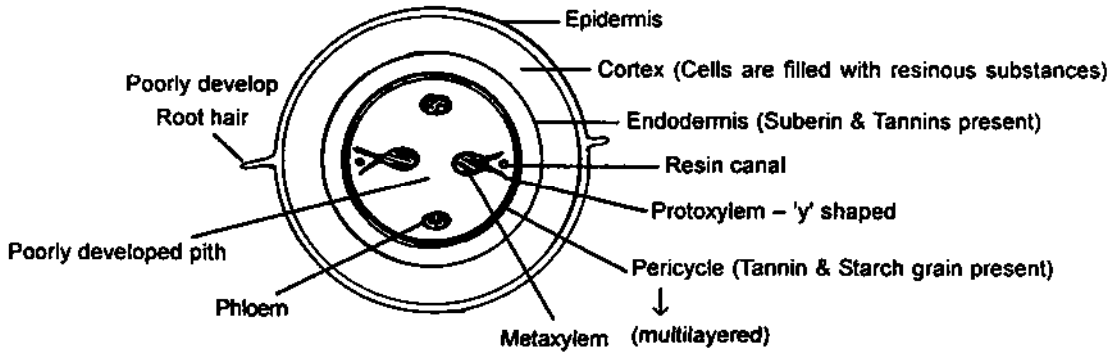
Species of Pinus	Number of needles	Types of spur
1. ***Pinus monophylla***	1	**Monofoliar**
2. ***P. merkushii*** and ***P. sylvestris***	2	**Bifoliar**
3. ***Pinus gerardiana***		
Pinus insularis	3	**Trifoliar**
P. roxburghii syn. P. longifolia		
4. ***Pinus quadrifolia***	4	**Quadrifoliar**
5. ***P. armandi***		
Pinus wallichiana syn. P. excelsa	5	**Pentafoliar**

Note : The foliage leaves are Photosynthetic and remain persistent for several years. The needle like nature of the foliage leaves indicates xerophytic adaptation.

INTERNAL STRUCTURE OF PINUS

(A) INTERNAL STRUCTURE OF ROOT :

- Internal structure of primary root of Pinus is similar to dicot root, but vessels in xylem and companion cell in phloem are absent.



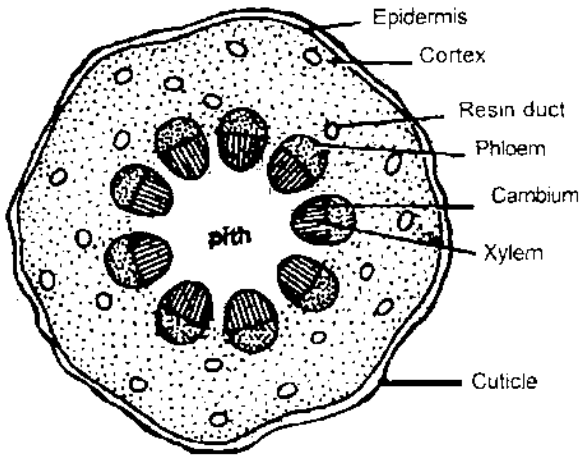
T.S. of pinus young root.

(B) INTERNAL STRUCTURE OF PINUS STEM.

- The internal structure of **Pinus** stem is similar to that of a dicotyledon stem.

1. **Epidermis :** It is the outer most layer and composed from compactly arranged and heavily **cutinised** cells.
2. **Cortex :**

- **Hypodermis :** The outer sclerenchymatous zone of the cortex forms hypodermis.
- **General cortex :** It is formed by several layers of parenchymatous cells. Some cells of this zone are filled with **tannin**. Several resin canals are also distributed irregularly in the cortex.
- **Endodermis :** The inner most layer of the cortex represents endodermis. It is indistinguishable from the cortical cells.



Outline diagram of T.S. of pinus young stem

3. **Pericycle :** 2-3 layered pericycle is present which is indistinct and undifferentiated.
4. **Vascular Bundles :** 5-9 Primary Vascular Bundles are presents. They are arranged in a ring. The vascular bundles are **conjoint, collateral, Open & endarch**. The protoxylem tracheids possess **spiral** thickening where as metaxylem tracheids have **reticulate** thickening.
5. **Pith :** A parenchymatous pith is present in the centre of the stem. Some pith cells are filled with **resinous substances**.

Note : In transverse section of the stem (long shoot) appears wavy or irregular in outline due to the presence of close appressing scaly leaves and dwarf shoots.

INTERNAL STRUCTURE OF PINUS NEEDLE

- Leaf of the pinus is **xeromorphic.** Outline of the T.S. section of **Pinus** leaf (Needle) depends upon number of foliage leaves on foliar Spur :

Species	Number of foliar leaves	Out line
P. monophylla	1	Circular
P. sylvestris	2	Half circular/semi circular
P. longifolia	3	Triangular

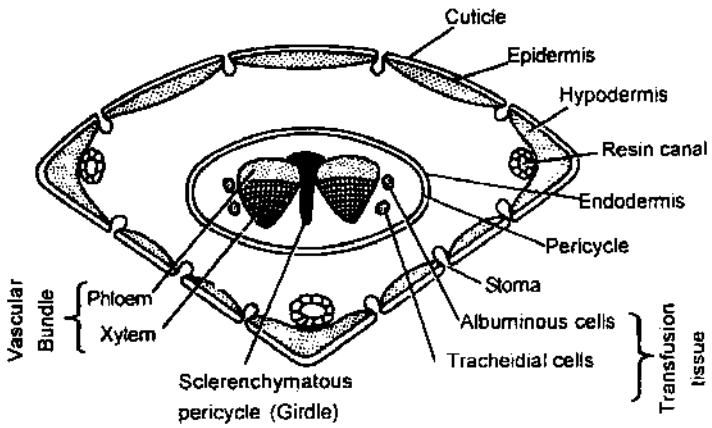
1. **Epidermis :** The single layered epidermis consists of heavily cutinized thick walled cells. It has many **sunken stomata**. Each stomata consists of **two** guard cells and **6-9 subsidiary** cells. Stomata are present on both surface.
2. **Hypodermis :** It is more than one layered and composed of **sclerenchymatous** cells. Due to the presence of substomatal cavities. Hypodermis is discontinuous.

- **In *P.longifolia*, the hypodermis is more developed at the corners.**

3. **Mesophyll :** Mesophyll (3 – 5 layered) is made up of parenchymatous cells. Large number of long peg like process are formed by **infolding** of **internal cell well** of mesophyll. So it is known as **"armed mesophyll"**. It increases the photosynthetic area of leaf. Leaf mesophyll is not differentiated in it.
4. **Endodermis :** It is made up of **barrel shaped** cells. **Casparian thickening** are present on their radial wall.
5. **Pericycle :** A multilayered pericycle is present next to endodermis. It consists of the following types of cells.

(i) Parenchymatous cell : Most of the pericycle is composed of parenchymatous cells which are densely filled with **starch grains**.

(ii) Albuminous cell : These cells occur in close contact with the **phloem cells**. They are also parenchymatous cells which are packed with **proteins** and **starch grains**. They **do not possess pits** and probably helps in translocation of nutrients from mesophyll to phloem cells.



***Pinus roxburghii* : Outline diagram of the T.S. of *Pinus* needle**

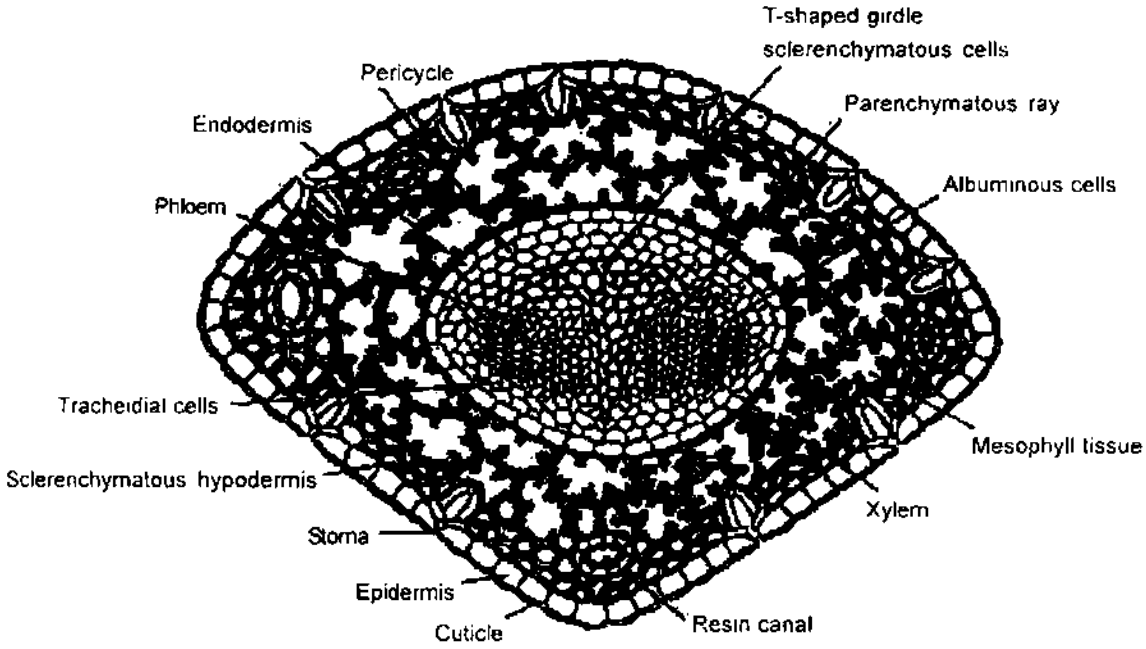
(iii) Tracheidial cells : These are tracheids like cells which occur close to **xylem cells**. These cells **possess pits** & helps in conduction of water & minerals from xylem to mesophyll cells.

Albuminous cell + Tracheidial cell ➡ Transfusion tissue

(vi) "T" Shaped sclerenchymatous girdle

6. Vascular Bundle :

- In the middle of the leaf two vascular bundles are Surrounded by bundle sheath. Vascular bundles are conjoint, collateral, Open & endarch. **"T' shaped girdle is found between the both vascular bundls. 'T' shaped girdle is composed of sclerenchymatous cells.**



Detailed cellular structure of the T.s. of Pinus needle

- **Pinus needle ➡ Amphistomatic**
- **Stomata – Haplochelic type. i.e.** subsidiary and guard cells are arises from separate cells.
- The needle possesses basal meristem which helps in their elongation

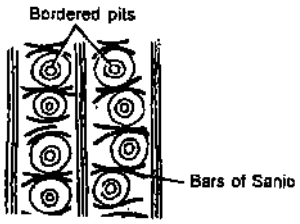
Secondary Growth in Pinus root is similar to that of a dicot root
Secondary Growth in Pinus stem is similar to that of a dicot stem

Linear **uniseriate bordered pits** are present in **tracheids.**

- Clear annual ring are found in **Pinus.**
- **Resin canals** are also found in **secondary xylem.**

IMPORTANT POINT :

- An important characteristics features of **Pinus** wood is the presence of **bars of Sanio**. They occur in the form of **crescentic bars** in between the bordered pits. These bars are formed by the deposition of **cellulose & pectin** on **Tracheidial walls**.



Bars of Sanio in between bordered pits in trachieds

REPRODUCTION IN PINUS

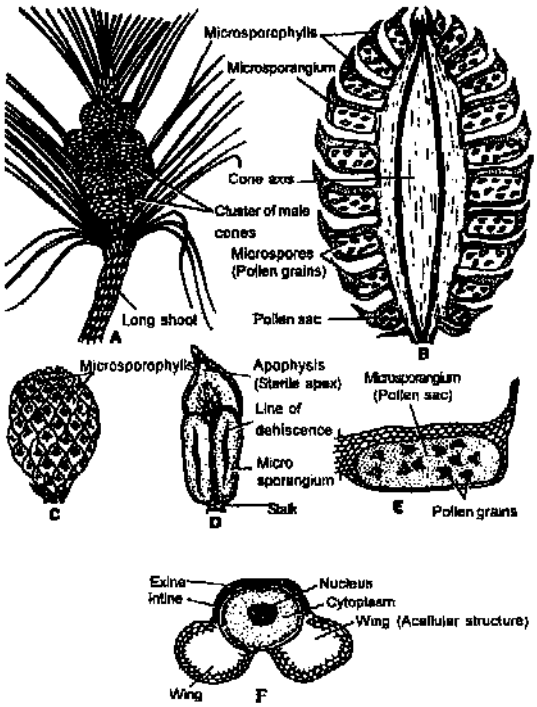
- Pinus is a **Sporophytic & heterosporous** plant. The plant body forms two types of spores i.e. **microspores** and **megaspores**. The spores are haploid which indicate the first cell of **gametophytic phase.**
- The plants are **monoecious** and male & female cones are formed on different branches of the same plant. It means it is a **autoicous** plant.
- Male & female cones are monosporangiate.
- **Exception :** In ***Pinus roxburghii***, ***P. montana*** and ***P. maritima*** the cones are **bisporangiate**. i.e. cone possess two types of sporangia.

MALE CONE :

- Male cone are developed in the axis of scaly leaves on the branches of unlimited growth in **place of dwarf shoot**. The male cones are considered as modified dwarf shoot. They are develops in groups, just behind the apical bud on the branches of unlimited growth. Thus main shoot continues to grow further. The number of cones in a cluster varies from **15 (*Pinus wallichiana*)** to **140 (*Pinus roxburghii*).**

STRUCTURE OF MALE CONE :

- Each male cone is small & oval shaped structure about **2-4 cm** long, **5-6 mm** in diameter and 60-150 micro sporophylls are arranged spirally on the central axis of each male cone. Each micro sprophyll is a membranous, stalked & **roughly triangular** structure. **(microsporophyll Compared with stamen of angiosperm)**
- The apical sterile part of the micro sporophyll is known as **apophysis**. It bears **two microsporangia** at the base of its **abaxial side**. Each micro sporangium has numerous microspores.
- Microsporophylls are arranged at right angle to the cone axis in such a manner that the apophysis of the upper micro sporophyll is overlapped by the apophysis of the lower microsporophyll.
- **Development of microsporangium :** - **Eusporangiate** type.



Pinus : A. Bunch of Male cone B. L.S of male cone C. Microsporophyll in male cone D. Microsporophyll E. Internal structure of microsprophyll F. Pollen grains

STRUCTURE OF MICROSPORE :

(i) Exine : This layer is highly cutinized and it is found only at one side.

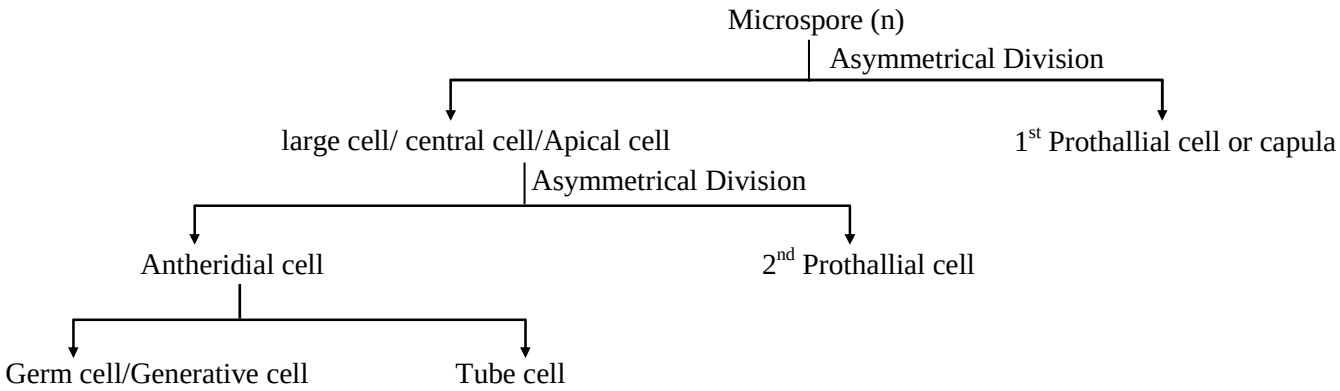
(ii) Exointine : Two wings are developed on lateral side of this layer of microspore. It is a part of exine.

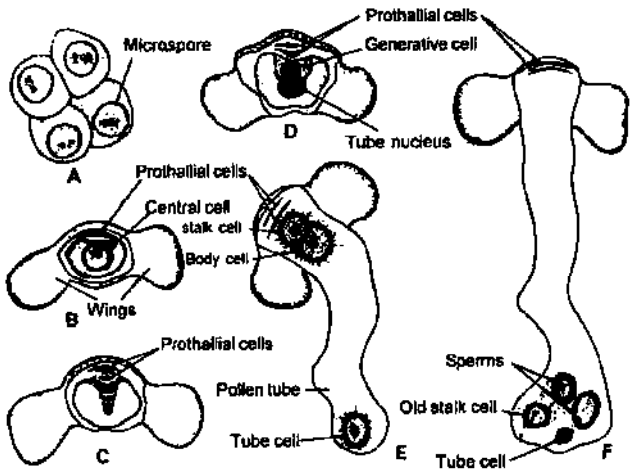
(iii) Intine : It is inner most layer of microspore.

DEVELOPMENT OF MALE GAMETOPHYTE :

- The microspore is the first cell of the male Gametophyte. The Germination of microspore starts **in situ** i.e., they germinate while still inside the microsporangium.
- The microspore are released from the microsporangium after partial development of male gametophyte. The rest of the development of male gametophyte takes place in the **pollen chamber of the ovule** after pollination.

(A) Development of male gametophyte with in the microsporangium before pollination :





Pinus : A. Tetrad of microspores, Development of male gametophyte B-D. Stages before pollination, E-F. Stages after pollination

Pollination : Pollination takes place through the air at 4-celled stage. In India, dehiscence of microsporangium takes place in **warm & dry** environmental conditions.

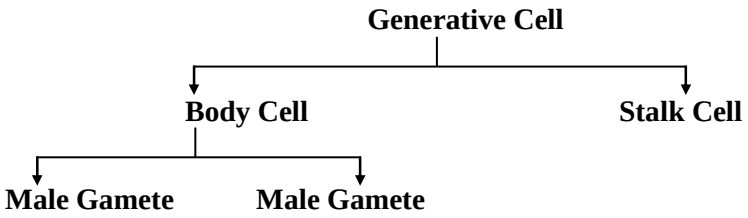
- The microspores are released in such a large quantity that pine forest appears yellow at the time of dehiscence of microsporangium. This is called **"shower of sulphur"**.

(B) Development of Male Gametophyte after pollination :

- After pollination the **4-celled** male gametophyte reaches to the pollen chamber and there it remains **inactive** for about **11 months**. **(The ovuliferous scale during this period have thickened and closed the**

cone completely. The ovule is not yet ready for fertilization.) Further development of the male gametophyte starts in the next spring.

- Exointine breaks off from the middle of the wing and the tube cell comes out in the form of pollen tube. Pollen tube reaches to archegonia through nucellus.
- Pollen tube is rich with starch grains & it may be **branched** or **unbranched**. It acts as a sperm carrier. Tube nucleus moves into the pollen tube while generative cell remains inside the pollen grain.
- The generative cells of the **4-celled gametophyte** divide to form a **body cell** and a **stalk cell**. The nucleus of the body cell divides to form **two nuclei** just before fertilization. The male nuclei function as **sperm** which is **microscopic, non flagellate** & **ephemeral** structure.



- Thus mature male gametophyte of **Pinus is 6-celled.**

FEMALE CONE :

- Female cones are developed on long shoot in place of dwarf shoot. Female cones are also called as **modified dwarf shoot**.
- The female cone are formed in groups (1-4 in each group), in the axis of the scaly leaves towards the tips of long shoots of the current year. The female cone with seed takes about three year to mature.
- The female cones are much larger than the male cones. They are usually 15-20 cm long.

[*Pinus coultre* = 25-35cm & *Pinus lambertiana* = 60 cm]

STRUCUTRE :

- The female cone is complicated structure. It has a central axis around which many (80-90) megasporophylls are arranged spirally.
- Some basal megasporophylls are small & sterile & the rest are fertile. The megasporophyll is a compound structure, consisting of two types of scales : -

(A) Bract scale (B) Ovuliferous scale

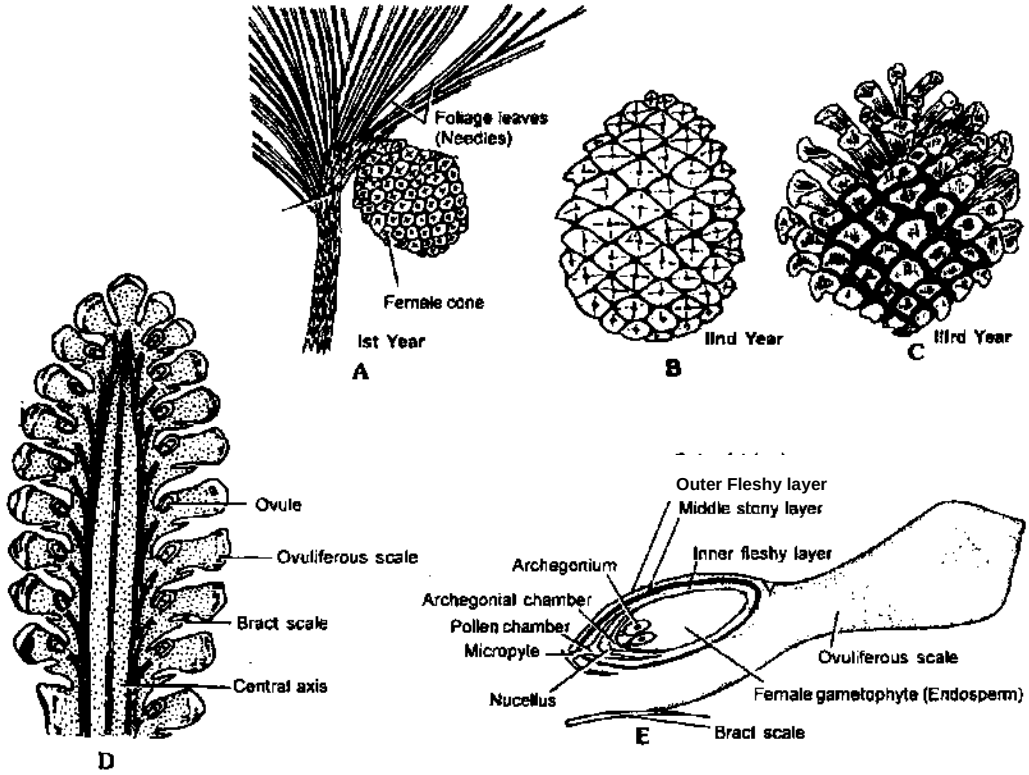
(A) Bract scale :

- It is small membranous structure which is directly attached to the cone axis just below the ovuliferous scale. At the maturity of cone, the bract scale curve inwards so that seeds are dispersed easily.
- Each bract scale has a **single vascular bundle** with its xylem pointing upwards.

(B) Ovuliferous scale :

- It is thick, large woody and brownish structure, attached to the **dorsal** surfaces of the bract scale.
- It is roughly triangular in shape and its upper broad and thick part is known as **apophysis**. Two ovules are present at the base of the ovuliferous scale on its **dorsal surface**.

- The micropyle of each ovule is directed towards the cone axis.



Pinus : A-C. Female cone First, Second and Third year **D.** L. S. of Female cone
E. Structure of Megasporophyll and female gametophyte.

- **Development of megasporangium/Ovule : Eusporangiate type** i.e. the megasporangium develops from more than one superficial initial cells.

STRUCUTRE OF OVULE :

- Ovule of pinus is **anatropous, unitegmic & sessile**. The following part can be seen in longitudinal section of the ovule.

(i) Nucellus : It is the massive **parenchymatous** region of the ovule.

(ii) Integument : It is the thick protective covering around the nucellus. It has a very narrow aperature at the apex of the nucellus. It is known as **micropyle**.

The integument is differenciated in to three layers.

(i) Outer fleshy layer
(ii) Middle stony layer
(iii) Inner fleshy layer.

(iii) Pollen chamber : A small furrow is present opposite to the micropyle in the **nucellus region** which is known as **pollen chamber**. Material secreted by nucellus is found in this chamber during pollination which is known as **"Pollen drop"**.

- **Endosperm & Archegonia are present in the centre of nucellus region.**

MEGASPOROGENESIS :

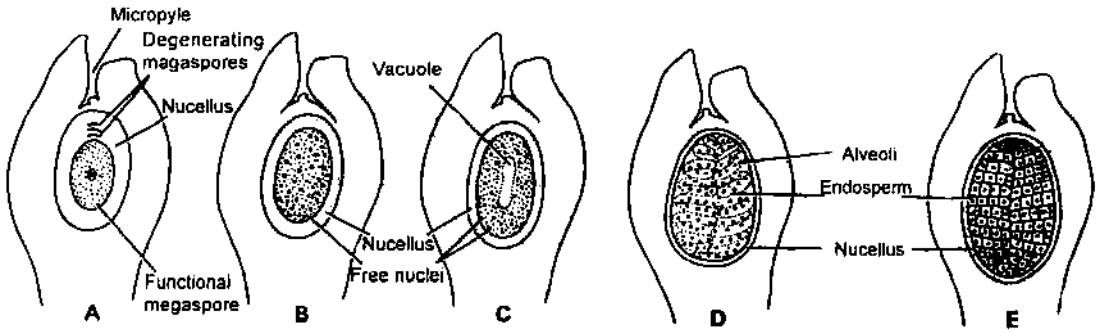
- At the apex of nucellus (**towards micropyle**), hypodermal cells is differentiated from other cells by its larger size, called as **archesporial cell**. Archesporial cell divides by periclinal division to form an outer primary parietal cell & inner sporogenous cell. Sporogenous cell function as a **megaspore mother** cell.

Megaspore mother cell divide **meiotically** to form a linear tetrad of megaspore. Out of four, three megaspore degenerat which **lies** towards the micropyle. Only one megaspore remains functional which is present towards the **chalazal end**.

DEVELOPMENT OF FEMALE GAMETOPHYTE

A. DEVELOPMENT OF ENDOSPERM :

- Functional megaspore first of all increases in size then after **free nuclear divsion** take place in nucleus of functional megaspore resulting 2000-2500 nucleus are formed. All the nucleus move towards the periphery due to vacuole formation in centre.
- There is one characteristic feature of Pinus, in which long **multinucleated** tube like cells are developed radially in early stage. These are known as **alveoli**. Later on **uninucleated** cells are formed due to formation of walls. The structure is known as **endosperm**.
- **Endosperm is haploid structure because it is derived from the megaspore before fertilization.**
- The nucellus cells surrounding the **endosperm** form a 2-3 layered nutritive layer. This layer is known as **spongy layer or endosperm jacket & it is equivalent to the tapetal layer**.



DEVELOPMENT OF ENDOSPERM

B. ARCHEGONIA :

- 2-5 archegonia (normally two) are formed towards the micropylar end in female gametophyte.
- Each archegonium at maturity consists of **eight neck jacket cells** arranged in two tiers of four each and a venter having a small venter canal cell and large egg cell. **Neck canal cells are absent**. The venter canal cell disorganizes before fertilization.
- A nutritive layer is differentiated around the central cell & this layer is known as **archegonial jacket**. The jacket helps in **conduction of nutrients** from the endosperm to the archegonium.

  Note : - *P.roxburghii* and *P.wallichiana* 4-4 neck cells & in **Cycas** archegonium 2-4 neck cells are found in neck region.

FERTILIZATION

- Fertilization in Pinus first of all described by ***Gauroschenchin***.
- Fertilization is ***siphonogamous***. The process of fertilization takes place after the **12-14 month** of pollination.
- Many archegonia fertilized in a female gametophyte but only one zygote is able to form an embryo successfully.

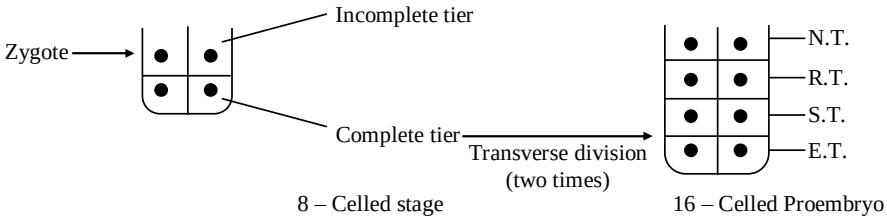
DEVELOPMENT OF EMBRYO :

- **Meroblastic** (embryo is formed by only a part of oospore) and **endoscopic** (development of embryo takes place inside the megasporangium directed away from micropyle)
- Development of embryo can be studied in the following two steps.

(A) Development of proembryo (16-celled) from zygote

(B) Development of embryo from proembryo

(A) Development of proembryo from zygote :



- Pinus proembryo consists of **16 cells** arranged in four tiers.

(i) Nutritive tier : The upper most tier consisting of incomplete cells is known as nutritive tier and it provides nutrition.

(ii) Rosette tier : Function conduction of nurtient between **embryo & suspensor**.

(iii) Suspensor tier : The cells of the suspensor tier elongate to form suspensor. Its cells are long which pushed the embryo into the endosperm.

(iv) Embryonal tier : The lower most tier is known as the embryonal tier; its cells divide to form **embryo**.

(B) Development of embryo from proembryo :

- All the four cells of the suspensor tier elongate considerably and as a result the embryonal cells present at their base are embedded in the endosperm.
- Due to the limitation of space in the endosperm, the primary suspensor cells become coiled to each other.
- At this stage, the cells of the embryonal tier divide by **transverse division** and form another tier of cells, known as **embryonal tubes** or **secondary suspensor**.
- The cells of the embryonal tier separate from each other and form **four independent embryos**. The phenomenon of the formation of more then one embryo from zygote is known as **polyembryony**.
- In pinus, as the polyembryony occurs by the splitting of a zygote. It is known as **cleavage polyembryony**.
- Another type of polyembryony found in pinus is **simple polyembryony** (when more than one embryo is developed as a result of fertilization of different archegonia.)

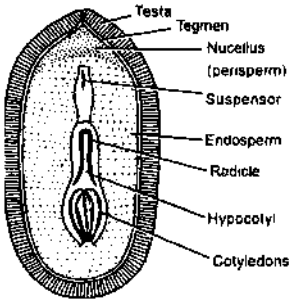
STRUCTURE OF EMBRYO :

(i) **Cotyledons :** Usually more than two **(3 to 18)**

(ii) **Plumule** or **Shoot apex** : Present between the cotyledons in the opposite direction of the micropyle.

(iii) **Radicle :** Directed towards the micropyle

(iv) **Hypocotyl :** Present in between the plumule & radicle.



Pinus : L.S. of Seed

Parts of Ovule		Parts of Seed
(1) Integument –		
(i) Outer fleshy layer	–	Disappear
(ii) Inner fleshy layer	–	**Tegmen** is formed in the form of thin layer
(iii) Middle stony layer	–	It forms the outer most covering of the seed called **testa**.
(2) Nucellus	–	Present in the form of thin layer which is known as **"perisperm"**.
(3) Micropyle	–	On the apex of seed in the form of a pore.
(4) Thin layer of Adaxial surface of ovuliferous Scale	–	Forms **wing** of seed.

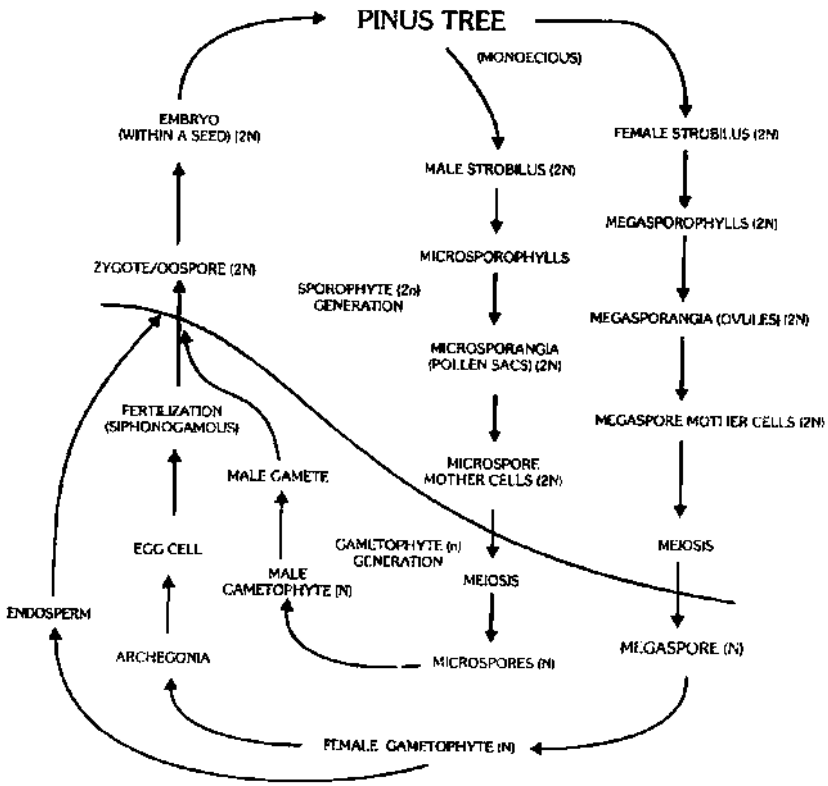
- The **mature seed** represents three generations –

(1) Old sporophyte – Testa, tegmen and nucellus
(2) Gametophyte – **Endosperm** (female gametophyte)
(3) New sporophyte – Embryo

GERMINATION OF SEED :

"Epigeal" type of germination is found in seed of **Pinus** i.e. cotyledon come outside on the soil surface by elongation of the **hypocotyl**.

Life Cycle – Diplontic :



ECONOMIC IMPORTANCE OF PINUS :

- The wood of ***P.roxburghii*** (Chir) and ***P.wallichiana*** (Kail) is an important timber. It is suitable for making railway sleeper, packing cases, furniture, etc Besides, it is also used for making match sticks.
- ***Pinus roxburghii***, ***P. wallichiana***, ***P.insularies*** and ***P.merkusii*** are the chief sources of **turpentine** in India. Rosins, obtained as a residue after the distillation of pine resin, are used in paper sizing, varnish making enamels and in the preparation of plasters and ointments.
- The roasted seeds of ***P.gerardiana*** (Chilgoza pine), ***P.edulis*** and ***P.monophylla*** are **edible**.
- The oleo-resin obtained from ***P.roxburghii*** is diuretic.
- The **fossilized resin**, obtained from a fossil species of Pinus (e.g., ***P.succinifera***), is known as **amber**. It is widely used in **ornaments** and **decoration work**.
- The wood and female cones of Pinus are used as fuel.

IMPORTANT POITNS:

1. **Endosperm** is formed by functional megaspore before fertilization in **gymnosperm**. so, it is **haploid**.
2. **Winged pollen grains** are found in **Pinus**, wings are formed from exine of pollens. These are **acellular**.
3. In Gymnosperms, gametes of **Cycas** and **Ginkgo** are motile and ciliated/Flagellated.
4. **Ephedra** is found in **Rajasthan** and in **Ephedra** pollination takes place at **5-celled** stage.
5. The **edible part** of **chilgoza seed** is **female gametophyte**.
6. In all seed bearing plants diplontic life cycle is found. In this type of life cycle pattern the diploid sporophyte is dominant. Photosynthetic independent phase of the plant. The gametophyte phase is represented by the single to few-celled haploid gametophyte.
7. ***Pinus longifolia*** known as Red wood of china

EXERCISE – 1

ULOTHRIX

Q.1 A motile flagellate asexual cell is known as -
(1) Zoospore (2) Zygospore
(3) Tetraspore (4) Zygote

Q.2 ***Ulothrix*** is a green algae because-
(1) It has a cell-wall
(2) Each cell has a single nucleus
(3) Each cell has a single chloroplast
(4) It has chl.'a', chl.'b', β-carotene and xanthophyll

Q.3 ***Ulothrix*** produces
(1) Quadri flagellate macrozoopores
(2) Biflagellate micro zoospores
(3) Quadriflagellate micro zoospores
(4) All the three types of zoospores stated above.

Q.4 The organ by which ***Ulothrix*** is attached to its substratrum is called a-
(1) Rhizoid (2) Holdfast
(3) Trichome (4) Root

Q.5 The number of flagella in the gametes of ***Ulothrix*** is -
(1) six (2) four
(3) one (4) none of the above

Q.6 The non-motile, highly thickened asexual spores are called-
(1) hypnospores (2) macro-spores
(3) aplanospores (4) micro zoospores

Q.7 The basal cell of Ulothrix is devoid of-
(1) Nucleus (2) Cytoplasm
(3) Chloroplast (4) All of these

Q.8 In Ulothrix reduction division occurs-
(1) In the gamete (2) In the zygospores
(3) In the zoospores (4) In the somatic cell

Q.9 The species of Ulothrix preferring Salty water is-
(1) ***U. flacca*** (2) ***U. tenarima***
(3) ***U. zonata*** (4) ***U. variabilis***

Q.10 The akinete formed during unfavourable conditions in the Ulothrix life cycle is-
(1) Protoplasm + thin cell
(2) Protoplasm + cell wall
(3) Cell + thick wall
(4) Naked protoplasm

Q.11 Which cell of ***Ulothrix*** does not divide-
(1) Rhizoidal cell (2) Apical cell
(3) Both the above (4) None of these

Q.12 In *Ulothrix,* colony formation occurs during-
(1) Formation of aplano spores
(2) Formation of zoospores
(3) Palmella stage (4) All of the above

Q.13 In ***Ulothrix***, eye spot does not occurs in-
(1) Zoospores (2) Gametes
(3) Microzoospores (4) None of the above

Q.14 In ***Ulothrix***, gametes are released in-
(1) Morning (2) After noon
(3) Evening (4) Night

Q.15 Which type of spores fix to substratum by anterior end at the time of germination-
(1) Macro zoospore (2) Micro zoospores
(3) Aplanospores (4) Hypno spores

Q.16 If ***Ulothrix*** is removed from water and placed in dry soil then it will produce-
(1) Aplanospores (2) Hypnospores
(3) Akinetes (4) Palmella stage

Q.17 When single thick walled aplanospore is produced in a cell of ***Ulothrix*** it is called-
(1) Akinete (2) Hypnospore
(3) Oidium (4) Torula

Q.18 Which type of gametes are produced in ***Ulothrix***-
(1) Biflagellate zoogametes
(2) Biflagellate antherozoids
(3) Quadriflagellate (4) Non motile gametes

Q.19 ***Ulothrix*** is-
(1) Homothallic (2) Heterothallic
(3) Protoandrous (4) 2 & 3 both

Q.20 ***Ulothrix*** inhabits-
(1) Slow flowing warm water
(2) Stagnant cool water
(3) Slow flowing cool water
(4) Any of the above

Q.21 Cells of ***Ulothrix*** are-
(1) Rectangular (2) Spherical
(3) Cylindrical (4) Ellipticle

Q.22 Pyrenoids are composed of-
(1) Starch (2) Protein
(3) Starch and lipid (4) Starch and protein

Q.23 Why Ulothrix is not considered a linear colony of cells-
(1) Because all cells are in a common cell wall
(2) Because cell exhibit a division of labour
(3) Because cells have plasmodesmatal connections
(4) All the above

Hint : In a colony cells mechanically held together generally in a gelatinous envelope. The cells in the colony have little or no dependence upon one another.

Q.24 Apical cell of thallus in Ulothrix is-
(1) Dome shaped (2) Cylindrical
(3) Rectangular (4) Club shaped

Q.25 Chloroplast of *Ulothrix* is-
(1) Girdle shaped with grana & intergrana
(2) Girdle shaped without or less developed grana & intergrana
(3) Disoidal with well developed grana
(4) Discoidal with poorly developed grana

SPIROGYRA

Q.26 Replicate septum occurs in -
(1) ***Ulothrix*** (2) ***Spirogyra***
(3) ***Chlamydomonas*** (4) All the above

Q.27 On germination each zygosopre of ***Spirogyra*** gives rise to-
(1) Four plants (2) Three plants
(3) Two plants (4) One plant

Q.28 Filament of ***Spirogyra*** is-
(1) Branched and filamentous
(2) Unbranched and filamentous
(3) Highly branched
(4) All the above

Q.29 ***Spirogyra*** also known as-
(1) Thread of wool (2) Water silk
(3) Pond silk (4) 2 and 3 both

Q.30 Gametes of ***Spirogyra*** are-
(1) Biflagellated (2) Multiflagellated
(3) Quadriflagellated (4) Non flagellated

Q.31 ***Spirogyra*** found in-
(1) Stagnant fresh water
(2) Running salt water
(3) Stagnant salt water
(4) Running fresh water

Q.32 Food is stored in ***Spirogyra*** in-
(1) Chloroplast (2) Pyrenoid
(3) Vacuole (4) Cytoplasm

Q.33 Scalariform conjugation occurs in-
(1) ***Ulothrix*** (2) ***Oedogonium***
(3) ***Spirogyra*** (4) ***Chlamydomonas***

Q.34 Which of the following produce non motile gametes-
(1) ***Ulothrix*** (2) ***Spirogyra***
(3) ***Anabaena*** (4) ***Cladophora***

Q.35 The sexual reproduction in ***Spirogyra*** is-
(1) Oogamous
(2) Physiological Anisogamous
(3) Cleistogamous
(4) None

Q.36 The zygospore of ***Spirogyra*** produces-
(1) 2-zoospores (2) 4-zoospores
(3) 2-4 zoospores (4) None of these

Q.37 The product of conjugation ***Spirogyra*** is called-
(1) Zoospores (2) Akinete
(3) Chlamydospore (4) Zygospore

Q.38 Flagellated stage are absent in-
(1) ***Ulothrix*** (2) ***Albugo***
(3) ***Spirogyra*** (4) ***Chlamydomonas***

Q.39 Which is the commn and advanced type of conjugation in ***Spirogyra***-
(1) Direct lateral conjugation
(2) Indirect lateral conjugation
(3) Scalariform conjugation
(4) None of these

Q.40 No growth of ***Spirogyra*** can occur in-
(1) River (2) Ponds
(3) Streams (4) Sea

RICCIA

Q.41 ***Riccia*** is a liverwort due to its-
(1) Use in liver disease (2) Liver like colour
(3) Shape
(4) Cause of liver disease

Q.42 How does the dehiscence of sporogonium and dispersal of spores occur in ***Riccia.***
(1) By internal pressure of elaters
(2) By death and decay of thallus and sporogonium and external pressure on calyptra
(3) By peristome teeth and seta
(4) By shrinking of annulus and dehiscence of capsule

Q.43 Scales on margins of ***Riccia*** are arranged in -
(1) Basipetal order (2) Acropetal order
(3) Scattered (4) None of the above

Q.44 Which of the following type of scales are found in ***Riccia***-
(1) Multicelled and ligulate
(2) Multicelled and appendiculate
(3) Unicelled and appendiculate
(4) Unicelled and ligulate

Q.45 In which of the following, sporogonium is having nurse cells-
(1) *Porella* (2) *Anthoceros*
(3) *Riccia* (4) *Marchantia*

Q.46 Rhizoids of **Riccia** are-
(1) One type and scattered
(2) One type and arranged in rows
(3) Two types and scattered
(4) Two type and arranged in rows

Q.47 Vegetative propagation is most common in -
(1) Fern sporophyte (2) Fern gametopyte
(3) *Riccia* gametophyte (4) *Riccia* sporophyte

Q.48 Where do air chambers occur in *Riccia*-
(1) Storage region
(2) Assimilatory zone
(3) Both (1) and (2)
(4) Below the lower epidermis

Q.49 Rosette habit of *Riccia* is due to-
(1) Dichotomous brancing
(2) Sympodial branching
(3) Monopodial branching
(4) Assymetrical branching

Q.50 How many antherozoids are produced from an Androgonial cell in *Riccia*-
(1) One (2) Two
(3) Three (4) Four

Q.51 What type of sexual reproduction occurs in *Riccia*-
(1) Isogamous (2) Anisogamous
(3) Oogamous (4) Conjugation

Q.52 The gametophytic phase of *Riccia* ends with-
(1) Gamete (2) Spore mother cells
(3) Spore (4) Oospore

Q.53 Aquatic *Riccia* are-
(1) Free floating (2) Submerged
(3) Amphibians (4) Suspended

Q.54 Spores release from sporogonium in *Riccia* take place in-
(1) Dry-season (2) Wet-season
(3) High temperature (4) Low temperature

Q.55 Cells of calyptra and wall of sporogonium in *Riccia* are respectively-
(1) Diploid, Diploid (2) Haploid, Haploid
(3) Triploid, Triploid (4) Haploid, Diploid

Q.56 Sex organ in *Riccia* develop on-
(1) Dorsal surface in acropetal order
(2) Dorsal surface in basipetal order
(3) Ventral surface in acropetal order
(4) Ventral surface in basipetal order

Q.57 Which statement/s is/are true-

(1) In *Riccia*, sporophyte is made up of only capsule

(2) In *Riccia* thallus rhizoids are present on ventral (adaxial) surface

(3) Six to eight cells are present in the axis of archegonium of *Riccia*

(4) All of these

Q.58 In dry weather, *Riccia* survives in form of-

(1) Tubers (2) Peristent apices

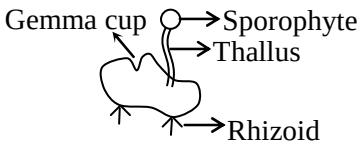
(3) Spores (4) All the above

Q.59 At the time of fertilization, how many cell/cells is/are present in the axis of archegonium of *Riccia*-

(1) One (2) Two

(3) Three (4) Four

Q.60 Given diagram related to which plant group :



(1) Thallophyta (2) Pteridophyta

(3) Bryophyta (4) Gymnosperm

Q.61 During formation of calyptra jacked cells divided by-

(1) Periclinal division (2) Anticlinal division

(3) Both (1) and (2) (4) Diagonal division

Q.62 In which of the following groups would you place a plant which produces spores and embryos but lacks seeds and vascular tissues-

(1) Bryophytes (2) Pteridophytes

(3) Gymnosperms (4) Fungi

Q.63 In aquatic *Riccia*-

(1) Rhizoids absent

(2) Scales poorly developed or absent

(3) Air canals more developed

(4) All the above

Q.64 Which characteristic assign *Riccia* to bryophyte-

(1) Depended sporophyte

(2) Plant body thallus

(3) Free gametophyte

(4) Non vascular

Q.65 In the life cycle of *Riccia* from 20 Androgonial cells, how many antherozoids will be formed-

(1) 10 (2) 20

(3) 40 (4) 80

Q.66 Which structure protects apical meristem in *Riccia* -

(1) Apical notch (2) Scales

(3) Primordial leaves

(4) Position of sex organ

Q.67 Which species of *Riccia* reproduces by Persistent apices-

(1) *R.glauca* (2) *R.curtisi*

(3) *R.bischoffii* (4) *R.discolor*

Q.68 The cell walls of mature spores in Riccia have

(1) One layer (2) Two layer

(3) Three layer (4) None of these

Q.69 If '6' chromosomes are present in each cell of the spore tetrad of *Riccia*. How many chromosomes should be present in the cells of apical cell and calyptra? Respectively-

(1) 6 & 12 (2) 6 & 6

(3) 12 & 6 (4) 3 & 6

Q.70 Bryophytes grow in moist and shady environments because-

(1) They cannot grow on land

(2) They requires water for fertilization

(3) They lack vascular tissue

(4) They lack roots and stomata

FUNERIA

Q.71 The two layers of teeth in the peristome of moss are-

(1) Decorative part functioning like sepals and petals in a flower

(2) Parts which help in the discharge of spores only when the capsule matures. After the operculum falls. They dry up and open out

(3) Parts which help in the gradual dispersal of spores. The upper teeth are hygroscopic and open out only in dry weather. The lower ones check sudden dispersal

(4) Part which help in the dispersal of spores. They are not hygroscopic and allow the discharge of spores by disintegration of capsule wall

Q.72 A bryophytes differs from Pteridophytes in-
(1) Presence of archegonia
(2) Lack of vascular tissues
(3) Presence of swimming antherozid
(4) Independent gametophyte

Q.73 Funaria is included in Bryophytes because-
(1) Heteromorphic alternation of generation
(2) It lacks roots
(3) Sporophyte is attached to gametophyte
(4) It lacks xylem

Q.74 Rhizoids of Funaria are-
(1) Multicellular
(2) Unicellular
(3) Multicellular, branched with oblique septum
(4) Tuberculated

Q.75 Conducting tissues in moss is made up of-
(1) Xylem (2) Parenchyma
(3) Collenchyma (4) Xylem and Phloem

Q.76 In Moss, medulla has -
(1) Piliferous layer (2) Endodermis
(3) Hadrome (4) Hypodermis

Q.77 Which of the following type of sex organs are found in ***Funaria***-
(1) Projecting and sessile
(2) Projecting and stalked
(3) Embedded and sessile
(4) Embedded and stalked

Q.78 In ***Funaria*** -
(1) Male and female reproductive organ are present on same branch
(2) Male and female reproductive organ are present on the different branches of same plant.
(3) Male and female reproductive organs on different plant
(4) None of these

Q.79 Which one of the following is not a part of moss gametophyte-
(1) Calyptra (2) Spore
(3) Protonema (4) Columella

Q.80 Why Mosses are found in moist regions -
(1) Because water is needed for fertilization
(2) Because rate of transpiration is very high
(3) Because it is free floating hydrophyte
(4) None of these

Q.81 Cells in leaves of *Funaria* are-
(1) Polyploid (2) Diploid
(3) Haploid (4) Haploid & Diploid

Q.82 The number of cells in neck canal of archegonium of Moss is -
(1) 1 (2) 2
(3) 4 (4) 6-10

Q.83 The sporophytic phase in *Funaria* is composed of -
(1) Foot and capsule
(2) Foot, seta and capsule
(3) Capsule only
(4) Spore sac

Q.84 Moss capsule represents -
(1) Gametophyte
(2) Sporophyte
(3) A part of protonema
(4) A part of sorus

Q.85 Stomata are present in *Funaria* plant on the-
(1) Upper part of capsule
(2) Lower part of capsule
(3) Leaf
(4) Stem

Q.86 Annulus of Moss capsule separates-
(1) Theca and columela
(2) Columela from apophysis
(3) Operculum and columela
(4) Operculum from theca

MUCOR & RHIZOPUS

Q.87 Reproduction in Mucor takes place by
(1) Anisogametes (2) Isogametangia
(3) Agametes (4) None

Q.88 The zygospore of Mucor thick walled and its colour is
(1) Blue (2) White
(3) Green (4) Black

Q.89 Zygospore of Mucor germinates to form
(1) Mycelium (2) Promycelium
(3) Germ tube (4) Hyphae

Q.90 In Mucor, heterothallism was discovered by -
(1) Lederberg and Tatum
(2) Debary
(3) Pontecorvo
(4) Blakeslee

Q.91 Yeast like budding of oidia in Mucor is termed as
(1) Gongrosira stage (2) Torula stage
(3) Palmella stage (4) None

Q.92 Thick walled spore like structure formed in the mycelium of Mucor are named as -
(1) Hypnospore (2) Akinetes
(3) Oidia (4) Chlamydospores

Q.93 How many zones are present in the sporangia of Mucor which develops from a vegetative mycelium -
(1) Two (2) Three
(3) Four (4) Five

Q.94 Zygospores are formed in -
(1) Puccinia (2) Penicillium
(3) Alternaria (4) Mucor

Q.95 Coenogametes are formed in -
(1) Mucor (2) Puccinia
(3) Pencillium (4) Ustilago

Q.96 Torula condition occurs in
(1) Mucor (2) Rhizopus
(3) Both (1) and (2) (4) Puccinia

ALBUGO & CYSTOPUS

Q.97 The disease produced by Albugo on the crucifers is
(1) Rust (2) White-rust
(3) Red rust (4) Black-rust

Q.98 The mycelium of the albugo is
(1) Inter cellular, septate
(2) Intracellular, aseptate
(3) Intra cellular, septate
(4) Intercellular, aspetate

Q.99 From one crop to next another; the infection of Albugo reaches in the form of
(1) Conidia (2) Mycelium
(3) Oospore (4) Zoospore

Q.100 The male gamete in albugo reaches to the female gamete by
(1) Flagella (2) Fertilization tube
(3) Swimming (4) Chemotaxis

Q.101 Which of the following sets of conditions favour rapid spread of white rust disease
(1) High temperature + High humidity
(2) Low temperature + High Humidity
(3) High temperature + Low humidity
(4) Low temperature + Low humidity

Q.102 *Albugo bliti* attacks on
(1) *Sonchus* (2) *Portulaca*
(3) *Amaranthus* (4) Sweet potato

Q.103 Haustoria of albugo are
(1) Sessile (2) Stalked
(3) Appendiculate (4) Biramous

Q.104 Sexual reproduction in albugo produced which type of symptoms on host plant
(1) Hypertrophy & deformation
(2) Raised white spots
(3) Phylloidy (4) All the above

Q.105 After fertilization ***coenocentrum*** in albugo
(1) Persists (2) Grows in size
(3) Grows in number (4) Disappears

Q.106 Haustoria of Albugo is
(1) Club shaped (2) Button shaped
(3) Palmate (4) Pinnate

Q.107 Viruses are similar to albugo in
(1) Being obligate parasite
(2) Having DNA as genetic material
(3) Being Coenocytic
(4) All the above

Q.108 Resting oospore of *A.candida* contains
(1) 100-nuclei (2) 64-nuclei
(3) 32-nuclei (4) One nucleus

Q.109 Which of the following is the source of primary infection by Albugo candida
(1) Soil born oospores
(2) Conidia born on ***Cleome visocsa***
(3) Conidia born on crop host
(4) 1 and 2 both

Q.110 Albugo is
(1) Intercellular, obligate parasite
(2) Intracellular, obligate parasite
(3) Intercellular, facultative parasite
(4) Intercellular, facultative saprophyte

Q.111 Which stain and mount are generally used for fungi
(1) Cotton blue and glycerine
(2) Saffranine and glycerine
(3) Cotton blue and Lactophenol
(4) Eosine & Lactophenol

Q.112 Conidia of ***Albugo-candida*** collected from mustard are not infective to raddish leaves because
(1) Thick cuticle on raddish leaves
(2) Raddish leaves secrete antibiotics
(3) Biological specialization in Albugo-candida
(4) Biological specialization is radish

Q.113 Study of secondary infection is called
(1) Etiology (2) Ecology
(3) Epidemiology (4) Pathology

Q.114 Bordeaux mixture is first fugicide, is discovered by
(1) Millardet (2) De-berry
(3) Mitchelli (4) Alexopolus

Q.115 How many nuclei is/are found in conidia of Albugo
(1) 1 (2) 2-3
(3) 3-8 (4) Many

Q.116 At what stage septa are formed in Albugo
(1) At the time of vegetative growth
(2) At the time of haustorial formation
(3) At the time of sexual & asexual reproduction
(4) Never Formed

Q.117 Albugo is found
(1) In dung
(2) In streams
(3) In decaying organic matter
(4) On the leaves of a living plant

Q.118 Which part of the plant is not infected by Albugo
(1) Stem (2) Root
(3) Leaf (4) Flowers

Q.119 Most common method of asexual reproduction in Albugo, by
(1) Zoosporangia (2) Aplanospores
(3) Conidiosporangia (4) Zygospore

SELAGINELLA

Q.120 Main plant body of the selaginella is :
(1) A gametophyte (2) A sporophyte
(3) Half gametophyte (4) Haploid phase

Q.121 The number of megaspores in ***Selaginella rupestris*** is:
(1) One (2) Two
(3) Three (4) Four

Q.122 Which is the epiphytic species of selaginella
(1) S. Lepidophylla (2) S. Oregana
(3) S. kraussiana (4) S. rupestris

Q.123 The 13-celled male gametophyte of Selaginella has
(1) 10 cells of the antheridium + 1 prothallial cells
(2) 12 cells of the antheridium + 1 prothallial cells
(3) 9 cells of the antheridium + 4 prothallial cells
(4) 8 cells of the antheridium +5 prothallial cells

Q.124 Which organ of the selaginella is "Organ sui-generis"-
(1) Root (2) Stem
(3) Ligule (4) Rhizophore

Q.125 Which type of stele is found in rhizophore of selaginella
(1) Monarch (2) Diarch
(3) Triarch (4) Polyarch

Q.126 Rhizophore is not a true root because it is
(1) Endogenous (2) Exogenous
(3) Intermediate (4) None of above

Q.127 Glossopodium is found in selaginella-
(1) In root (2) In rhizophore
(3) In stem (4) In leaves

Q.128 How many cotyledons are present in embryo of selaginella
(1) Two cotyledons (2) One cotyledons
(3) Many cotyledons (4) Cotyledon absent

Q.129 By which type of leaf is found in selaginella
(1) Aligulate and microphyllous
(2) Ligulate and megaphyllous
(3) Ligulate and microphyllous
(4) Aligulate and megaphyllous

Q.130 In which of the following trabeculated endoderm is found
(1) Funaria (2) Selaginella
(3) Monocots (4) Dicots

Q.131 By in which character selaginella is alike as Gymnosperm
(1) In heterospory (2) In vascular tissues
(3) Cone (4) All of the above

Q.132 Which structure is developed from microspore of the selaginella
(1) Male gametophyte
(2) Female gametophyte
(3) Male sporophyte
(4) Female sporophyte

Q.133 In which plant, male and female sporangia are developed in same plant
(1) Dryopteris (2) Cycas
(3) Selaginella (4) Nephrolepis

PTERIDIUM

Q.134 Which of the following venation is characteristic of fern -
(1) Parallel
(2) Reticulate
(3) Open and furcate
(4) Closed and dichotomous

Q.135 The most important characteristic of a fern plant is -
(1) Circinate pinnules
(2) Photosynthetic sporophyll
(3) Compound leaves
(4) Spores in sporangia

Q.136 The stele of **Pteridium** root is -
(1) Diarch, exarch
(2) Diarch, endarch
(3) Polyarch, exarch
(4) Polyarch, endarch

Q.137 Meristele of **pteridium** is -
(1) Collateral
(2) Concentric and leptocentric
(3) Bicollateral and leptocentric
(4) Amphicribral and mesarch

Q.138 Sori of **Pteris** and **Pteridium** are -
(1) Continous and linear
(2) Discontinous and circular
(3) Discontinous and reniform
(4) Discontinous and vermiform

Q.139 Protective structure of fern sorus is -
(1) Ramenta (2) Indusium
(3) Tapetum (4) Stomium

Q.140 The shape of fern sporangium is -
(1) Bi-concave (2) Bi-convex
(3) Plano-convex (4) Plano-concave

Q.141 Which combination of characteristics is correct for a fern sporangium -
(1) Sessile, Unicellular, non-jacketed
(2) Stalked, unicellular, non jacketed
(3) Sessile, multicellular, non jacketed
(4) Stalked, multicellular, jacketed

Q.142 Which of the following statements is not correct for **Pteridium** -
(1) Young sporophyte is parasite on gametophyte
(2) Free alternation of generation
(3) Exhibits a step in evolution of seed habit
(4) Gametophyte is parasite on sporophyte

Q.143 In **Pteridium** cross fertilization take place due to -
(1) Protandry (2) Protogyny
(3) Dicliny (4) Monocliny

Q.144 In **Pteridium,** antheridium and archegonium are respectively -
(1) Stalkless and stalked
(2) Stalked and stalkless
(3) Both stalked
(4) Both stalkless

Q.145 Embryonal leaves of **Pteridium** are -
(1) Simple
(2) Bipinnate-Paripinnate
(3) Bipinnate-Imparipinnate
(4) Unipinnate

Q.146 True and false indusia can be differentiated on the basis of -
(1) Origin (2) Function
(3) Structure (4) All the above

Q.147 Stem of **Pteridium** is -
(1) Vertical in soil (2) Horizontal in soil
(3) Tuber like (4) Sub-aerial

Q.148 Dehiscence of sporangium in pteridium take place -
(1) In dry season by water loss
(2) In wet season by water absorption
(3) By mucilage formation
(4) Any of above

Q.149 In Fern stem xylem is -
(1) Exarch (2) Mesarch
(3) Endarch (4) Polyarch

Q.150 Neck of the archegonium of fern is -
(1) Long & Straight (2) Short and straight
(3) Long and curved (4) Short and curved

Q.151 Leaf-gap in the vascular cylinder in fern is -
(1) Air space
(2) Parenchymatous zone
(3) Collenchymatous zone
(4) Area exclusively of phloem

Q.152 The ferns are usually found in -
(1) Near marshy places
(2) Marshy places
(3) Moist and shady places
(4) Dry climate

Q.153 The sori bearing leaves of pteridium are known as -
(1) Apophylls (2) Sporophylls
(3) Tropophylls (4) Sclerophylls

Q.154 The Chief characteristic of ferm leaf is that they-
(1) Have ramenta
(2) Are microphyllous
(3) Have ramenta and circinate vernation when young
(4) Are simple

Q.155 In **Pteridium** the root are -
(1) tap root (2) Adventitious roots
(3) Rhizoids (4) Coralloid

Q.156 In **Pteridium,** main plant body represent -
(1) Sporophytic generation
(2) Gametophytic generation
(3) None of the above
(4) May be sporophyte

Q.157 The **Prothallus** of pteridium is -
(1) Kidney shaped (2) Club-shaped
(3) Heart shaped (4) Flask shaped

Q.158 The stem and petiole are covered with numerous brownish scale like structure which are called -
(1) Root hair (2) Hairs
(3) Ramenta (4) Scales

Q.159 The **pteridium** plant is -
(1) Homosporous
(2) Heterosporous
(3) None of the above
(4) May be heterosporous or Homosporous

Q.160 The prothallus of **Pteridium** represents -
(1) Sporophytic generation
(2) Gametophytic generation
(3) Both of the above
(4) Asexual stage

Q.161 The sex organs that develop towards the rhizoids of fern prothallus are called as -
(1) Archegonia (2) Antheridia
(3) None of above (4) Sporangia

Q.162 In **Pteridium the archegonia** are present -
(1) Near rhizoids on lower surface
(2) Near anterior notch on lower surface
(3) Distributed on whole surface
(4) On posterior end of prothallus

Q.163 The stele of **pteridium** is a -
(1) Dictyostele (2) Eustele
(3) Siphonostele (4) Protostele

Q.164 The sori of pteridium are covered by a thick multicellular covering known as -
(1) Indusium (2) Ramenta
(3) Stele (4) Sclerenchyma

Q.165 The sori in pteridium are found on -
(1) Lateral surface of sporophyll
(2) Abaxial surface of sporophyll
(3) Adaxial surface of sporophyll
(4) On the margins of leaves

Q.166 The capsule of sprogonium of fern contains-
(1) 32 or 64 spores (2) 8 spores
(3) 128 spores (4) 16 spores

Q.167 The capsule of fern sporangium brust at a place called -
(1) Annulus (2) Stomium
(3) Placenta (4) Ramenta

Q.168 Which of the following is not involved in the fertilization of ferns -
(1) Pollen tube (2) Water
(3) Archegonium
(4) Flagellated antherozoids

Q.169 Pteridium prothallus normally is -
(1) Haploid (2) Diploid
(3) Tetraploid (4) Triploid

Q.170 The major role in the dehiscence of a fern sporangium is played by its -
(1) Indusium (2) Annulus
(3) Stomium (4) None of these

Q.171 Spores of **Pteridium are -**
(1) Haploid (2) Diploid
(3) Tetraploid (4) Hexaploid

Q.172 In the archegonium of **Pteridium** the number of neck-canal cells is / are -
(1) 4 (2) 2
(3) 3 (4) 1

Q.173 Prothallus of pteridium bears -
(1) Sporangia (2) Sex organ
(3) Both sporangia and sex organ
(4) None of the above

CYCAS

Q.174 Female cone is absent in which gymnosperm :
(1) Cycas (2) Pinus
(3) Ephedra (4) None of these

Q.175 How many species of Cycas are found in India:
(1) 20 (2) 4
(3) 2 (4) 1

Q.176 How many kinds of leaves are found in Cycas :
(1) 3 (2) 2
(3) 1 (4) 0

Q.177 Cycas trunk is covered with :
(1) Leaves (2) Leaf bases
(3) Scale leaves (4) Both (1) and (2)

Q.178 Inverted 'Omega' (Ω) shaped arrangement of vascular bundles are found in :
(1) Cycas leaf (2) Cycas rachis
(3) Cycas stem (4) Cycas root

Q.179 Transfusion tissue is found in :
(1) Cycas leaf (2) Cycas leaflet
(3) Cycas petiole (4) Cycas root

Q.180 Cycas is :
(1) Monoecious (2) Dioecious
(3) Sterile (4) None of these

Q.181 Pollen grains are shed at ..... celled stage in Cycas :
(1) 4 (2) 3
(3) 2 (4) 1

Q.182 The number of prothallial cells in male gametophyte of Cycas is :
(1) 1 (2) 2
(3) 3 (4) 0

Q.183 Cycas ovule is :
(1) Orthotropous and unitegmic
(2) Orthotropous and bitegmic
(3) Anatropous and unitegmic
(4) None of the above

Q.184 How many archegonia develop on one gametophyte of Cycas :
(1) 1 (2) 2
(3) 1 - 5 (4) 3 - 6

Q.185 Male gametes are largest and visible to naked eyes in :
(1) Cycas (2) Pinus
(3) Gnetum (4) Ginkgo

Q.186 The number of neck canal cells in the archegonium of Cycas is/are :
(1) 2 (2) 4
(3) 6 (4) 0

Q.187 The number of cotyledons in seed of Cycas is/are :
(1) 1 (2) 2
(3) Many (4) All of these

Q.188 Cycas plant is like ..... in appearance :
(1) Mango (2) Wheat
(3) Palm (4) Ficus

Q.189 Leaves in Cycas show :
(1) Hydrophytic characters
(2) Xerophytic characters
(3) Mesophytic characters
(4) Lithophytic characters

Q.190 Stem of Cycas contains :
(1) Pycnoxylic wood (2) Manoxylic wood
(3) Heart wood (4) Porous wood

Q.191 Number of ovules present on megasporophyll of Cycas is :
(1) Only one (2) One pair
(3) 1-6 pairs (4) Absent

Q.192 Cycas is a gymnosperm because
(1) It form seeds
(2) It bear pollen grains
(3) It lacks ovary but has exposed ovules
(4) Its xylem consists of tracheids

PINUS

Q.193 Which of the following is commonly known as "Blue pine" : -
(1) ***Pinus roxburghii***
(2) ***P.Strobus***
(3) ***P. Wallichiana***
(4) ***P. Sylvestris***

Q.194 Which is commonly known as "Khasi Palm"
(1) ***Pinus strobus*** (2) ***P. wallichiana***
(3) ***P. sylvestris*** (4) ***P. insularis***

Q.195 Why **Pinus** seedling do not grow on places after fire. This is because the soil becomes
(1) Hard
(2) Devoid of bacteria
(3) Dry (4) Devoid of fungi

Q.196 Foliage leaves of Pinus are borne on :
(1) Branches of unlimited growth
(2) Branches of limited growth
(3) Both of above
(4) None of above

Q.197 Which type of resin canal are found in cortex and secondary xylem of the stem of Pinus : -
(1) Schizogenous cavities
(2) Lysigenous cavities
(3) Schizolysigenous cavities
(4) None of these

Q.198 Dimorphic branches and leaves are found in -
(1) Pea (2) Cycas
(3) Pinus (4) Fern

Q.199 Sclerenchymatous hypodermis in Pinus needle helps in
(1) Mechanical support
(2) Checking transpiration
(3) Photosynthesis
(4) Increasing the absorptive surface of the cell

Q.200 The mesophyll tissue of Pinus needle is -
(1) Collenchyma
(2) Spongy parenchyma
(3) Armed parenchyma
(4) Transfusion tissue

Q.201 In *Pinus roxburghii*, microsporophyll are having :
(1) 2 Microsporangia on abaxial side
(2) 4 Microsporangia on adaxial side
(3) 2 Microsporangia on adaxial side
(4) 4 Microsporangia on abaxial side

Q.202 Vascular bundles in leaves of Pinus needle are:
(1) Collateral & closed
(2) Collateral & open
(3) Radial (4) None of above

Q.203 Foliar spur of **Pinus sylvestris** is called : -
(1) Unifoliar (2) Bifoliar
(3) Trifoliar (4) Pentafoliar

Q.204 Vascular bundle in stem of Pinus is : -
(1) Conjoint, Collateral and Endarch
(2) Conjoint, Collateral and Exarch
(3) Radial and diarch
(4) Conjoint, Bicollateral and Endarch

Q.205 **Pinus armandi** is known as : -
(1) Unifoliar (2) Bifoliar
(3) Trifoliar (4) Penta foliar

Q.206 **Pinus** is a cold xerophyte, its adaptation is/are-
(1) Thick cuticle & sunken stomata
(2) Sclerenchymatous hypodermis in leaves
(3) Compact mesophyll of armed parenchyma
(4) All the above

Q.207 Male cone of **Pinus** is a modification of
(1) Long shoot (2) Dwarf shoot
(3) Megasporophylls (4) Vegetative leaves

Q.208 What causes sulphur clouds in spring season of temperate climate :
(1) Male gametophytes of Pine
(2) Male gamets of Pine
(3) Volatile resin & turpentine
(4) Sulphur bacteria

Q.209 The male gametophyte of gymnosperms differ from angiosperms in having -
(1) One or more prothallial cells
(2) No prothallial cells
(3) One male gamete
(4) One tube nucleus

Q.210 Wings of **Pinus** pollen grains are -
(1) Multicellular (2) Unicellular
(3) Acellular (4) Coenocytic

Q.211 If the chromosome number of cells of nucellus of megasporangium of Pinus 16 (sixteen) what would be the chromosome number of endosperm cells :
(1) 32 (2) 16
(3) 48 (4) 08

Q.212 Female cone of **Pinus** is considered a modified
(1) Flower (2) Dwarf shoot
(3) Long shoot (4) Sporophyll

Q.213 The ovuliferous scale of **Pinus** is part of -
(1) Microsporophyll (2) Ovule
(3) Dwarf shoot (4) Megasporophyll

Q.214 In Pinus the megaspore after germination develops into -
(1) Endosperm with naked egg
(2) Endosperm with embryo sac
(3) Endosperm with archegonia
(4) Pollen tube with two motile male gametes

Q.215 In **Pinus** oospore develops into
(1) Compound suspensor with a single embryonal mass
(2) No suspensor but single embryo mass
(3) Compound coiled suspensor with four embryo masses formed by cleavage polyembryony
(4) Simple suspensor with single embryo

Q.216 What is the intermediate stage in the development of the embryo of Pinus
(1) Protonema (2) Polyembryony
(3) Proembryo (4) Protocorm

Q.217 The development of embryo in **Pinus** is
(1) Discoblastic (2) Meroblastic
(3) Periblastic (4) Mesoblastic

Answer Key

Exercise – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	4	4	2	4	1	3	2	1	3	1	3	4	1	2	3	2	1	2	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	4	3	1	2	2	4	2	4	4	1	2	3	2	2	4	4	3	3	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	2	2	1	3	3	3	2	1	2	3	1	1	2	4	1	4	4	1	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	1	4	1	3	2	4	3	2	2	3	2	3	3	2	3	2	2	4	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	4	2	2	2	4	2	4	2	4	2	4	1	4	1	3	2	4	3	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	3	2	1	4	2	1	3	4	1	3	3	3	1	3	3	4	2	3	2
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	2	2	4	1	2	4	1	3	2	4	1	3	3	1	1	4	1	2	2
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	4	4	1	4	1	1	2	1	2	4	2	3	2	3	2	1	3	3	1	2
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	2	2	1	1	2	1	2	1	1	2	1	4	2	1	2	2	2	2	2	2
Ques.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
Ans.	2	1	1	4	1	4	2	3	2	2	3	3	3	4	4	2	1	3	1	3
Ques.	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217			
Ans.	1	2	2	1	4	4	2	1	1	3	4	2	4	3	3	3	2			

EXERCISE – 2

ULOTHRIX

Q.1 Hold-fast of *Ulothrix* is-
(1) Living and without chloroplast
(2) Living and without nucleus
(3) Non-living and without chloroplast
(4) Non-living and with nucleus

Q.2 Red eye spot of zoospores of *Ulothrix* is made up of-
(1) Lycopene (2) Haematochrome
(3) Carotene (4) Leutine

Q.3 The name "Palmella Stage" is after the name of a-
(1) Lady (2) Slime molds
(3) Scientist (4) Algae

Q.4 How many mating types occur in *Ulothrix*-
(1) One (2) Two
(3) Three (4) Many

Q.5 Vegetative reproduction in Ulothrix takes place by-
(1) Parthenogenesis (2) Fragmentation
(3) Harmogonium (4) Aplanospore

Q.6 Lithophytic species of Ulothrix is-
(1) ***U. implexa*** (2) ***U. flacca***
(3) ***U. zonata*** (4) ***U. flaccida***

Q.7 In Ulothrix food is stored in the form of-
(1) Protein (2) Starch
(3) Pyrenoid (4) Lipid

Q.8 Which type of sexual reproduction occurs in Ulothrix-
(1) Isogamous (2) Anisogamous
(3) Oogamous (4) Conjugation

Q.9 In Ulothrix, Zygote is initially-
(1) Uniflagellate (2) Biflagellate
(3) Quadriflagellate (4) Aflagellate

Q.10 One celled sporophyte are found in-
(1) Ulothrix (2) Riccia
(3) Moss (4) Fern

Q.11 The zoospores of Ulothrix exhibit a closer resemblance to the thallus of -
(1) Ulothrix (2) Chlamydomonas
(3) Palmella (4) Chlorella

Q.12 Micro zoospores in Ulothrix are-
(1) Biflagellate (2) Quadri flagellate
(3) Both (1) & (2) (4) Multiflagellate

Q.13 How many zoospores are produced in a single cell of Ulothrix-
(1) 1-8 (2) 8-16
(3) 8-32 (4) 8-64

Q.14 The type of zoospores not formed in Ulothrix are-
(1) Qudriflagellated macro zoospores
(2) Qudriflagellated micro zoospores
(3) Biflagellated macro zoospores
(4) Biflagellated micro zoospores

Q.15 How many chloroplast occur in Ulothrix cell-
(1) One, Girdle shaped (2) Two, star shaped
(3) Three, Girdle shaped
(4) Biflagellated zoospores

Q.16 The zoo gametangia and zoo sporangia of Ulothrix are-
(1) Jacketed and unicellular
(2) Non-jacketed and unicellular
(3) Jacketed and multi cellular
(4) Non jacketed and multi cellular

Q.17 Parthenogenesis in Ulothrix forms a resting structure called-
(1) Zygospore (2) Azygospore
(3) Hypnospore (4) Zoospores

Q.18 The cause of polarity in Ulothrix is due to-
(1) Apical cell (2) Basal cell
(3) Intercalary cell
(4) Both apical and Basal cell together

Q.19 Which of the following reproductive structure is equivalent to a complete cells-
(1) Aplanospore (2) Zoospore
(3) Akinete (4) Hypnospore

Q.20 Ulothrix is-
(1) A colonial algae
(2) An anchored & branched algae
(3) An attached filamentous algae
(4) A free floating algae

Q.21 Filaments of Ulothrix are-
(1) Brick shaped (2) Branched
(3) Girdle shaped (4) Unbranched

Q.22 How many thalli (filaments) are produced from the germination of a zygospore of Ulothrix-
(1) 1-4 (2) 4-16
(3) 16-32 (4) 4-64

Q.23 What type of nuclear division occurs at the time of the germination of zoospores and zygospore respectively?
(1) Both mitotic (2) Mitotic and meiotic
(3) Meiotic and mitotic (4) Both meiotic

Q.24 If total 52 cells are present in a Ulothrix filament, how many of them can divided to produce zoospore or aplanospores-
(1) All the 52 (2) 51 only
(3) 40 only (4) 1 only

Q.25 Ulothrix cell have a double layered cell-
(1) The outer of cellulose and inner of protopectin
(2) Inner of cellulose and outer of protopectin
(3) Both of cellulose
(4) Both of pectin

Q.26 In Ulothrix the common mode of Asexual reproduction take place by-
(1) Aplanospores (2) Macro-zoospores
(3) Micro-zoospores
(4) Macro & micro zoospores

SPIROGYRA

Q.27 In ***Spirogyra***, Meiosis occurs-
(1) During conjugation
(2) During vegetative reproduction
(3) During formation of gametes
(4) As the zygospores germinates

Q.28 ***Spirogyra*** belongs to-
(1) volvocales (2) conjugales
(3) ulotrichales (4) siphonales

Q.29 Which is not true for ***Spirogyra***-
(1) Spiral chloroplast
(2) Presence of pyrenoids
(3) Flagellated zoospores
(4) Presence of chlorophyll 'a' and 'b'

Q.30 Ribbon shaped chloroplast is found in-
(1) ***Spirogyra*** (2) ***Ulothrix***
(3) ***Chlamydomonas*** (4) ***Nostoc***

Q.31 How many chloroplast occur in a single cell of ***Spirogyra***-
(1) One to four (2) One to eight
(3) Four to eight (4) One to sixteen

Q.32 The outer cell-wall of ***Spirogyra*** is made up of-
(1) Cellulose (2) Pectin/Pectose
(3) Hemicellulose (4)Protein

Q.33 Cell wall of ***Spirogyra*** is-
(1) One layered (2) Two layered
(3) Three layered (4) Four layered

Q.34 ***Spirogyra*** is more advanced than ***Ulothrix*** because it has-
(1) Internal fertilization
(2) Multicellular thallus
(3) Absence of hold fast
(4) Heterothallic thallus

Q.35 ***Spirogyra*** appear ladder like during-
(1) Lateral conjugation
(2) Direct lateral conjugation
(3) Scalariform conjugation
(4) Semidrying condition

Q.36 In which of the following plant archegonium is absent -
(1) ***Spirogyra*** (2) ***Funaria***
(3) ***Pteris*** (4) ***Cycas***

Q.37 At the time of germination of zygospore in ***Spirogyra***-
(1) All haploid nuclei are functional
(2) Only one haploid nucleus is functional
(3) Diploid nucleus does not divide
(4) Diploid nucleus divides mitotically

Q.38 Pyrenoid is found in one of the following organs of ***Spirogyra***-
(1) Nucleus (2) Chloroplast
(3) Cytoplasm (4) Cell wall

Q.39 Sexual reproduction in ***Spirogyra*** is an advanced feature because it shows-
(1) Different sizes of motile sex organs
(2) Same size of motile sex organs
(3) Morphologically different sex organs
(4) Physiologically differentiated sex organs

Q.40 The sexual reproduction in which cells of two different spirogyra filaments conjugate is known as-
(1) Lateral conjugation
(2) Scalariform conjugation
(3) Parthenospory
(4) Azygospory

Q.41 ***Spirogyra*** has a-
(1) Haplontic life cycle
(2) Haplodiplontic life cycle
(3) Diplontic life cycle
(4) Diplohaplontic life cycle

RICCIA

Q.42 What is the function of the Ventral scales of *Riccia*-
(1) Fixation
(2) Absorption and protection
(3) Protection
(4) Perennation and protection

Q.43 In *Riccia*, stomata are found on-
(1) Dorsal assimilatory region
(2) Sporangium
(3) Ventral scales
(4) No where on ***Riccia***

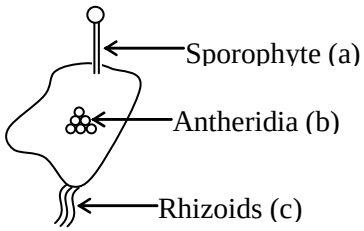
Q.44 **Violet colour** of scales of **Riccia** is due to-
(1) Presence of anthocyanin pigment in cytoplasm
(2) Presence of anthocyanin pigment in cell sap
(3) Presence of anthocyanin pigment in chloroplast
(4) None of the above

Q.45 In *Riccia*, whats is the first and last stage of gametophytic generation-
(1) Gamete and spore
(2) Spore and gamete
(3) Spore mother cell and zygote
(4) Sporocyte and gamete

Q.46 The gametangia of ***Riccia*** are present in -
(1) Dorsal side (2) Ventral side
(3) Dorsal surface in medium groove
(4) Any where in the thallus

Q.47 In the life cycle of ***Riccia***, the stage in which meiosis occurs is-
(1) Sporogonium (2) Oospore
(3) Spore mother cell (4) Gamete formation

Q.48 Given a picture of Bryophyte. The correct ploidy levels of the indicated structure are-



(1) (a) ; 2N (b) ; N (c) ; N
(2) (a) ; N (b) ; N (c) ; N
(3) (a) ; N (b) ; 2N (c) ; 2N
(4) (a) ; 2N (b) ; N (c) ; 2N

Q.49 Conducting tissue in *Riccia* is made up of-
(1) Parenchyma (2) Collenchyma
(3) Xylem and Phloem (4) Thick walled cells

Q.50 The nature of movement of antherozoids in *Riccia* is-
(1) Phototactic (2) Chemotactic
(3) Chemotrophic (4) Chemonastic

Q.51 The simplest sporophyte among bryophyte is of-
(1) *Riccia* (2) *Marchantia*
(3) *Anthoceros* (4) Moss

Q.52 In *Riccia*, the shape of antheridium is-
(1) Pear-shaped (2) Spherical
(3) Conical shaped (4) Flask-shaped

Q.53 *Riccia* and other bryophytes differ from algae in-
(1) Discoidal chloroplast and absence of pyrenoids
(2) Jacketed gametangia and sporangia
(3) Mitotic development of Oospores into embryo
(4) All of these

Q.54 In *Riccia*, what is first cell of a gametophytic and first cell of a sporophytic generation respectively-
(1) Gamete and spore (2) Spore and Oospore
(3) Oospore and Spore (4) Spore and gamete

Q.55 In *Riccia*, reduction division take place in-
(1) Archegonium (2) Antheridium
(3) Capsule (4) Rhizoids

Q.56 *Riccia* is a bryophyte because-
(1) It occurs mostly on land and have motile sperm
(2) It has heteromorphic alternation of generation
(3) It has multicelled sex organ with a jacket of sterile cells
(4) Sporophyte depends upon gametophyte

Q.57 The positive evidence of aquatic ancestry of Bryophyte is-
(1) Their green colour
(2) Thread like protonema
(3) Flagellated antherozoids
(4) Some bryophytes are still aquatic

Q.58 What is the most common method of vegetative reproduction of *Riccia*-
(1) Fragmentation
(2) Formation of adventitious buds
(3) Progressive death and decay of older parts of the cells
(4) Tuber formation

Q.59 The assimilatory tissue of *Riccia* thallus is made up of-
(1) Assimilatory filaments
(2) Spongy mesophyll
(3) Palisade tissue (4) Both (2) and (3)

Q.60 Exchange of gases into assimilatory region occurs via-
(1) Stomata (2) Air pores
(3) Lenticels (4) All of these

Q.61 Which structures causes apical growth in *Riccia*?
(1) Promeristem (2) Procambium
(3) Transverse row of apical cell
(4) All of these

Q.62 The neck canal of *Riccia* archegonium is filled up with-
(1) 2-cells (2) 4-6 cells
(3) 6-12 cells (4) 24 cells

Q.63 Sporophyte of *Riccia* possess-
(1) Foot and Seta
(2) Foot and capsule
(3) Foot, Seta and Capsule
(4) Capsule only

Q.64 The sporophyte is completely dependent on gametophyte in-
(1) *Riccia* (2) *Pteris*
(3) *Cycas* (4) *Pinus*

Q.65 Calyptra is a structure-
(1) Formed of the venter of archegonium
(2) Formed at the base of antheridium
(3) Formed in the center of the capsule
(4) Formed at the base of leaves

Q.66 The rhizoids of *Riccia* are-
(1) Unicellular and coloured
(2) Unicellular and colourless
(3) Multicellular and Green
(4) Multicellular and Brown

Q.67 The shape of apical cell in *Riccia* is-
(1) Pyramidal (2) Tetrahedral
(3) Sclerenchyma (4) All of these

Q.68 Storage region in *Riccia* is made up of-
(1) Collenchyma (2) Parenchyma
(3) Sclerenchyma (4) All of these

Q.69 The spores from *Riccia* capsule are released-
(1) Through stomium and annulus
(2) Through transverse slit
(3) Through vertical slit
(4) On decay of thallus

Q.70 The jacket of antheridium in *Riccia* is made up of-
(1) One layer of three cells
(2) One layer of many cells
(3) Two layer of many cells
(4) Many layer of many cells

Q.71 Shape of chloroplast in assimilatory zone of *Riccia* is-
(1) Girdle shaped (2) Spiral
(3) Discoidal (4) Cake like

Q.72 A student came from U.P. to Rajasthan to study on ***Riccia discolor*** a species of ***Riccia*** found in dry habitat. When dry season becomes start he observed, a mass of multicellular structure is formed, due to fast division of apical cell of the apex of every branch, in which food materials stored and develop a thick protective layer around it after degeneration of marginal cell. This perennating body called as-

(1) Rhizoids (2) Tuber

(3) Rhizome (4) Persistent apices

Q.73 An order of development of structures successively towards the apex, the oldest at the base and youngest nearest the apex called as-

(1) Acropetal (2) Basipetal

(3) Both (1) and (2) (4) None of these

Q.74 An order of development of organs in which the youngest structures are at the base and the oldest at the apex, called as-

(1) Acropetal (2) Basipetal

(3) Both (1) and (2) (4) None of these

FUNERIA

Q.75 When moss spores germinate, they form-

(1) Leafy gametophyte directly

(2) First protonema, then form a bud and then a leafy gametophyte

(3) Capsule directly

(4) Protonema which bears archegonia and antheridia

Q.76 The middle part of funaria capsule is sterile is known as -

(1) Columella (2) Operculum

(3) Apophysis (4) Spore sac

Q.77 The peristome in Funaria is consist of -

(1) 8 teeth (2) 16 teeth

(3) 32 teeth (4) 64 teeth

Q.78 In Funaria, the antherozoids swim in water to reach upto archegonium for the process of fertilization, this type of movement is known as-

(1) Chemotropic (2) Chemotactic

(3) Thermotactic (4) Phototactic

Q.79 The air in the capsule of moss are partitioned with delicate strands of cells, these are called-

(1) Partitions (2) Compartments

(3) Trabeculae (4) Septa

Q.80 The dehiscence of moss capsule take place by the rupture of the following-

(1) Operculum (2) Annulus

(3) Calyptra (4) None of above

Q.81 In which part reduction division take place in Moss plant-

(1) Antheridium (2) Archegonium

(3) Seta (4) Capsule

Q.82 Dispersal of spores of *Funaria*-

(1) By bursting of the capsule

(2) Through peristome

(3) Death & decay of operculum

(4) By bursting of operculum

Q.83 If the number of chromosomes of a spore mother cell of *Funaria* is 18, then what will be the chromosome numbers of the following structures-

	Perichaetial leaf	Protonema	Operculum	Columella
(1)	9	9	18	18
(2)	18	9	9	18
(3)	9	18	9	18
(4)	18	18	9	18

Q.84 The development of a sporophyte from moss gametophyte without gametes formation is called-

(1) Apospory (2) Parthenogenesis

(3) Apogamy (4) None of these

Q.85 Which of the following is not common in *Funaria* and *Selaginella*-

(1) Roots (2) Archegonium

(3) Embryo (4) Motile antherozoids

Q.86 If the number of chromosomes in the cells of spore sac of *Funaria* is 20. What will be the number of chromosomes in the cells of its calyptra-

(1) 20 (2) 10

(3) 40 (4) 30

Q.87 Chloroplasts are present in the spores of-
(1) *Rhizopus* (2) *Funaria*
(3) *Dryopteris* (4) *Penicillium*

Q.88 The peristome in *Funaria* consists of a-
(1) One series of curved narrow triangular teeth, 16 in number
(2) One series of curved narrow triangular teeth, 32 in number
(3) Two series of curved narrow triangular teeth, 8 teeth in each series
(4) Two series of curved narrow triangular teeth, 16 teeth in each series

Q.89 When antherozoids of *Pteridium* and *Funaria* are put together near the archegonia of *Pteridium* only the antherozoids of *Pteridium* readily enter the archegonia and reach the egg. The reason being that-
(1) Archegonia of *Pteridium* secrete a substance which repels antherozoids of *Funaria*
(2) Archegonia of *Pteridium* secrete a chemical substance which attracts antherozoids of *Pteridium*
(3) Antherozoids of *Funaria* are less motile
(4) Antherozoids of *Funaria* are killed when mixed with antherozoids of *Pteridium*

MUCOR & RHIZOPUS

Q.90 Mucor mucedo is a -
(1) Homothallic fungus
(2) Heterothallic fungus
(3) Heteroecious fungus
(4) None

Q.91 Mucor belongs to order -
(1) Mucoraceae (2) Mucorales
(3) Zygomycetes (4) Oomycetes

Q.92 Dung-mold is -
(1) Rhizopus stolonifer
(2) Mucor mucedo
(3) Aspergillus flavus
(4) Clostridium tetani

Q.93 Which one of the following life cycles is associated with mucor
(1) Heteromorphic (2) Haplontic
(3) Diplontic (4) Isomorphic

Q.94 Mucor is -
(1) Heterothallic and heterotrophic
(2) Heterotrophic and heteroecious
(3) Heteroecious and heterosporous
(4) heterosporous and heterothallic

Q.95 Bread mold is the common name of -
(1) Batrachospermum (2) Rhizopus
(3) Agaricus (4) Bacillus

Q.96 In Mucor species, usually isogamy takes place between -
(1) Same strains (2) (+) and (–) strain
(3) Zygospores (4) Microspores

Q.97 In mucor, stored food is –
(1) Glycogen and oil (2) Starch
(3) Leucosine and oil (4) Foridean starch

Q.98 Mucor is -
(1) With chlorophyll
(2) Without chlorophyll
(3) With carotenes (4) None

ALBUGO & CYSTOPUS

Q.99 Albugo produces conidiosporangia
(1) In chain (2) In Clusters
(3) Singly (4) In Clumps

Q.100 The order of development of conidia in Albugo is
(1) Acropetal (2) Basipetal
(3) Irregular (4) Radial

Q.101 The flagella on the zoospores of Albugo are
(1) Equal & Lateral
(2) Equal and terminal
(3) Unequal and terminal
(4) Unequal and Lateral

Q.102 Albugo draws nutrition from its host by
(1) Extra cellular phagocytosis
(2) Club shaped conidiophores
(3) Tuberculate rhizoids
(4) Globular or Button shaped haustoria

Q.103 In what form of the food is stored in the mycelium of Albugo
(1) Sugar, oil and mannitol
(2) Strach and protein
(3) Protein and cellulose
(4) Glycogen and oils

Q.104 Which structure of Albugo exhibits symptoms of white rust disease
(1) Mycelium (2) Conidia
(3) Gametangia (4) Oospore

Q.105 Albugo mycelium can reproduce (a) Sexually (b) Asexually (c) Vagetatively.
(1) 'a' and 'b' (2) 'a' and 'c'
(3) 'b' and 'c' (4) 'a', 'b' & 'c'

Q.106 The conidiophores of Albugo are
(1) Club shaped and branched
(2) Club shaped and unbranched
(3) Peltate and branched
(4) Peltate and unbranched

Q.107 Secondary infection of white rust could be controlled by
(1) Crop rotation
(2) Use of bordeaux mixture
(3) Soil fumigation
(4) Use D.D.T.

Q.108 Female Gametangium of Albugo is called :
(1) Trichogyne (2) Archegonium
(3) Ascogonium (4) Oogonium

Q.109 The gametes of Albugo are
(1) Non-flagellated
(2) Flagellated and Motile
(3) Male flagellated & Female non flagellated
(4) Female flagellated & Male non flagellated

Q.110 Sexual reproduction (or fertilization) can occur without water in
(1) Ulothrix (2) Albugo
(3) Funaria (4) Fern

Q.111 Which stage in the life cycle of Albugo candida is not coenocytic
(1) Vegetative mycelium
(2) Conidiosporangia
(3) Zoospores (4) All of these

Q.112 The flagella on the zoospore of Albugo are
(1) Whiplash type (2) Tinsel type
(3) One whiplash and one tinsel type
(4) Mixed type

Q.113 Hypertrophy of floral parts in a cruciferous plant is caused by
(1) Conidia of Cystopus
(2) Conidiophores of Cystopus
(3) Accumulation of hyphae of Cystopus for sexual reproduction
(4) All the above

Q.114 To cause infection, the germ tube enters through
(1) Epidermal cell (2) Guard cell
(3) Stomata (4) Lenticels

Q.115 An excessive enlargement of a diseased organ due to an increase in the number of its cells is called
(1) Hyperplasia (2) Damping off
(3) Necrosis (4) Hypertrophy

Q.116 Which of the following is the symptom of white rust disease of crucifers
(1) Hypertrophy of floral axis
(2) White blisters on the stem
(3) White blisters on the leaf
(4) All the above

Q.117 Which of the following produced non-motile gamete -
(1) Ulothrix (2) Albugo
(3) Riccia (4) Pteridium

Q.118 Sexual reproduction in Albugo is
(1) Isogamous (2) Anisogamous
(3) Oogamous (4) None of these

Q.119 What holds the conidia together into a chain in *Cystopus/Albugo* -
(1) Middle lamella (2) Cell-wall
(3) Intercalary mucilagenous septum
(4) Plasmodesmata

Q.120 Albugo belongs to
(1) Phycomycetes and zygomycetes
(2) Archaemycetes and Oomycetes
(3) Phycomycetes and Oomycetes
(4) Zygomycetes and archaemycetes

Q.121 A combined solution of copper sulphate and calcium hydroxide which used as a fungicide is
(1) Collins mixture (2) Bordeaux mixture
(3) Carminative mixture
(4) Fehling's solution

SELAGINELLA

Q.122 Selaginella is a type of plant
(1) Oogamous and homosporous
(2) Oogamous and heterosporous
(3) Isogamous & heterosporous
(4) Isogamous & Homosporous

Q.123 In which stage of the male gametophyte of selaginella pollination take place
(1) 3 celled stage (2) 6 celled stage
(3) 13 celled stage (4) 2 celled stage

Q.124 By which plant seed habit originated-
(1) Moss (2) Little Club moss
(3) Pinus (4) Angiosperm

Q.125 How many cells of prothelial and antheridial are found in male gametophyte of selaginella
(1) P_4A_9 (2) P_2A_{11}
(3) P_1A_{12} (4) P_8A_5

Q.126 Selaginella is associated with class-
(1) Psilopsida (2) Coniferopsida
(3) Lycopsida (4) Pteropsida

Q.127 When does meiotic division take place in selaginella
(1) During gametes formation
(2) During spores formation
(3) During zygote formation
(4) During germination

Q.128 Selaginella differs from Pteris in which of the following character
(1) Heterosporous condition
(2) Absence of seed
(3) Absence of vessels in xylem
(4) Need of water for fertilization

Q.129 In which species of the selaginella vivipary is found
(1) S. rupestris (2) S. kraussiana
(3) S. Lepidophylla (4) S. oregana

Q.130 What is the function of foot of selaginella
(1) Fusion (2) Water absorption
(3) Food absorption (4) None of above

Q.131 Which species of the selaginella are known as "Resurrection plants"
(1) Epiphytic species (2) Aquatic species
(3) Mesophytic species (4) Xerophytic species

Q.132 Selaginella differ from moss in having-
(1) Well developed vascular system
(2) Swimming antherozoid
(3) Free gametophyte
(4) Archegonium

Q.133 Number of Prothallial cell in selaginella-
(1) 1 (2) 2
(3) 3 (4) 4

Q.134 In some pteridophytes and most gymnosperm a temporary organ of cell filament is form which pushes growing embryo in tissue of female gematophyte, it is known as-
(1) Strobilus (2) Tapetum
(3) Suspensor (4) Trabeculae

Q.135 Which of the following is essential for seed habit-
(1) Free gametophyte
(2) Dependent sporophyte
(3) Heterospory (4) Haploid life cycle

Q.136 Megasporophyll of selaginella is equivelant to which structure of angiosperm-
(1) Carpel (2) Stamen
(3) Ovule (4) Leaf

PTERIDIUM

Q.137 Formation of a sporophyte from a vegetative portion of prothallus is called -
(1) Apocarpy (2) Apogamy
(3) Apomixis (4) Apospory

Q.138 Sex organ in prothallus develop on -
(1) Dorsal surface
(2) Lateral surface
(3) Ventral surface
(4) Dorsilateral surface

Q.139 The ferns in which the entire sporangium develops from a single superficial cell of the sporophyll are knows as -
(1) Lepto sporangiate
(2) Eusporangiate
(3) Unisporangiate
(4) Mesosporangiate

Q.140 Distinct alternation of generation is found in -
(1) **Mucor** (2) **Riccia**
(3) **Pteridium** (4) **Ulothrix**

Q.141 In **Pteridium** meiosis occurs when -
(1) Spores are formed
(2) Gametes are formed
(3) Prothallus is formed
(4) Sex organ are formed

Q.142 Structures that produce gametes in prothallus are -
(1) Anther and archegonia
(2) Ascogonium and anther
(3) Antheridia and archegonia
(4) None of these

Q.143 Young sporophyte of pteridium draws nourishment from prothallus through -
(1) haustorium (2) foot
(3) root (4) rhizoids

Q.144 Pteridium pholem lacks -
(1) Sieve cell
(2) Companion cell
(3) Phloem parenchyma
(4) All of the above

Q.145 The heart shaped prothallus of **Pteridium** always -
(1) Monoecious
(2) Dioecious
(3) Both monoecious and dioecious
(4) Not certain

Q.146 The xylem of stele of **Pteridium** is made up of-
(1) Vessels
(2) Tracheids
(3) Tracheids and xylem parenchyma
(4) None of these

Q.147 Fern plant are -
(1) Ornamental (2) Of medical value
(3) Of food value
(4) Of no particular value

Q.148 Indusium of **Pteridium** is -
(1) Outer false & inner true
(2) Outer true & inner false
(3) Only true type (4) Only false

Q.149 An indusium is said to be true if it originates from -
(1) Sorus region (2) Extra sorus region
(3) Stelar region (4) Rhizome

Q.150 In **Pteridium** the annulus is -
(1) Transverse (2) Oblique
(3) Vertical (4) Horizontal

Q.151 Fern prothallus is -
(1) Heterothallic (2) Heteromorphic
(3) Heterotrophic (4) Homothallic

Q.152 The sex organs of **Pteridium** which develops on ventral surface of prothalli & intermingled with rhizoids are -
(1) Antheridia (2) Archegonia
(3) Sorus (4) Sporangia

Q.153 Sexuality in fern is -
(1) Isogamy (2) Anisogamy
(3) Oogamy (4) Siphonogamy

Q.154 In **Pteridium**, the flagella of antherozoids are attached to -
(1) Body surface (2) Nucleus
(3) Blephroplast (4) Ovum

Q.155 Antherozoids attractant in an archegonial ooze in **Pteridium** (Fern) is -
(1) Sugar (2) Amino acid
(3) Malic acid (4) Mucliage

Q.156 How many cells form the jacket of fern antheridium -
(1) One (2) Two
(3) Three (4) Four

Q.157 Development of Oospore in fern produces -
(1) X-Gametophyte
(2) 2X-embryo & sporophyte
(3) Prothallus
(4) Zoospores & Antherozoids

Q.158 The dominant phase in fern plant is -
(1) Spore (2) Sporophyte
(3) Gametophyte (4) Prothallus

Q.159 What is the criterion used in the classification of ferns -
(1) Sori
(2) Nature of indusium
(3) Nature of sporophyll & sporangia
(4) Nature of annulus

Q.160 A feature is common to gametophytes and sporophytes of Moss and **Pteridium** -
(1) Independent existance
(2) Unbranched habit
(3) Dichotomous branching
(4) Autotrophy

Q.161 How does the spores of a fern plant behaves-
(1) Joins with another spore to form a seedling
(2) Germinates in to a prothallus
(3) Germinates into a fern plant
(4) Act as a resting structure

Q.162 The male gametes in **Pteridium** are -
(1) Non motile
(2) Motile, biflagellated
(3) Motile, multiflagellated
(4) Non-Motile, multi nucleate

Q.163 What type of polarity is exhibited by the embryo of **Pteridium** -
(1) Apical (2) Basal
(3) Lateral (4) Central

Q.164 The place of point where sporangium of a fern bursts is -
(1) Annulus (2) Stomium
(3) Ostiole (4) Operculum

Q.165 The annulus of sporangium of the fern assists in the dispersal of spores by -
(1) Collapsing in the strong wind
(2) Loosing the air of its cells
(3) Loosing water from its cells
(4) Taking up water from air

Q.166 What may be the possible advantage accrueing out of the presence of antheridia and archegonia on the underside of a fern prothallus -
(1) They are protected from direct rays of sun
(2) Capillary water accumulates on the underside of the prothallus between its lower surface and the soil surface. Sex organs projecting in this water can be readily fertilized by the Flagellated antherozoids which are chemotactically attracted by the archegonia
(3) The sex organs are protected from the wind
(4) Nutrients manufactured by the green prothallus can readily seep downwards to the sex organs due to the action of gravity

Q.167 Which statement is generally true for pteridium-
(1) Gametophyte depends upon Sporophyte
(2) Mature sporophyte depends upon gametophyte
(3) Young sporophyte depends upon gametophyte
(4) None of these

Q.168 What is the nature of tapetum of Pteridium?
(1) 1 N (2) 2 N
(3) 3 N (4) Polyploid

Q.169 Tapetum is a nutritive tissue of –
(1) Male and female gametes
(2) Spore mother cells
(3) Both of above
(4) None of the above

Q.170 Which type of alternation of generation is found in Pteridium ?
(1) Well defined heteromorphic, diplobiontic
(2) Haplobiontic, haploid phase dominant
(3) Haplobiontic, diploid phase dominant
(4) Triplobiontic, heteromorphic

Q.171 How many sporophytes develop on a prothallus of Pteridium ?
(1) One (2) Many
(3) Many initially but finally one sporophyte
(4) The same number of embryos and sporophytes as the number of archegonia

Q.172 The primary root of young sporophyte of the sporangium is –
(1) Tap root (2) Short lived
(3) Both of above (4) None of these

Q.173 Which is found in Pteridium ?
(1) Protandry (2) Heterothallism
(3) Both of above (4) None of these

Q.174 Which type of branching is found in Pteridium stem ?
(1) Alternate (2) Monopodial
(3) Dichotomous (4) Cyclic

Q.175 What is the situation of cortex in root of Pteridium ?
(1) Completely parenchymatous
(2) Outer part parenchymatous, inner part sclerenchymatous
(3) Outer sclerenchymatous, inner one parenchymatous
(4) Outer and inner part parenchymatous, middle part sclerenchymatous

Q.176 What is essential for fertilization in Pteridium ?
(1) Air (2) Water
(3) Chemical (4) Insect

CYCAS

Q.177 Which of the following is not the characteristic feature of Cycas :
(1) Naked ovules (2) Circinate vernation
(3) Vessels in xylem (4) Girdling leaf traces

Q.178 In the plants of Cycas, the male cone lacks :
(1) Microspore (2) Microsporophyll
(3) Microsporangium (4) Nucellus

Q.179 The girdle leaf traces in Cycas go to leaves :
(1) After making a semi-circle
(2) After making a complete circle
(3) After making two circle
(4) None of the above

Q.180 Polyembryony seen in Cycas is :
(1) Potential true polyembryony
(2) Potential true polyembryony and cleavage polyembryony
(3) Adventive polyembryony
(4) All of the above

Q.181 Each leaf of Cycas is supplied by :
(1) Two direct traces and two girdle traces
(2) A number of direct traces and two girdle traces
(3) A number of direct traces and a number of girdle traces
(4) Two direct traces and a number of girdle traces

Q.182 In which of the following, sexual reproduction is possible without water :
(1) Ulothrix (2) Funaria
(3) Dryopteris (4) Cycas

Q.183 The tracheids of Cycas have :
(1) Uniseriate bordered pits
(2) Biseriate bordered pits
(3) Multiseriate bordered pits
(4) No bordered pits

Q.184 The leaves of Cycas are :
(1) Unipinnately compound with parallel venation
(2) Unipinnately compounds with unicostate reticulate venation
(3) Unipinnately compounds with multicostate reticulate venation
(4) Unipinnately compounds with no venation

Q.185 Which is absent in coralloid roots of Cycas :
(1) Root hair and casparian band in endodermis
(2) Root cap and casparian band in endodermis
(3) Both root hair and root cap
(4) None of the above

Q.186 Which species of Cycas is having largest male cones :
(1) ***Cycas revoluta*** (2) ***C. rumphii***
(3) ***C. circinalis*** (4) ***C. beddomei***

Q.187 Male and female Cycas plants show which type of growth :
(1) Monopodial in both
(2) Sympodial in both
(3) Monopodial in male and sympodial in female plant
(4) Sympodial in male and monopodial in female plant

Q.188 A single microsporophyll in Cycas revoluta is having about ..... sporangia :
(1) 1000 (2) 2000
(3) 100-300 (4) 400-500

Q.189 Seeds of Cycas are dispersed by :
(1) Wind (2) Birds
(3) Water (4) Insects

Q.190 Radicle (embryonic root) is covered by a hard podlike covering 'coleorrhiza' in :
(1) Cycas (2) Pinus
(3) Both (1) and (2) (4) None of these

Q.191 In Andaman and Nicobar islands, common species of Cycas is :
(1) ***C. circinalis*** (2) ***C. revoluta***
(3) ***C. beddomei*** (4) ***C. rumphii***

Q.192 During pollination, pollen grains in Cycas are trapped by :
(1) Malic acid drop
(2) Pseudostigma
(3) Stigma
(4) Viscous Fluid in pollen chamber

Q.193 Sago is obtained from :
(1) Cycas (2) Cedrus
(3) Pinus (4) Taxus

Q.194 If haploid number of chromosomes in a gymnosperm is 12, the number of chromosomes in its endosperm will be
(1) 12 (2) 24
(3) 36 (4) 64

Q.195 The number of neck canal cells in Cycas
(1) 2 (2) 4
(3) Nil (4) One with two nuclei

Q.196 Cycas is
(1) Monoecious and seed bearing
(2) Dioecious and seed bearing
(3) Monoecious and seedless
(4) Dioecious and seedless

PINUS

Q.197 Gymnosperm produce seed in -
(1) Pericarp (2) Cones
(3) Flowers (4) Ovary

Q.198 Seed of Pinus contain several embryos with a compound suspensor. They are developed through
(1) Adventive polyembryony
(2) Normal polyembryony
(3) Cleavage polyembryony
(4) both 2 & 3

Q.199 Which of the following is not applicable to Pinus ?
(1) Sessile ovules
(2) Motile sperm
(3) Embryo with many cotyledons
(4) Resin ducts

Q.200 Which is true for Pinus -
(1) Haploid endosperm
(2) Biflagellate sperms
(3) Occurence of double fertilization
(4) Presence of antheridia

Q.201 Ovule in gymnosperm is generally : -
(1) Anatropous and bitegmic
(2) Orthotropous and bitegmic
(3) Anatropous and unitegmic
(4) Orthotropous and unitegmic

Q.202 In gymnosperm "pollen drop" is -
(1) Pollen dropped by wind
(2) Water drop
(3) Secretion of nucellus
(4) Pollinium

Q.203 **Resin** and **turpentine** are obtained from : -
(1) Cycas (2) Pinus
(3) Cedrus (4) Gnetum

Q.204 The germination of seed in Pinus is : -
(1) Hypogeal (2) Epigeal
(3) Both (4) None

Q.205 If the haploid no. of chromosomes in gymnosperm is 12, what will be the no. of chromosomes in its root and endosperm : -
(1) 12, 12 (2) 12, 24
(3) 24, 12 (4) 24, 36

Q.206 'Naked seed' of gymnosperm mean : -
(1) Seed without seed coats
(2) Seed without tegmen
(3) Seeds not enclosed in ovary wall
(4) All of the above

Q.207 In which plant "chilgoza" is the name of seed of : -
(1) ***P. longifolia*** (2) ***P.gerardiana***
(3) ***Cycas circinalis*** (4) ***P.insularis***

Q.208 The characteristic of ovule of Pinus is presence of : -
(1) Integument (2) Vascular supply
(3) Pollen chamber (4) Nucellus

Q.209 Endosperm in Pinus is : -
(1) Post fertilization tissue
(2) Pre and post fertilization tissue
(3) Pre fertilization tissue
(4) None of the above

Q.210 Pollination in Pinus is exclusively by : -
(1) Wind (2) Insect
(3) Water (4) Birds

Q.211 **Compact** and **hard wood** of Pinus is known as:
(1) Porous (2) Pycnoxylic
(3) Manoxylic (4) Soft and loose

Q.212 Pinus differs from mango in having : -
(1) Presence of wood
(2) Ovules not enclosed in ovary
(3) Tree habit (4) Green leaves

Q.213 Pinus has : -
(1) Motile male gametes
(2) Ciliated male gametes
(3) Non motile male gametes
(4) All of the above

Q.214 The interval between pollination and fertilization in Pinus is : -
(1) One day (2) One week
(3) One month (4) One year

Q.215 Number of the cotyledons in embryo of Pinus is : -
(1) One (2) Two
(3) 3 - 18 (4) 3 – 10

Q.216 Wings in Pinus seeds develop from : -
(1) Bract scale (2) Ovuliferous scale
(3) Cone axis (4) Seed coat

Q.217 In Pinus male and female reproductive structures occur : -
(1) On same branch of plant
(2) On different plant
(3) On different branches of same plant
(4) None of above

Q.218 Pinus is a Gymnosperm because : -
(1) It is large tree
(2) It is pollinated by wind
(3) It has exposed naked ovules
(4) It produces seeds and it has narrow leaves

Q.219 In which of the following fertilization / reproduction is possible without water : -
(1) **Ulothrix** (2) **Funaria**
(3) **Dryopteris** (4) **Pinus**

Q.220 Turpentine is obtained from : -
(1) Angiosperm wood
(2) Angiospermic flowers
(3) Gymnosperm wood
(4) Fern

Q.221 In microsporophylls of **Pinus** micro-sporangium are present on :
(1) Abaxial side (2) Adaxial side
(3) Along the margins (4) In the axils

Answer Key

Exercise – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	4	2	2	1	2	1	3	1	2	3	3	3	1	2	2	4	3	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	2	2	2	2	4	4	2	3	1	4	2	2	1	3	1	2	2	4	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	4	2	2	3	3	1	1	2	1	1	4	2	3	4	3	3	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	2	4	1	1	2	1	2	4	2	3	2	1	2	2	1	3	2	3	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	2	1	3	1	2	2	4	2	2	2	2	2	1	2	2	1	2	1	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	4	4	2	1	2	2	4	1	2	3	3	3	3	1	4	2	3	3	3
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	2	3	2	3	3	2	1	1	3	4	1	1	3	3	1	2	3	1	3
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	1	3	2	2	1	3	1	1	1	3	4	1	3	3	3	3	2	2	3	4
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	2	3	3	2	3	2	3	2	2	1	3	3	3	3	2	2	3	4	1	1
Ques.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
Ans.	1	4	3	4	3	3	4	1	2	1	4	4	1	1	3	2	2	3	2	1
Ques.	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
Ans.	4	3	2	2	3	3	2	3	3	1	2	2	3	4	3	2	3	3	4	3
Ques.	221																			
Ans.	1																			

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EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

ULOTHRIX

Q.1 In Ulothrix, Zygote is- **[RPMT 2000]**
(1) Quadriflagellate (2) Biflagellate
(3) Unifilagellate (4) Aflagelate

Q.2 Life cycle of "*Ulothrix*" is - **[RPMT 2001]**
(1) Haplontic (2) Diplontic
(3) Haplodiplontic (4) None of them

Q.3 Morphologically similar but physiologically different gametes are called- **[RPMT 2001]**
(1) Isogamete (2) Oogamete
(3) Physiological anisogamete
(4) Syngamous

Q.4 Pigments present in chloroplast of Ulothrix- **[RPMT 2002]**
(1) Chlorophyll α, Ch-β, fucoxanthin β-carotene
(2) Ch-α, Ch-β, Ch-c, C-phycocyanin, C-phycoerythrin
(3) Ch-α, Ch-β, β-carotene and xanthophylls
(4) Ch-α, Ch-β, r-phycocyanine, r-phycoerythrin

Q.5 In *Ulothrix,* zoospores are libereated by- **[RPMT 2003]**
(1) Degeneration of lateral walls
(2) Formation of pore in lateral wall
(3) Gelatinisation of lateral walls
(4) Gelatinisation of all cell walls

Q.6 Which one of the following shows *haplontic* life cycle- **[MP PMT 2002]**
(1) Ulothrix (2) Funaria
(3) Selaginella (4) Pinus

Q.7 Meiosis in Ulothrix take place during- **[MP PMT 2002]**
(1) zoospore formation (2) gamete formation
(3) zygospore germination
(4) zoospore germination

RICCIA

Q.8 Photosynthetic filaments occur in- **[RPMT 2000]**
(1) *Nostoc* (2) *Chlamydomonas*
(3) *Phytopthora* (4) *Riccia*

Q.9 Which type of rhizoids are presents in *Riccia* **[RPMT 2002]**
(1) Unicellular and smooth
(2) Multicellular and smooth
(3) Unicellular, smooth and tuberculated
(4) Multicellular smooth and tuberculated

Q.10 *Antherozoids* of *Riccia* are - **[RPMT 2003]**
(1) Long, curved and multifilagellate
(2) Small and non-filagellate
(3) Small, curved (comma shaped) and biflagellate
(4) Rod shaped and biflagellate

Q.11 Sporophyte of *Riccia* is- **[RPMT 2005]**
(1) Saprophyte (2) Partial parasite
(3) Complete parasite (4) None of these

FUNERIA

Q.12 Antherozoids of ***Funaria*** are – **[CPMT-1991]**
(1) Biflagellated and spirally coiled
(2) Biflagellated with no coiling
(3) Multi flagellated (4) Aflagellated

Q.13 Spore of *Funaria* represents- **[Dehli PMT 1986]**
(1) Gametes
(2) Beginning of gametophyte
(3) Beginning of sporophyte
(4) None

Q.14 In the capsule of moss peristome teeth show- **[RPMT - 2000]**
(1) Hydrochasy (2) Chemotropism
(3) Hydrotropism (4) Xerochasy

Q.15 What is formed by the germination of spores of moss- **[RPMT - 2000]**
(1) Leafy gametophyte (2) Stem
(3) Protonema (4) Rhizoids

Q.16 Spore of which plant produces protonema- **[RPMT - 2001]**
(1) *Riccia* (2) *Funaria*
(3) *Anthoceros* (4) *Pellia*

Q.17 In *Funaria* spore germinates to produce- **[MP PMT - 1999]**

(1) Protonema (2) Prothallus

(3) Proembryo (4) Embryo

Q.18 In *Funaria*, plant stomata are present in- **[MP PMT - 2002]**

(1) Foot (2) Seta

(3) Capsule (4) Leaf

Q.19 Which of the following is absent in moss sporophytes- **[MP PMT - 2002]**

(1) Seta (2) Foot

(3) Elater (4) Columella

Q.20 The sporophyte of *Funaria* develop within- **[MP PMT - 2002]**

(1) Antheridium (2) Archegonium

(3) Capsule (4) Protonema

Q.21 Peat moss is used as a packing material for sending flowers and live plants to distant places because- **[AIPMT - 2006]**

(1) It reduces transpiration

(2) It serves as a disinfectant

(3) It is easily available

(4) It is hygroscopic

Q.22 In a moss the sporophyte- **[AIPMT 2006]**

(1) arises from a spore produced from the gametophyte

(2) manufactures food for it self, as well as for the gametophyte

(3) is partially parasitic on the gametophyte

(4) produces gametes that give rise to the gametophyte

MUCOR & RHIZOPUS

Q.23 Mycelium of mucor is **[MP PMT 2000]**

(1) Septate and unicellular

(2) Septate and multicelluar

(3) Asptate and Uninucleate

(4) Coenocytic

Q.24 Sporangiospores of mucor is -**[MP PMT 2002]**

(1) Haploid (2) Diploid

(3) Triploid (4) Polyploid

Q.25 Mucor shows **[MP PMT 2002]**

(1) Isogamy (2) Anisogamy

(3) Oogamy (4) None of the above

Q.26 Which of the following environmental conditions are essential for optimum growth of Mucor on a piece of bread ? **[CBSE 2006]**

A. Temperature of a about 25ºC

B. Temperature of a bout 5ºC

C. Relative humidity of about 5%

D. Relative humidity of about 95%

E. A shady place

F. A brightly illuminated place

(1) B, D and E only (2) B, C and F only

(3) A, C and E only (4) A, D and E only

ALBUGO & CYSTOPUS

Q.27 Which is correct statement : - **[RPMT 2001]**

(1) Perithecium is fruiting body of ***Aspergillus***

(2) Sexual reproduction in ***Albugo*** is oogamous

(3) Ascomycetes is known as club fungi

(4) Male gametes of Albugo are flagellated

Q.28 Botanical name of speicies which cause white rust of cruciferae - **[RPMT 2002]**

(1) *Pernospora Parasitica*

(2) *Puccinia graminis*

(3) *Phythium debarganum*

(4) *Albugo candidia*

Q.29 Branched aseptate, coenocytic mycelium present in : - **[RPMT 2002]**

(1) *Aspergillus* (2) *Albugo*

(3) *Penicillium* (4) *Erysiphe*

Q.30 *Albugo candida* which causes white rust of cruciferae is : -

(1) Saprophyte

(2) Facultative parasite

(3) Obligate parasite

(4) Obligate saprophyte

Q.31 White rust diesease of crucifers is caused by : - **[RPMT 2005]**

(1) *Puccinia* (2) *Ustilago*

(3) *Albugo candida* (4) *Aspergillus*

SELAGINELLA

Q.32 An evolutionary characteristic is found in selaginella: **[MP PMT 1997]**
(1) Presence of ligule (2) Heterophilly habits
(3) Sporangia present in cone
(4) Heterospory

Q.33 In selaginella, male gametes are **[MP PMT 2000]**
(1) Multi flagellate (2) Aflagellate
(3) Biflagellate (4) Mono flagellate

Q.34 In selaginella, trabeculae, represent **[MP PMT 2000]**
(1) Endodermis (2) Cortex
(3) Xylem (4) Epidermis

Q.35 Which one of the following is not fond in selaginella **[MP PMT 2002]**
(1) Heterophylly (2) Heterospory
(3) Homospory (4) Ligulate leaf

Q.36 Club mass is common name of **[RPMT 2001]**
(1) Lycopodium (2) Selaginella
(3) Funaria (4) Potamogeton

PTERIDIUM

Q.37 If the aerial parts of a typical pteridophyte are destroyed by the fire then which plant part helps to regenerate -
(1) Root (2) Rhizome
(3) Leaf - tip (4) Pinnule

Q.38 **Pteridium** shows - **[RPMT – 2000]**
(1) Only true indusium (2) Only false indusium
(3) Both (1) and (2) (4) None of the above

Q.39 In which stage meiosis takes place in **Pteridium**- **[RPMT – 2001]**
(1) During the spore germination
(2) During the spore formation
(3) During the gamete formation
(4) During the organ formation in prothallus

Q.40 In Fern, gametophyte is - **[RPMT – 2001]**
(1) Main plant body
(2) Prothallus attached to the sporophyte
(3) Prothallus free from sporophyte
(4) A structure attached to the rhizome

Q.41 In rhizome of **Pteridium,** stele which is composed of two or more than two concentric rings of vascular bundles is called - **[RPMT – 2002]**
(1) Polycyclic
(2) Siphonostele
(3) Ectophloic siphonostele
(4) Cladosiphonostele

Q.42 Archegonium of fern has - **[RPMT – 2003]**
(1) Four neck canal cells
(2) Binucleated, one neck canal cell
(3) Uni nucleated two neck canal cells
(4) Three neck canal cell

Q.43 Fern Prothallus produces - **[RPMT – 2005]**
(1) Gametes (2) Spores
(3) Both (1) & (2) (4) None

Q.44 Which of the following is not common in **Funaria** & **Pteridium** - **[RPMT – 2006]**
(1) Root (2) Archegonia
(3) Embryo (4) Motile sperms

Q.45 In the prothallus of a vascular cryptogam, the antherozoids and eggs mature at different time. As a result- **[AIPMT – 2007]**
(1) there is no change in success rate of fertilization
(2) there is high degree of sterility
(3) one can conclude that the plant is apomictic
(4) self fertilization is prevented

CYCAS

Q.46 Ciliated male gametes are found in : **[Pb PMT 1997]**
(1) Cycas (2) Ginkgo
(3) Pinus (4) Both (1) and (2)

Q.47 'Sago palm' is : **[CPMT 2002]**
(1) Cycas revoluta (2) C. circinalis
(3) C. rumphii (4) Pinus

Q.48 Germination of Cycas seed is : **[CPMT 2002]**
(1) Epigeal (2) Hypogeal
(3) Both (1) and (2) (4) None of these

Q.49 The coralloid roots of Cycas have an algal zone and the alga present in this zone is **[CPMT 1991]**

(1) Ulothrix (2) Anabaena
(3) Nostoc (4) 2 and 3 both

Q.50 The neck canal cells are absent in the archegonia of : **[Re. Ex. CPMT 1991]**

(1) Cycas (2) Bryophytes
(3) Funaria (4) Pteridophytes

Q.51 Cycas has an embryo with two cotyledons yet it is not classified as dicotyledonous plant because : **[CBSE 2001]**

(1) It has compound leaves
(2) It bears megasporophylls
(3) It looks like a palm tree
(4) Its ovules are naked

Q.52 Multiciliate male gametes (spermatozoids) are found in : **[CPMT 1999, BHU 1999]**

(1) Angiosperms (2) Cycas
(3) Ulothrix (4) Funaria

Q.53 The secondary growth in stem of Cycas is brought about by : **[CPMT 1990]**

(1) Persistent cambium
(2) Short lived cambium
(3) Number of cambia produced in succession
(4) Isolated strips of cambium

Q.54 The neck cells in the archegonium of Cycas are: **[CPMT 1990]**

(1) One (2) Two
(3) Eight (4) Six

Q.55 From the pith of stem of Cycas revoluta "sago" is obtained which is used as food article for a patient with stomach disorders because : **[AIIMS 1997]**

(1) It is much tastier
(2) Its nutritive value is very high
(3) It is having less amount of starch and easily digestable
(4) It is a cheap food article

Q.56 The main character of gymnospermic plant is : **[CPMT 1991]**

(1) Presence of xylem
(2) Presence of circinate vernation
(3) Presence of traces of leaves
(4) Presence of naked exposed ovules

Q.57 Largest ovule is found in : **[CPMT 1998; AFMC 2002]**

(1) Cycas (2) Pinus
(3) Taxus (4) Watermelon

Q.58 Largest sperms in the plant world are found in : **[CBSE 1998]**

(1) Thuja (2) Pinus
(3) Banyan (4) Cycas

Q.59 Which of the following statements about Cycas is incorrect ? **[CPMT 2000]**

(1) Its coralloid roots contain some blue-green algae
(2) It does not have a well organized female flower
(3) It has circinate vernation
(4) Its Xylem is mainly composed of xylem vessels

Q.60 Male cone of Cycas consists of : **[CPMT 2000]**

(1) Megasporophylls (2) Microsporophylls
(3) Archegonia (4) None of these

Q.61 In which portion of Cycas, diploxylic vascular bundle are found : **[AIIMS 2000, EAMCET 2002, APMEE 2002]**

(1) Root (2) Stem
(3) Leaflet (4) Rachis and leaflet

Q.62 Which of the following is correct regarding Cycas : **[AIIMS 2001]**

(1) The same sporophyll bears microsporangia and ovules
(2) A single cone consists of both mega and microsporophylls
(3) Male strobilus and megasporophylls occur on the same plant
(4) Male strobilus and megasporophylls on separate plants

Q.63 In Cycas, male gamets are produced in the pollen tube by the division of which of the following cells : **[BHU 2001]**

(1) Body cell (2) Stalk cell
(3) Tube cell (4) Prothallial cell

Q.64 Male gametes of cycas are : **[CPMT 1992]**

(1) Rounded and nonciliate
(2) Sickle – shaped biflagellate
(3) Boat – shaped nonciliate
(4) Large, top-like, spirally twisted with cilia

Q.65 Vascular bundles of Cycas stem are :
[CPMT 1996, MP PMT 2001]
(1) Conjoint, collateral and closed
(2) Conjoint, collateral and open
(3) Conjoint, bicollateral and open
(4) Conjoint, bicollateral and closed

Q.66 Naked seeds occur in :
[CPMT 1986, JIPMER 1998]
(1) Pteris/Pteridophytes
(2) Cycas/Gymnosperms
(3) Funaria/Bryophytes
(4) Maize/Angiosperms

Q.67 Cycas resembles angiosperms in having :
[MP PMT 1996]
(1) Circinate venation in leaves
(2) Vessels
(3) Motile sperms
(4) Ovules

Q.68 Vegetative reproduction in Cycas occurs by :
[RPMT 1997]
(1) Scale leaves (2) Bulbils
(3) Sporophylls (4) Fragmentation

Q.69 Cycas occurs commonly in : **[AMU 1999]**
(1) South America (2) North America
(3) South East Asia (4) Europe

Q.70 Algal zone is characteristic of :
[Pb PMT 2000, BHU 1999]
(1) Coralloid root of Cycas
(2) Normal root of Cycas
(3) Normal root of Pinus
(4) Mycorrhizal root of Pinus

Q.71 Microsporangia of Cycas occur over microsporophyll : **[RPMT 2000]**
(1) Adaxially (2) Abaxially
(3) Laterally (4) Marginally

Q.72 Megasporophyll of Cycas is homologous to :
[AIIMS 2002]
(1) Carpel (2) Stamen
(3) Coralloid root (4) Sepal

Q.73 What is the true about leaves of cycas-
[AMU 2002]
(1) Palmate and Pinnate foliage leaves
(2) Brown scales and Pinnate green foliage leaves
(3) Oblong and long leaves
(4) Green and scaly leaves

Q.74 Which one is living fossil : **[CBSE 2003]**
(1) Pinus (2) Cycas
(3) Selaginella (4) Sphagnum

PINUS

Q.75 What is the habit of **Pinus** plant –
[BHU – 84, Delhi PMT 85]
(1) Decurrent (2) Excurrent
(3) Recurrent (4) Dichotomous

Q.76 The excurrent/conical habit of Pinus tree is caused by -
[AIIMS-85, CPMT-85, EMCET-86]
(1) Auxin effect on the growth of stem tip & axillary branches
(2) Competition of neighbouring pine trees for sunlight
(3) Mutual competition of branches
(4) Efficiency of water movement in plants

Q.77 The mycorrhizal relationship between fungi & roots of **Pinus** plant is – **[CPMT 73, BHU 82]**
(1) Parasitic relationship
(2) Saprophytic relationship
(3) Symbiotic relationship
(4) Epiphytic relationship

Q.78 Pine wood comprises of **[CPMT 85]**
(1) Vessels only
(2) Tracheids only
(3) Both equally
(4) More vessels & less tracheids

Q.79 Male gametophyte of **Pinus** is – **[AIPMT 90]**
(1) Male cone (2) Microsporophyll
(3) Pollen grain (4) Megasporophyll

Q.80 In **Pinus** the third distal tier of its proembryo from below is – **[BHU 82]**
(1) Embryonal tier (2) Suspensor tier
(3) Rosette tier (4) Upper tier

Q.81 Example of a plant which bears seeds but does not bear fruit is - **[Delhi PMT 82]**
(1) **Pinus** (2) **Selaginella**
(3) Maize (4) Groundnut

Q.82 Winged seeds are found in – **[BHU 1985]**
(1) **Fern** (2) **Pinus**
(3) China rose (4) **Cycas**

Q.83 If the number of chromosomes in the pollen grains of Pinus is 12 i.e., n = 12, the number of chromosomes in its endosperm cells should be **[Delhi PMT 81, MPPMT 2000]**

(1) 36 (2) 24
(3) 12 (4) 6

Q.84 If the number of chromosome in the nucellus of **Cycas** or **Pinus** is 24 its number in their endosperm should be – **[CPMT 1989]**

(1) 12 (2) 24
(3) 36 (4) 48

Q.85 The edible part of Pinus chilgoza seed is – **[CPMT 1989]**

(1) Pericarp
(2) Female gametophyte
(3) Diploid perisperm
(4) Triploid endosperm

Q.86 Which of the following plants produces seeds but not flowers – **[AIPMT 2002]**

(1) Maize (2) Mint
(3) Peepal (4) Pinus

Q.87 Pinus is – **[MP PMT 1999]**

(1) Deciduous (2) Dioecious
(3) Monoecious (4) None of these

Q.88 The wood of pinus is – **[MP PMT 2000]**

(1) Pycnoxylic & Homoxylous
(2) Pycnoxylic & Heteroxylous
(3) Manoxylic & Homoxylous
(4) Manoxylic & Heteroxylous

Q.89 Winged pollen grains are formed in **[MP PMT 2002]**

(1) **Pinus** (2) **Cycas**
(3) **Triticum** (4) **Solanum**

Q.90 **Endosperm** in pinus is – **[MP PMT 2002]**

(1) Haploid (2) Diploid
(3) Triploid (4) Polyploid

Q.91 Conifers differ from grasses in the **[AIPMT - 2006]**

(1) absence of pollen tubes
(2) formation of endosperm before fertilization
(3) production of seeds from ovules
(4) lack of xylem tracheids

Q.92 If number of chromosomes in pollen grain of any species of Pinus is 8, then after fertilization what will be the number of chromosomes in Endosperm : - **[RPMT - 2006]**

(1) 24 (2) 16
(3) 08 (4) 32

Q.93 Flagellated male gametes are present in all the three of which one of the following sets ? **[RPMT - 2006]**

(1) **Anthoceros, Funaria** and **Spirogyra**
(2) **Zygnema, Saprolegnia** and **Hydrilla**
(3) **Fucus, Marsilea** and **Calotropis**
(4) **Riccia, Dryopteris** and **Cycas**

Q.94 In gymnosperms, the pollen chamber represents **[AIPMT 2007]**

(1) a cell in the pollen grain in which the sperms are formed
(2) a cavity in the ovule in which pollen grains are stored after pollination
(3) an opening in the megagametophyte through which the pollen tube approaches the egg.
(4) the microsprorangium in which pollen grains develop

Q.95 Select one of the following pairs of important features distinguishing ***Gnetum*** from ***Cycas*** and ***Pinus*** and showing affinities with angiosperm : - **[AIPMT 2008]**

(1) Presence of vessel and absence of archegonia
(2) Perianth and two integuments
(3) Embryo development and apical meristem
(4) Absence of resin duct and leaf venation

Q.96 In which one of the following, male and female gametophytes do not have free living independent existence ? **[AIPMT 2008]**

(1) *Funaria* (2) *Polytrichum*
(3) *Cedrus* (4) *Pteris*

Q.97 Which one of the following plant is monoecious ? **[AIPMT 2009]**

(1) Papaya (2) Marchantia
(3) Pinus (4) Cycas

Q.98 In **Pinus** the megaspore on germination develops **[CPMT 99]**

(1) Pollen tube with two sperms

(2) Endosperm with archegonia

(3) Endosperm with naked egg

(4) Endosperm with embryo sac

Q.99 Female cone of **Pinus** is a

(1) Modified dwarf shoot

(2) Modified long shoot

(3) Modified needles

(4) None of the above

Q.100 Which of the following part of **Funaria**, sporophyte is involved in the dispersal of spores ? **[UTTARANCHAL PMT-2004]**

(1) Calyptra (2) Operculum

(3) Peristome (4) Annulus

Q.101 In **Selaginella**, the adaxial outgrowth, develops from the base of leaf, is called :

[UTTARANCHAL PMT-2004]

(1) ligule (2) velum

(3) rhizophore (4) glassopodium

Q.102 In pinus, the third tier of embryonal cells from below is known as :

[UTTARANCHAL PMT-2004]

(1) rosette tier (2) suspensor tier

(3) embryonal tier (4) free-nuclear tier

Q.103 If a sporangium is derived from a single cell, it is called :

[UTTARANCHAL PMT-2004]

(1) leptosporangiate (2) eusporangiate

(3) heterosporangiate (4) monosporangiate

Q.104 Which is haploid in case of Cycas ?

[UTTARANCHAL PMT-2005]

(1) Stem (2) Root

(3) Endosperm (4) All the above

Q.105 In which of the following pairs of genera sporocarps are presents ?

[UTTARANCHAL PMT-2006]

(1) Marsilea and Salvinia

(2) Marsilea and Isoetes

(3) Isoetes and Salvinia

(4) Marsilea and Lycopodium

Q.106 In Equisetum stem, the cavity formed by dissolution of protoxylem is known as :

[UTTARANCHAL PMT-2006]

(1) vallicular canal (2) vasuclar canal

(3) carinal canal (4) resin canal

Q.107 Sperms of both Funaria and Dryopteris were placed near the archegonia of Dryopteris. Only sperms of Dryopteris entered the archegonia and reached the egg because of :

[WEST BENGAL JEE 2007]

(1) less motility of Funaria sperms

(2) Dryopteris archegonia secrete chemicals which attract dryopteris sperms only

(3) Dryopteris archegonia secrete chemical to repel Funaria sperms

(4) Funaria sperms are killed when mixed with Dryopteris sperms

Q.108 The moss plant develops from :

[CG PMT-2004]

(1) Diploid spores (2) Protonema

(3) Oospores (4) Anthrozoids

Q.109 Fern plant is a : **[CG PMT-2004]**

(1) Haploid gametophyte

(2) Diploid gametophyte

(3) Diploid sporophyte

(4) Haploid sporophyte

Q.110 How much time is generally required/taken by the pine plant from pollination to fertilizaton?

[CG PMT-2004]

(1) Four months (2) Twelve months

(3) Two years (4) Four years

Q.111 In Pinus male and female reproductive structures occur? **[CG PMT-2005]**

(1) On different branches of the same plant

(2) On different plants

(3) On same branch

(4) None of these

Q.112 Stomata in Funaria are found in :

[CG PMT-2005]

(1) Capsule (2) Foot

(3) Seta (4) No where

Q.113 Embryo is found in : **[CG PMT-2006]**

(1) Ulothrix (2) Spirogyra

(3) Funaria (4) Chlorella

Q.114 In which of the following protonema stage is found : **[CG PMT-2006]**
(1) Riccia (2) Funaria
(3) Selaginella (4) Pinus

Q.115 Haploid structure of Funaria is : **[JHARKHAND-2006]**
(1) protonema (2) capsule
(3) apophysis (4) operculum

Q.116 Sperm of Cycas is : **[JHARKHAND-2006]**
(1) multiflagellated and very large
(2) small and biflagellated
(3) multiflagellated and small
(4) large and biflagellated

Q.117 Fern gametophyte bears : **[JHARKHAND-2005]**
(1) archegonia (2) antheridia
(3) sporangia (4) both (1) and (2)

Q.118 Spore of Funaria on germination give rise to : **[JHARKHAND-2005]**
(1) protonema (2) embryo
(3) antheridia (4) archegonia

Q.119 The number of prothallial cell in male gametophyte of Selaginella is : **[JHARKHAND-2002]**
(1) one (2) two
(3) twelve (4) numerous

Q.120 In Funaria, the number of peristomial teeth is : **[JHARKHAND-2002]**
(1) 8 (2) 16
(3) 32 (4) 64

Q.121 Number of peristomial teeth in moss is **[BIHAR-2005]**
(1) 16 + 16 (2) 16 + 32
(3) 8 + 16 (4) 32 + 32

Q.122 Turpentine oil is obtained from : **[BIHAR-2006]**
(1) Pinus longifolia (2) Azadirachta
(3) Eucalyptus (4) All of these

Q.123 The sclerenchyma of the hypodermis in Pinus needle helps in : **[BIHAR-2006]**
(1) increasing the absorptive surface of the cell
(2) checking transpiration
(3) mechanical support
(4) photosynthesis

Q.124 In Cycas, the vascular bundles are arranged in the shape of inverted omega in : **[UP-CPMT 2001]**
(1) Stem (2) rachis
(3) leaflet (4) both stem & leaf

Q.125 Cleavage polyembryony is found in : **[UP-CPMT 2001]**
(1) Cycas (2) Pinus
(3) Funaria (4) Ephedra

Q.126 The rhizoids in **Funaria** are : **[UP-CPMT 2001]**
(1) tuberculated
(2) unicellular and simple
(3) distinct, branched and coenocytic
(4) multicellular and oblique septate

Q.127 In Funaria, stomata are present on the : **[UP-CPMT 2001]**
(1) stem (2) leaves
(3) capsule (4) archegonia

Q.128 Which of the following statement is true regarding the archegonium of fern : **[UP CPMT 2001]**
(1) there are four neck canal cells
(2) there are three neck canal cells
(3) there is one neck canal cell with one nucleus
(4) there is one neck canal cell with two nuclei

Q.129 Cycas revoluta is popularly known as : **[UP CPMT 2002]**
(1) date palm (2) sago palm
(3) sea palm (4) royal palm

Q.130 Protonema stage is found in : **[UP-CPMT 2005]**
(1) fern (2) mosses
(3) liverworts (4) fungi

Q.131 Funaria is attached to substratum by : **[UP-CPMT 2005]**
(1) roots (2) rhizoids
(3) haustoria (4) stem

Q.132 Which of the following are formed due to germination of spores in ferns **[UP-CPMT 2006]**
(1) protonema (2) prothallus
(3) thallus (4) gametophore

Q.133 Funaria is not : **[UP-CPMT 2006]**
(1) acrocarpous (2) cleistogamous
(3) monoecious (4) autoicous

Q.134 In which of the following feature, Cycas resembles angiosperm **[UP-CPMT 2007]**

(1) presence of tracheids

(2) circinate vernation

(3) dichotomously branched leaves

(4) pollen tube is the carrier of male gametes

Q.135 The number of prothallial cells in male gametophyte in pinus **[UP-CPMT 2007]**

(1) 2 (2) 1

(3) 3 (4) 0

Q.136 The plant of Funaria is : **[MP-PMT 2001]**

(1) Monoecious (2) Dioecious

(3) Heteroicous (4) none of these

Q.137 The sporophyte of Funaria always begins development within the : **[MP-PMT 2002]**

(1) Antheridium (2) Archegonium

(3) Capsule (4) Protonema

Q.138 Trabaculae is the transformation of : **[MP-PMT 2003]**

(1) pericycle (2) endodermis

(3) xylem (4) phloem

Q.139 Meiosis in pteridophytes takes place at the time of : **[MP-PMT 2003]**

(1) spore formation

(2) sexual organ formation

(3) germination of spores

(4) gamete formation

Q.140 Pinus seed is originated in :**[MPPMT 2002,03]**

(1) Capsule (2) microsporophyll

(3) microsporangia (4) megasporophyll

Q.141 The endosperm of Pinus is : **[MP-PMT 2003]**

(1) haploid (2) diploid

(3) triploid (4) polypoid

Q.142 Fern prothallus is developed from : **[MP-PMT 2003]**

(1) elaters (2) spore mother cells

(3) spore (4) zygote

Q.143 The development of Funaria gametophyte always initiated from : **[MP-PMT 2003]**

(1) antheredium (2) protonema

(3) archegonium (4) capsule

Q.144 Gametophyte in Funaria is : **[MP-PMT 2004]**

(1) Heterothallic (2) Dioecious

(3) Monoecious

(4) Monoecious and dioecious

Q.145 Winged pollen grains are found in which of the following : **[MP-PMT 2002, 04]**

(1) Pinus (2) Selaginella

(3) Pteris (4) Cycas

Q.146 Calyptra of Funaria arises from : **[MP-PMT 2007]**

(1) capsule (2) antheridium

(3) columella (4) archegonium

Answer Key

Exercise – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	3	3	2	1	3	4	3	3	3	1	2	4	3	2	1	3	3	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	3	4	1	1	4	2	4	2	3	3	2	3	1	3	1	2	3	2	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	1	1	4	4	1	2	4	1	4	2	3	2	3	4	1	4	4	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	4	1	4	2	2	4	2	3	1	2	1	2	2	2	1	3	2	3	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	2	3	1	2	4	3	1	1	1	2	3	4	2	1	3	3	2	2	3
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	1	1	3	1	3	2	2	3	2	1	1	3	2	1	1	4	1	1	3
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	1	3	2	2	4	3	4	2	2	2	2	2	4	1	1	2	2	1	4
Ques.	141	142	143	144	145	146														
Ans.	1	3	2	3	1	4														

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** Water is necessary to complete their life-cycle.
R : All bryophytes are land dwellers.

Q.2 **A :** The bryophytes exist in two phases gametophyte and sporophyte.
R : The sporophyte is nutritionally independent.

Q.3 **A :** Fragmentation is means of vegetative reproudction in bryophytes.
R : Bryophytes lack non-motile mitospores.

Q.4 **A :** Unlike thallophytes, bryophytes show formation of embryo.
R : The embryo gives rise to gametophyte plant of bryophytes .

Q.5 **A :** Bryophytes possess archegonium as a female sex organ.
R : Algae also possess the archegonium.

Q.6 **A :** Meiospores are produced by gametophytic plant of bryophtes.
R : They are of two types.

Q.7 **A :** Liverworts possess rhizoids.
R : It helps in the attachment to the substratum only.

Q.8 **A :** Bryophytes need water for fertilization.
R : Bryophytes can withstand desiccation very well.

Q.9 **A :** The thallus of liverworts is small in size.
R : They are not completely adapted to land condition.

Q.10 **A :** Some liverworts form tubers.
R : Tubers form plants even in unfavourable season.

Q.11 **A :** Many species of liverworts form the gammae.
R : They are fomed on the ventral surface.

Q.12 **A :** Liverworts fail to spread to a new locality through fragmentation.
R : Gemmae are helpful in propagating liverworts in different locality.

Q.13 **A :** Each part of liverworts is capable of regeneration.
R : Isolated scales and rhizoids of liverworts fail to form new individuals.

Q.14 **A :** Marchantia consists of unicellular rhizoids.
R : Rhizoids are of tuberculate type only.

Q.15 **A :** Riccia is many cells thick.
R : Riccia has both assimilatory region and storage region.

Q.16 **A :** Horn worts resemble algae.
R : Their chloroplasts contain pyrenoid.

Q.17 **A :** The sporogonium of riccia is the simplest among the liverworts.
R : Sporophyte consists of capsule only.

Q.18 **A :** The sporogonium of riccia is parasitic on the gametophytes.
R : The sporogonium never dehisces.

Q.19 **A :** Mature marchantia bears gametophores.
R : The antheridiophores and archegoniophores are borne on different thalli.

Q.20 **A :** In marchantia, elaters are directly formed from the sporogenous cells.
R : Elaters are haploid.

Q.21 **A :** The sporogonium of marchantia has three regions foot, seta and capsule.
R : Meiosis takes place in all cells of capsule.

Q.22 **A :** Morphologicall the spores of marchantia are identical.
R : The spores show physiological heterospory.

Q.23 **A :** Sporogonium of riccia is totally dependent on the gametophyte.
R : Sporogonium of marchantia is partly dependent on the gametophyte.

Q.24 **A :** In marchantia, dispersal of spores is done by wind.
R : Elaters facilitate dispersal of spores.

Q.25 **A :** Upper surface of marchantia thallus shows formation of gemma cups.
R : One gemma cup contains one gemma.

Q.26 **A :** Hornworts are more close to algae.
R : Chloroplasts of hornworts contain pyrenoid.

Q.27 **A :** The tuberculate rhizoids are absent.
R : Hornwort-thallus shows regular dichotomous branching.

Q.28 **A :** Nostoc lives in anthoceros thallus.
R : Nostoc obtains organic nutrition from anthoceros.

Q.29 **A :** Pseudoelater is present in the capsule of anthocerous.
R : Pseudoelater is single celled structure.

Q.30 **A :** The sporophyte of anthoceros is long-lived.
R : Sporophyte of anthoceros is semi independent.

Q.31 **A :** The mosses occur in almost all habitats.
R : They do not occur in sea.

Q.32 **A :** Early moss gametophyte is protonema stage.
R : Late moss gametophyte is leafy stage.

Q.33 **A :** Leafy moss contains tubers.
R : Tuber directly gives rise to new leafy gametophore.

Q.34 **A :** The primary protonema of moss by death and decay of cells may break into fragments.
R : Each fragment gives rise to leafy gametophyte.

Q.35 **A :** Any undamaged cell of the moss sporophyte can grow into a protonema.
R : It is a case of apospory.

Q.36 **A :** Autoicous mosses bear sex organs on different branches.
R : Paroicous mosses have both sex organs intermingled together.

Q.37 **A :** In paroicous moss, the antheridial and archegonial groups are demarcated by perichaetial bracts.
R : In synoicous moss, the leaves below the sex organs form a distinct sheath or a rosette-like structure.

Q.38 **A :** Archegonial venter forms calyptra.
R : Calyptra is present a the top of the sporophyte as a hood.

Q.39 **A :** The capsule of moss is highly differentiated.
R : Each region performs a distinctive function.

Q.40 **A :** The peristome is a fringe of teeth-like projections found at the mouth of the capsule.
R : It may be of two types nematodontous and orthodontous.

Q.41 **A :** True mosses bearing peristome teeth are called cleistocarpous.
R : Stegocarpous mosses do not show differentiation of peristome teeth.

Q.42 **A :** Spore of liverworts produces a single sporeling.
R : A number of leafy gametophytes of moss forms from a single spore.

Q.43 **A :** Sphagnum is called peat moss.
R : It is the major component of peat.

Q.44 **A :** Juvenile erect leafy gametophyte of sphagnum is called gametophore.
R : Gametophores bear rhizoids like the mature gametophyte.

Q.45 **A :** It can survive without water.
R : Mature sphagnum cannot absorb water due to lack of rhizoids.

Q.46 **A :** Sphagnum is used for dressing wounds.
R : Sphagnum cannot absrob water.

Q.47 **A :** Sphagnum has great ecological importance.
R : It brings succession in pond ecosystem.

Q.48 **A :** The growth of funaria stem occurs by a single cell.
R : Its position is apical.

Q.49 **A :** Funaria multiplied vegetatively by means of bulbils.
R : Bulbils and tubers are two different structures.

Q.50 **A :** Sporophytes of pteridophyta are dominant individual.
R : They do not show the formation of true root.

Q.51 **A :** Filicales are usually homosporous.
R : They are monoecious.

Q.52 **A :** The sporophytes of polypodiaceae are of various types.
R : Polypodiaceae contains common ferns.

Q.53 **A :** Adiantum caudatum is called walking fern.
R : It can reproduce by its leaf tips.

Q.54 **A :** Coenosorus lacks true indusium.
R : Indusium covers sori.

Q.55 **A :** Ramenta are scales which cover young

rhizome and leaves of Dryopteris.

R : Pteridium lacks ramenta.

Q.56 **A :** Indusium dries in mature sorus and releases sporangia.

R : Mature sporangium releases spors by the structures annulus and stomium.

Q.57 **A :** Both bryophytes and pteridophytes contain well-developed antherida.

R : Biflagellate sperms are formed by their antheridia.

Q.58 **A :** In leptosporangiate development, sporangia are formed from a group of initials.

R : Eusporangiate development of sporangia starts from single initial.

Q.59 **A :** Gymnosperms seeds are naked.

R : They lack ovary wall.

Q.60 **A :** All gymnosperms trees.

R : They lack vegetative reproduction.

Q.61 **A :** Manoxylic wood is soft.

R : The amount of secondary xylem is very small.

Q.62 **A :** The nucellus is present in the ovule.

R : It forms pollen chamber.

Q.63 **A :** In gymnosperms pollination occurs through wind.

R : The ovule secretes a pollination drop.

Q.64 **A :** Cycas has two types of root-tap root system and coralloid roots.

R : Coralloid root contains anabaena.

Q.65 **A :** Xylem of gymnosperms consists of tracheids and no vessels.

R : Phloem of gymnosperms consists of phloem parenchyma, companion cells and sieve tubes.

Q.66 **A :** All living species of cycas are dioecious.

R : Cycas contains male and female cones on the same plant.

Q.67 **A :** *Pinus* has mycorrhizal roots.

R : *Pinus* has no root hairs.

Q.68 **A :** Pinus leaf shows xerophytic adaptations.

R : Cycas too, has xerophytic adaptation,

Q.69 **A :** In India, Cycas revoluta is grown by means of bulbils.

R : Cycas revoluta never forms seed.

Q.70 **A :** In cycas, male cones are found in cluster.

R : The stem of male plant is monopodial.

Q.71 **A :** The male cone of cycas is woody.

R : The microsporophyll at the base cone is sterile.

Q.72 **A :** The male of cycas change in size when the microspores became mature.

R : The microspores are dispersed by wind.

Q.73 **A :** The female cone of cycas is not true cone.

R : Its formation checks the growth of the stem.

Q.74 **A :** The megasporophyll of cycas bears ovules.

R : The ovules are arranged terminally.

Q.75 **A :** Nucellus of cycas forms nucellar beak.

R : Nucellus of cycas forms pollen chamber.

Q.76 **A :** The interval between pollination and fertilization is about 4 months in cycas.

R : Cycas show retention of swimming sperm.

Q.77 **A :** Cycas embryo has many cotyledons.

R : Compound suspensor is formed due to fusion of suspensors of proembryos.

Q.78 **A :** Cycas revoluta is of high economic importance.

R : It yields sago grains.

Q.79 **A :** Pinus has a pyramidal appearance.

R : The older parts of long shoot have scars of fallen dwarf shoots.

Q.80 **A :** Pinus tree is evergreen.

R : Its needles are persistent.

Q.81 **A :** Resin protects Pinus tree from microbial attack.

R : Resin is formed in resin canals.

Q.82 **A :** The pollen grains of pinus are wind pollinated.

R : They are winged.

Q.83 **A :** Companion cells are absent in gymnosperm.

R : In gymnosperms, plants show well-developed vessels and fibres.

Q.84 **A :** "Uper carboniferous" period is also called "Age of Ferns".

R : Ferns dominated during the period.

Q.85 **A :** Pinus is heterosporous.

R : Microspore and megaspore are present in them.

Q.86 **A :** Pinus tree is evergreen.

R : Leaves of pinus are xerophytic in nature.

Q.87 **A :** Conifers shed their leaves during winter

season.

R : In temperate areas, conifers are deciduous in nature.

Q.88 **A :** Long shoots bears male cones.

R : Long shoots of pinus grow vigorously for some time, then growth stops.

Q.89 **A :** The scale leaves on the long shoots are called cataphylls.

R : Cataphylls lack mid rib.

Q.90 **A :** It shows presence of albuminous cells.

R : Pinus lacks sieve plates.

Q.91 **A :** Bract scale is a membranous structure.

R : Bract scales helps in the disporsal of seeds.

Q.92 **A :** Pinus shows formation of annual rings.

R : Pinus grows in area of environmental fluctuation.

Q.93 **A :** The mesophyll of pinus shows no distinction as mesophyll and palisade.

R : Parenchymatous cells are present in mesophyll of pinus.

Q.94 **A :** Pinus is monoecious.

R : Each sporophyll bears only one microsporangia.

Q.95 **A :** Male cone bears pollen grains.

R : Male cone of Pinus is equivalent to stamens of angiosperms.

Q.96 **A :** The female cones are same in number as male cones.

R : Male and female cones appears alternately on the same branch of the Pinus.

Q.97 **A :** The female cones take much time to mature.

R : The seeds are shed when the cone is 22 months old.

Q.98 **A :** Pinus shows polyembryony.

R : Pinus embryo has two cotyledons.

Q.99 **A :** Pinus displays the alternation of generations.

R : The gametophyte is dependent upon the sporophyte phase.

Q.100 **A :** Cedrus deodara yields highly valued timber.

R : Cedrus deodara is resistant to pathogen attack.

ANSWER KEY

EXERCISE–4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	3	3	3	3	4	3	3	2	3	3	2	3	3	2	1	1	2	2	4
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	2	2	2	3	1	3	1	3	1	2	2	3	3	1	3	2	2	1	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	2	1	3	3	3	1	2	3	3	2	2	3	2	2	2	4	4	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	2	2	2	3	3	1	2	3	4	2	2	3	3	2	2	1	3	2	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	1	3	3	1	2	2	3	4	3	2	1	3	3	3	4	2	3	2	1

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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AMOEBA

CLASSIFICATION

Phylum - **Protozoa** - Acellular animals. (According to DOBELL), Body organisation- **Protoplasmic**

Subphylum - **Plasmodroma** - Locomotory organs are flagella or pseudopodia or Absent.

Class - **Rhizopoda (or Sarcodina**) - Locomotary organs are pseudopodia. Body-Naked

Order - **Lobosa (or Amoebina)**- Pseudopodia are with rounded ends called lobopodia.

Genus - **Amoeba** - Pseudopodia distinct, C.V. present, uninucleate.

Species - ***A. proteus*** - Body shape irregular, keep changing its form.

DISCOVERY & HISTORY

R.V. Rossenhoff :

– Discovered Amoeba. Termed it as "Little Proteus" on the name of an Yunanian God able to change his shape.

Saint Vincent :

– Named "Amoeba" which was further changed to "Amoeba".

Heirsch Field :

– Detailed study of *Amoeba proteus*.

HABIT AND HABITAT

– Most of the species of Amoeba are found in fresh water and feeds on algae and bacteria.
– It is present in dirty water with mud. Culture of Amoeba = By **Hay infusion process**.
– Two species of Amoeba are also found in sea water or marine water.- ***Amoeba verucosa, Amoeba striata***

***Amoeba radiosa* :**

– Found in tropical areas.
– This is the most common species found in India.

***Amoeba proteus* :**

– Present in temperate areas.
– Its structure is like a simple cell and the size is also sufficient therefore is most studied.

***Amoeba pelomyxa* :**

– (Chaos - Chaos) = Giant Amoeba.
– This is the biggest Amoeba (2.5 to 6 mm), its structure is uncommon because it is exceptionally multinucleated.

MORPHOLOGY

Shape and Size :

– Amoeba is micro organism.
– Size varies from 0.2 mm to 0.6 mm.
– It is colourless and transparent.

– Shape is variable because pellicale is absent and pseudopodia are continuously forming and disappearing.

Exception :

– Due to presence of pellicle in *Amoeba verucosa and A. striata***,** pseudopodia are not formed and their shape is fixed.

Pseudopodia - (= false feet) :

– These are finger like and blunt extensions of the cell body.
– These are formed due to liquefication and forward flow of the cytoplasm.
– They are formed by both ecto and endoplasm.
– *Amoeba proteus* is a polypodial species. In this, pseudopodia are large and tubular with rounded tips, called "lobopodia".
– Body of amoeba is differentiated into protoplasmic membrane, cytoplasm and nucleus.

Protoplasmic membrane (Plasma lemma) :

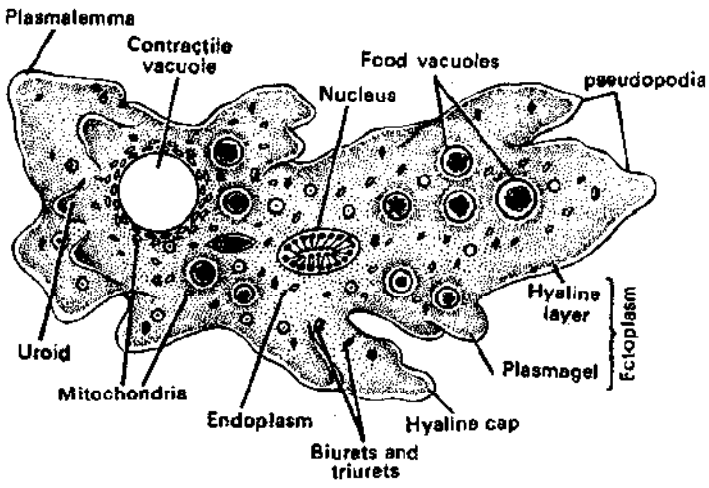
– This is the outermost covering.
– It is thin (0.2μ to 2μ in thickness) soft, selectively permeable unit membrane which is capable of regeneration.
– Electron microscope shows that hair like extensions are present on whole of the membrane, hence are called microvilli .
– They are mucoproteinaceous in nature.
– These microvilli helps amoeba in adhesion with the surface.
– Plasma lemma covers the body thus it is protective in nature.
– It is excretory, NH_3 diffuses out through it.
– It is also respiratory, diffusion of O_2 and CO_2 takes place through it.

CYTOPLASM

It is divided into two parts-Outer = Ectoplasm or Ectosarc. Inner = Endoplasm or Endosarc

1. Ectoplasm :

– It is transparent and present in the form of a thin layer.
– It is devoid of granules and structures.
– Electron microscope shows that it is differentiated into two area.
– Outer part is made of a watery fluid which is called "Hyaline layer".
– This layer is thick in pseudopodia and called as "Hyaline cap". It gives strength to pseudopodia.
– Internal part is made of plasmagel.



– The ectoplasm of *Amoeba proteus* contains various perpendicular projections.
– These are called as "longitudinal ridges".
– These ridges causes friction and helps amoeba to adhere with the ground.

2. Endoplasm :

- It is semi transparent, and granular.
- All the structures of Amoeba are present in endoplasm.
- According to "Mast" Endoplast is divided into two parts.
- Internal - Plama sol. Peripheral - Plasma gel. But electron microscope does not show this type of division.
- So whole of the endoplasm is considered as sol in the modern theory Endoplasm shows cyclosis around the nucleus.

NUCLEUS

- Normally Amoeba is uninucleated but exceptionally ***Amoeba diploidia*** has two nucleus.
- While *Amoeba pelomyxa* is multi nucleated.
- The nucleus of young or baby Amoeba is Biconcave but biconvex in adult Amoeba.
- Nucleus is granular and refractive to light.
- It is bounded by a thin nuclear membrane which is double and intercepted by pores.
- A network of protein fibers is present just inside the nuclear membrane.
- It is Honey comb in shape so called as "Honey comb lattice".
- It maintains the shape of nucleus.
- Nucleus of Amoeba is massive in nature. It means that chromatin material is more and nucleoplasm is less in quantity.
- Chromatin material is present in spherical granules known as **"Chromidia"** .
- These are 500-600 in number.
- Every chromidia is made up of one or two genes.
- Study of Amoeba shows development of chromosomes. Initially there were separate chromosomes which combine and remain in sets during development.
- So more genes are found on a single chromosome.
- Nucleolus - Many in number, but minimum three are present.

CELL ORGANELLES

Contractile Vacuole (C.V) :

- Only one in number.
- It is formed by union of many small vacuoles.
- C.V. is present in endoplasm. Its position is not fixed, but usually it is present between nucleus and rear part of Amoeba (Uroid).

Function :

- Water balance.
- The liquid medium around amoeba is Hypotonic so water is coming inside from outside continuously.
- This extra incoming water is thrown out by C.V. Functionally C.V. is equivalent to kidney or nephron or uriniferous tubules of higher animals.

– Numerous long tubules are related to C.V. These are called as **Feeding canals or Radiating canals**.
– These canals collect water from cytoplasm and drain into C.V.

Diastole :

– Increase in size of C.V. due to filling of water.

Systole :

– When C.V. becomes sufficiently large, it bursts near plasmalemma and water is thrown out. This process is called systole.
– Then many small vacuoles combines to form a C.V. Maximum energy is used in this process so many mitrochondria surrounds the C.V.
– The functional ability of C.V. increases when Amoeba is put in distilled water. When Amoeba is transferred from fresh water to marine water C.V. disappears. When marine amoeba is transferred to distilled water, a new C.V. is formed.

Food Vacuole :

– Many food vacuoles are present in endoplasm.
– Every time when food is ingested, a new food vacuole is formed and full digestion occurs in this vacuole.
– Fuctionally it is closely related to alimentary canal of higher animals. In hungry amoeba food vacuole is absent.

Water Vacuoles :

– These are small, non contractile vacuoles filled with water and are present in endoplasm.
– Formation by pinocytosis. for getting minerals.

Other organelles :

– The ribosomes occurs on some of, the endoplasmic reticulum as well as scattered in the endoplasm.
– Golgi bodies present as several group of sac like tubes.
– Mitochondria are more or less and have tubular cristae.

Biurets and Triurets :

– Many bipyramidal and tripyramidal crystals are present in endoplasm of amoeba.
– These crystals are made up of excretory product:- **carbonyl diurea**. (Specific property).
– Probably these crystals are excreted during reproduction.
– Stored food of Amoeba - Glycogen and Oil drops.
– Every cell organelle is present in cytoplasm of Amoeba except centriole.
– Endoplasmic reticulum in Amoeba does not contain cisternae.

LOCOMOTION IN AMOEBA

Amoeba is a **polypodial** animal but the **locomotion is monopodial**, means Amoeba uses a single pseudopodia in locomotion. Speed = .02 - .03 mm/min.

Locomotion in Amoeba is completed in three stages :

1. **Adhesion with base :**

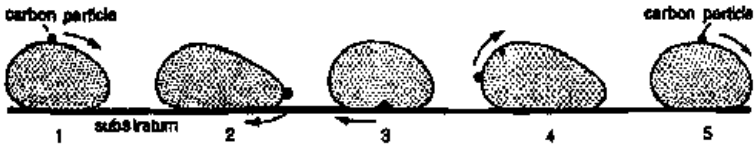
– In this process, microvilli, longitudinal ridges, and ions present in water like Ca^{++}, Mg^{++}, K^{+}, etc. are helpful.

– This is essential for pseudopodia formation.

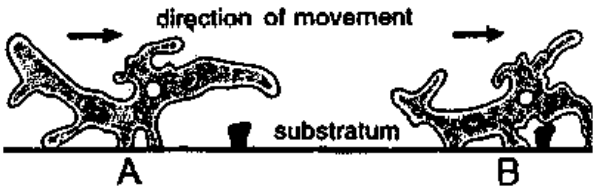
3. **Contraction in body :**
   – Amoeba moves forward by this contraction.

THEORIES RELATED TO LOCOMOTION

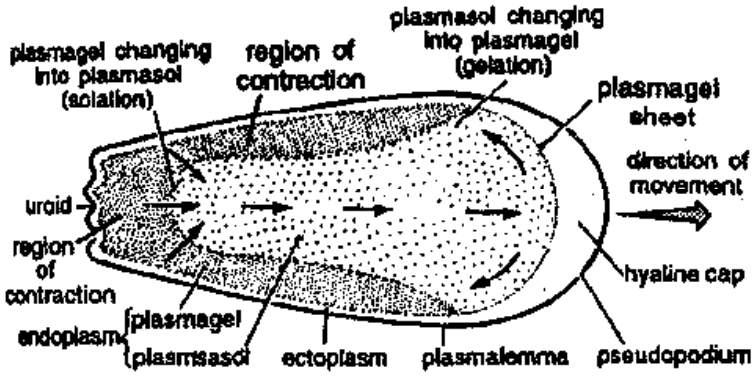
1. **Rolling movement theory :**
   – This theory was proposed by "**Jennings**".
   – This type of rolling movement was observed on *Amoeba verucosa*.
   – This theory is correct for only two species. *Amoeba verucosa, Amoeba striata*. (because on his surface pellicle is present).
   – He explained that the amoeboid movement takes place due to rolling movement of the body surface comparable to the rolling movement of the fluid filled sac on substratum.
2. **Contraction theory :**
   – This theory is given by **Heitzman & Schultze.**
   – According to this theory a pseudopodia is formed due to contraction.
   – Contraction occurs in posterior portion of Amoeba while pseudopodia forms in front part or in the direction of locomotion.
   – Pseudopodia formed is considered as Hernia.
   – This theory is not valid.
   – Only contraction is not responsible for pseudopodia formation.



3. **Walking movement theory :**
   – This theory was given by **Dellinger**.
   – This theory says, that pseudopodia forms in the front part.
   – These pseudopodia serves as feet for amoeba which causes locomotion.
   – Pseudopodia disappears in the back part and are observed as wrinkles.
   – These wrinkles are called **Uroids**.
   – This theory is not right.
   – At the time of locomotion Amoeba is in contact with surface.



4. **Surface tension theory :**
   – Proposed by **Berthold. Butschli and Rhumbler** supported this theory.
   – According to this theory pseudopodia are formed due to difference in surface tension of body of Amoeba and ground.
5. **Sol-Gel Theory :**
   – (Change in viscosity theory) = Proposed by = Hyman
   – Detailed study by = **Pantin and Mast**
   – This theory suggest that pseudopodia are formed due to interconversion of sol. and gel.
   – According to Mast endoplasm is divided into two parts.



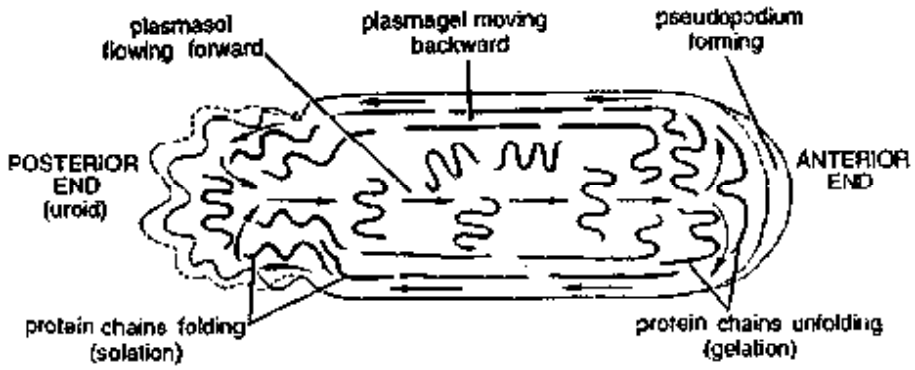
- Central part - Sol. Peripheral - Gel
- In locomotion sol flows in the direction of locomotion and breaks the gel barrier.
- This sol strikes with the ectoplasm.
- After striking it moves on either side and converts into gel.
- In locomotion the gelation process occurs in front while solation (gel to sol) occur in rear outward.
- This process helps in pseudopodia formation.
- Pseudopodia is a tube like structure of ectoplasm in which endoplasm is filled.
- The wall of pseudopodia is made up of gel while sol is inside.

Drawbacks :

- This theory do not explain the sol-gel interconversion.
- It does not mention about the force by which sol moves forward.

SOME THEORIES IN FAVOUR OF SOL-GEL THEORY

1. **Molecular folding unfolding theory :**
   - **Proposed by Goldacre and Lorch**. It explains the sol-gel interconversion.
   - This is a biochemical and biophysical process.



   - The sol form of protoplasm is due to tertiary structure (folded state) of protein.
   - While the gel form is due to secondary structure which is formed by unfolding of tertiary protein.
2. **Contraction Hydraulic theory :**
   - **Given by Rinaldi**. It explains how do sol moves in the direction of locomotion.
   - According to this, actin and myosin type of proteins are present in rear portion of Amoeba.
   - These proteins produce hydraulic pressure by contraction.

- This pressure is maximum in front, minimum in middle and moderate in rear.
- According to "Huxley", the proteins participating in solution and gelation are similar to actin and myosin of muscles fibres.

3. **Fountain zone theory :**
   - **Proposed by Allen.** According to this, sol is present in periphery while gel inside.
   - This central gel moves like a fountain in the direction of locomotion.
   - This fountain applies pressure over ectoplasm and thus pseudopodia is formed.
   - But this theory is absolutely wrong because in amoeba sol is always inside while gel is always outside.

PHYSIOLOGY

Nutrition :

- Nutrition in amoeba is holozoic or zootropic.
- It means that initially ingestion of food and then digestion occurs in body.
- Amoeba is omnivorous. It takes bacteria, algae, ciliated and flagellated protozoa.
- There is no pore for ingestion and excretion of digested food.
- Any part of plasmalemma can ingest food and excrete digested food.
- Some protozoans like paramecium contain pore.
- These are called **cytostome (mouth) and cytoproct (anus)**. (or cytopyge).

Methods of food ingestion - Studied by Rhumbler :

1. **Import :**
   - Amoeba do not take effort in this method.
   - Any moving food when strikes with amoeba, it is embedded into the cytoplasm.
2. **Invagination :**
   - By this process small and non-motile food is ingested.
   - This type of food when comes in contact with plasmalemma, it invaginates and food is ingested due to invagination of plasmalemma in the form of a food vacuole.
3. **Circumfluence :**
   - This process is used to ingest large and nonmotile food e.g. Filaments of algae.
   - In this process amoeba moves and covers the food by sitting on it.
   - Now it spreads over the food, plasmalemma invaginates and forms a food cup which further converts to a bit food vacuole.
4. **Circumvallation :**
   - By this process amoeba ingests active, motile food.
   - Amoeba surrounds its food by pseudopodia.
   - Later these pseudopodia unite and form a food cup.
   - These pseudopodia along with the food are absorbed in the endoplasm.

Digestion :

- Digestion occurs completely in food vacuole.
- The total duration is approximately 30 hrs. when digestion is completed.
- Digested food is thrown out by exocytosis.

- The mechanism of digestion is same as in higher animals.
- Initially the medium is acidic, in this medium food is dissolved.
- Later on the medium becomes basic so that digestive enzymes digest the food.
- All digestive enzymes are present in amoeba but the presence of carbohydrate digestive enzymes is suspicious. After digestion, digestive food is diffused from food vacuole to endoplasm.
- During digestion food vacuole shows changes.
- Initially food present in food vacuole is complex and insoluble.
- So medium in food vacuole is hypotonic with respect to external media.
- So that food vacuole looses some water and hence it becomes a little small.
- When food is digested, it becomes soluble.
- Now medium of food vacuole is hypertonic and hence water is re absorbed which increases the size of food vacuole.
- Later on, digestive food is diffused to cytoplasm and this causes the medium to become hypotonic which in turn causes food vacuole to a smaller size.
- This decreased size food vacuole is thrown by exocytosis.

Respiration and excretion :

- Both these functions are completed by plasmalemma through diffusion.
- Amoeba is an obligate aerobe.
- It depends only on aerobic respiration.
- So when amoeba is put under O_2 less water, it dies.
- In view of excretion amoeba is ammonotelic.

Reproduction :

There are many processes -

1. **Binary fission :**
   - Simplest type of reproduction.
   - It occurs in desirable condition.
   - In this process division is primitive type of mitosis called as cryptomitosis.
   - Phases of this division are as under.
2. **Sporulation - Occurs in two stages :**
   - i. Sometimes amoeba reproduces by sporulation in unfavourable conditions.
   - ii. When excessive energy is spent in continous binary fission, ability of survival decreases.
   - To reproduce, it does sporulation.
   - Spore is the **resting stage of amoeba** hence it saves energy.
   - In sporulation amoeba retracts its pseudopodia and becomes a sphere.
   - Nuclear membrane disappears and chromidia disperse in sets of 2 or 3 chromidia.
   - Every set of chromidia is surrounded by a newly formed nuclear membrane.
   - After that cytoplasm divides and breaks in 200 pieces.
   - Every piece contains a nucleus.

- Every piece now secretes a hard and thick coat around itself.
- This structure is called spore.
- So 200 spores are formed by this process.
- Coat of spore is made up of chitin.
- Now plasma lemma in a parent amoeba dissolves and spores are spread out.
- When favourable conditions arrive, spore germinates.
- They absorb water and swallow.
- Thick coat splits and a young amoeba comes out.
- In this young stage endomitosis occurs in nucleus, so that chromidia increases in number up to 500-600 nuclei formed by endo mitosis is called **restitution or polyenergid nucleus**.
- Spore also helps in dispersion of amoeba.

3. Encystment and multiple fission :

- This process is used under unfavourable conditions, like lack of O_2, lack of food and high temp.
- In this case amoeba secretes a three layered thick coat around itself.
- Now amoeba is called cyst.
- Coat of cyst is also made up of chitin like of spore.
- It is impermeable for water and permeable for O_2 and CO_2.
- Inside cyst, amitosis occurs several times so that 500 small amoeba are formed.
- These are called pseudopodiospores or swarm spores.
- On returning of favourable conditions, cyst splits and amoeba are free in water.
- According to modern scientists multiple fission is very rare.
- It is not a process of reproduction. It is a process of perennation.
- Amoeba is least active inside cyst.
- This is called **"Suspended Animation"**.
- This is also a process of dispersion but its efficiency is more than spore.

4. Rejuvenation :

- This is also called non-functional conjugation.
- In this process, two old amoebae come close to each other and adhere themselves.
- After a while they get separated.
- Now both of these amoebae are more active than before.
- Exchange do not occurs in this process.

5. Regeneration :

- Studied by bruno & Hoger – There is maximum power of regeneration in amoeba.
- Any part of amoeba which contain at least one chromidia may regenerate.

IMMORTALITY IN AMOEBA - STUDIED BY HERTMAN

- Amoeba is immortal because its natural death do not occur, as a parent amoeba is converted completely into two daughter amoeba by binary fission.
- Immortality can also be explained on the basis of "Germplasm theory of Weismann".

- According to this theory, amoeba is not differentiated into somatoplasm and germplasm.
- This type of differentiation is present in multicellular animals.

Irritability :

- Amoeba has protoplasmic grade of irritability.
- Maximum taxis movement of amoeba are negative, these are called phobotaxis.
- Some positive taxis are also present these are called philotaxis.

Examples of irritability

1. **Thigmotaxis :** Normally phobotaxis, but in response to food it is always philotaxis.
2. **Phototaxis :** Amoeba likes dim light. So phobotaxis is seen in response to bright light & darkness.
3. **Thermotaxis :** Optimum temp = 20-25ºC. When amoeba is kept suddenly under high temperature, it dies but when rise in temp is gradual it forms cyst.
4. **Chemotaxis :** Amoeba shows phobotaxis when kept under water in which those chemicals are present that are not present normally in water.
5. **Galvanotaxis :** When low current is passed, amoeba moves toward cathode but in high current it dies.
6. **Rheotaxis :** Amoeba moves with the flow of water.
7. **Geotaxis :** Philotaxis because amoeba like to live in bottom. These animals are called benthos or benthic. For locomotion ground is available to amoeba. Sufficient food is also present.

Entamoeba histolytica

Discovered by = Lamble.

- Pathology of Ent. histolytica given by = LOSCH (Life cycle monogenetic). Ent. Histolytica is a parasitic amoeba and it causes "amoebic dysentery".
- A patient with this disease has acidic stools.
- Stool also contain mucous and blood and cyst of entamoeba.
- So this disease is diagnosed by stool test. Ent. Histolytica is a parasite of large intestine of man.
- Here, it secretes histolytic enzymes which causes harm to wall of intestine. Ent. destroys the mucosa and submucosa of colon and enters in its wall.
- Finally, it approaches in other organs of body like liver, lungs, kidney, brain etc. through blood circulation.
- In this stage, it may be dangerous.

Two forms of Entamoeba

[i] Trophozoites or Magna form.

[ii] Precyst or minuta form.

[i] Trophozoites or Magna form :

- Trophozoite form is larger than Minuta form.
- Trophozoite is the adult stage of entamoeba.
- This stage of entamoeba is motile, actively feeding and pathogenic.
- Basically structure of entamoeba is similar to Amoeba, but C.V. is absent in entamoeba because of isotonic medium.
- It's food vacuole contains R.B.C., W.B.C. and bacteria.
- Nucleus of entamoeba is vesicular chromatin material less and nucleoplasm is more.
- Chromidia are arranged on periphery of nucleus.
- At the centre of nucleus, a false nucleus or karyosome or Endosome occurs.

- Endosome surrounded by a small clear shiny and transparent area which is called "Halo".
- Nucleoplasmic striations connect Halo to chromidia.
- *Ent. Histolytica* :- monopodial animal.
- In its rear portion plasmalemma is gelatinous and sticky.
- So that it helps in sticking of food particles.
- Food is ingested by the process of invagination.
- This is the only process of food ingestion.

(ii) Minuta or Precyst form :

- This is non-motile form, non-pathogenic, non-feeding form called as **minuta**.
- Cytoplasm of these minuta contain only one or two granules of glycogen, but contains a dense body called as "Chromatid body". (in only unmature cyst) Possibly it is made up of Ribo nucleoproteins which further disappear.

Life Cycle :

- Division is by binary fission the daughter are formed which receive their nutrition and become adult called Trophozoite.
- But some daughter Ent. do not take nutrition and hence no growth occurs, so they remain small in size called minuta.
- Minuta secretes a thin but strong coat around itself.
- This is called cyst. Nucleus of cyst undergo two mitosis and a tetra nucleated cyst is formed it is carried out from the body by stools of the patient.
- This tetra nucleated cyst is the infective stage of Ent. for human.
- Cyst enters in human by impure water and food.
- Houseflies carry these cyst to food.
- When these cyst reaches to colon their hard coat is damaged this process is called hatching or excystment now mono nucleated stage comes out this is called metacyst.
- Metacyst undergo binary fission and eight Ent. are formed.
- So cytoplasmic division is only one times while nuclear division is three times to make eight Ent.
- All these Ent. enters the wall of colon and after growth converted into Trophozoite.
- Some medicines used in prevention of diseases caused by ent. histolytica. Emetine (Inj.), Diodoquin, Dependal, Carborsone metrogyl, magma, Amicline.

Entamoeba gingivalis

- It is present in Tarter which is deposited in between teeth and take W.B.C. and Bacteria.
- Approximately 70% humans are infected by this.
- Some times it also infect gums.
- *Ent. gingivalis* is a human parasite but it **is not pathogenic** actually it helps some pathogenic protozoa. In infection e.g. **Trichomonas tenax** and **Trichomonas buccalis** both of these causes pyorrhoea.
- In this disease there is leakage of blood & pus from gums.
- *Ent. gingivalis* do not form cyst.
- It spreads through mouth to mouth kiss (*E. gingivalis* KTP = Kiss Transmitted parasite).
  Prevention may be done by using sensoform mouth wash.

Entamoeba coli.

- This species is found in human colon.
- It shows commanselism means host is neither in gain nor in loss.
- It feeds on non digestive food & bacteria. E. Coli = Escherichia Coli - It is a bacteria it also shows commanselism found in alimentary canal of human.

SPECIAL POINTS

- Amoeba is omnivorous.
- Pelomyxa is the largest amoeba.
- *Amoeba proteus* is a free living and solitary animal.
- Amoeba is polypodial where as Entamoeba is Monopodial.
- Amoeba shows polarity as uroids are present on rear.
- Chromatin material of Amoeba is granular and called chromidia.
- Gaseous exchange in Amoeba is done through body surface.
- Excretion of Ammonia is also done through body surface.
- The universal theory for locomotion in Amoeba is sol-gel theory.
- Mechanism of binary fission in Amoeba is cryptomitosis.
- General method of reproduction in Amoeba is binary fission.
- Digestion is intracellular.
- Food vacuole of Amoeba is analogous to the alimentary canal of an animal or gastrovascular cavity of Hydra.
- Quadrinucleate cyst of Ent. amoeba is infective stage.
- Most effective medicine for amoebiasis is metrogyl or flagyl.
- Amoeba has no skeleton.
- Difference between Amoeba and Entamoeba is contractile vacuole.

PLASMODIUM (Malaria Parasite)

CLASSIFICATION

Phylum - **Protozoa**
Sub Phylum - **Plasmodroma** – Locomaotive organs are pseudopodia or flagella or absent
Class - **Sporozoa** - All members are endoparasites. So locomotive organs are absent
Subclass - **Telosporidea** thin and long sporozoites and sporulation found
Order - **Haemosporidia** = Digenetic life cycle and parasite on blood and tissue
Genus - **Plasmodium** – Blood parasite of mammals, birds or reptiles. Vector is usually mosquito.
Species - There are 60 species of Plasmodium are known. Only four species causes malaria.

P. vivax
P. ovale
P. malariae
P. falciparum

LIFE CYCLE OF PLASMODIUM

- Plasmodium is a member of order Haemosporidia therefore it completes its life cycle in two hosts.
- **Primary host -** Primary host for **plasmodium** is **human being**. Plasmodium completes only **asexual life cycle** in this host.
- **Secondary host -** Intermediate host = Carrier host - **female anopheles** serves as secondary host for plasmodium. Both sexual cycle and sporogony (asexual) are completed in this host.
- **Reservoir host -** Monkey is reservoir host for plasmodium.
- All the stages of plasmodium life cycle that occurs in human are also found in monkey, but monkey do not suffer or die of malaria.
- Eradication of **plasmodium** is not easy due to its several hosts. Another reason is that vaccine can not be formed because **plasmodium** do not induce human body to form antibodies and hence no immunity against **plasmodium** can develop.
- **NMEP** - National Malaria Eradication Programme

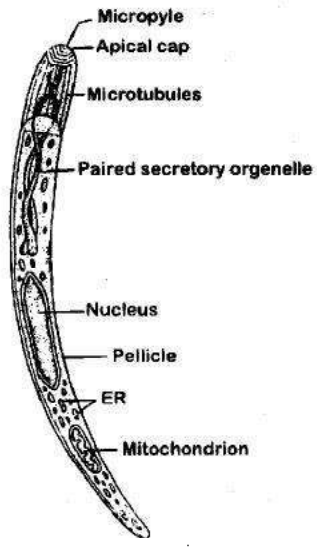
LIFE CYCLE OF PLASMODIUM IN HUMAN

Infection :

- A healthy person acquires infection when a female Anopheles mosquito contains infective stages (sprozoites) of the parasite in its salivary gland, bites him for sucking blood.
- Sporozoite are present around a number of 2,00,000 in salivary glands of female **anopheles**.

Sprozoites :

- Sporozoites are spindle or sickle shaped.
- Body is covered by pellicle which is made up of **11-15** microtubules. Pelicle is contractile due to pelicle sporozoite show wriggling movment.
- No. of microtubles in pelicle of P. vivax – 11, P.ovale – 13 and P. falciparum – 15.
- Sporozoite contains an aperture at the apex. This is called "Micropyle".



Sprozoite

- A structure which covers micropyle is known as apical cap. It is made up of 3 concentric microtubules.
- A pair of secretory organelles are related to micropyle. It contains **lytic enzymes** which helps sporozoite to penetrate human liver cells.
- A big oval shaped nucleus is present in middle of sporozoite. Just beneath it, there is a mitochondria.

- An anticoagulant **(Anophellin)** is secreted when female anopheles bites, it do not allow blood to clot so that anopheles can suck blood easily. With the saliva, a number of sporozoites enters in human blood.
- Within 30 minutes all of these sporozoites approaches the liver. Now no sporozoite is visible in the blood.

Exo erythrocytic Cycle :

- There are two sites for activity of plasmodium in human (i) Liver (ii) RBC.
- All the activities that oocurs in liver are known as **"Exo erythrocytic Cycle"**.
- Whereas activities in RBC are termed as "**Erythrocytic cycle**".
- Exo erythrocytic Cycle consist of (a). pre erythrocytic cycle and (b). post exo erythrocytic cycle.

(a) Pre Erythrocytic Cycle :

- The first cycle of plasmodium in liver is called as pre erythrocytic cycle.
- Sporozoite enters into the liver cell and become spherical by phagocyting the cytoplasm.
- Now these are termed as "**Cryptozoites**". Cryptozoites undergo multiple division.
- This is called "**Schizogony**". This results in the formation of 1000-1500 small structure called as **cryptomerozoites**.
- At this stage cryptozoite is called "Schizont" (According to old scientists) schizont name is used for cryptozoite which undergoes schizogony.
- Old scientist use the name cryptozoite for products of schizogony.
- Finally cell membrane of liver cell & schizont bursts and cryptomerozoites are now free in blood sinusoids of liver.
- A few of these cryptomerozoites infect RBC and start the erythrocytic cycle.
- Rest of the cryptomerozoites go back in liver cells and starts the post exoerythrocytic cycle.
- All these cycles in liver, **except the first one** are called **post erythrocytic cycles**.
- Time taken to complete pre erythrocytic cycle is called **pre patent period**.
- In this period plasmodium is not visible in blood.
- After pre-patent period report of blood test is positive and plasmodium can seen in blood.
- Plasmodium starts its life cycle from liver because
  (i) To prevent itself from the phagocytic action of WBC
  (ii) Plasmodium use glycogen as food and liver is rich in glycogen.
  (iii) To multiply in number

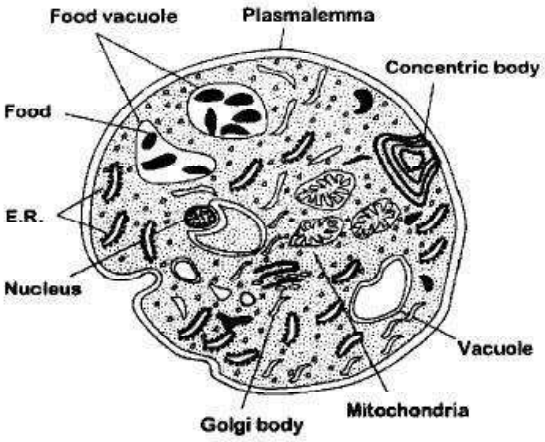
(b) Post Exoerythrocytic cycle :

- In this cycle, cryptomerozoites infect the liver cells.
- They phagocytise the cytoplasm and become big and spherical.
- Now these are known as **Metacryptozoite or phanerozoites.**
- Two types of metacryptozoites are formed.
  (i) Micro Metacryptozoites - (Mi mcz) (ii) MacroMetacryptozoites - (Ma mcz).
- **Mi mcz** are further divided into 100-1000 merozoites by the process of schizogony.
- The product is called Micro meta crypto merozoite (Mi mcmz).
- **Ma mcz** also undergo the process of schizogony.
  It results in the formation of 64 merozoites these are called (Ma mcmz) *Macrometacryptomerozoite.*

- Mi mcmz infect only & only RBC, whereas Ma mcmz infect liver cells.
- This cycle goes on repeating again and again which causes destruction of liver cells.
- In case of an excessive Malaria, liver may damage and jaundice like symptoms may appear.

Erythrocytic cycle or Golgi cycle :

- This cycle starts at first by cryptomerozoites and further carried on by micrometacryptomerozoite.
- Cryptomerozoite infects R.B.C. They phagocytosis hemoglobin of R.B.C. & become big & spherical.
- Then they are called **trophozoites**. Later on, a big central vacuole is formed in the cytoplasm of trophozoite and nucleous come in lateral side.
- This makes it appear like a "Ring". So this stage is called **signet ring stage.** Double signet ring found in falciparum.
- After a while vacuole is lost and trophozoite become irregular in shape.
- At this stage plasmodium looks like Amoeba, so this is called as amoeboid stage.



Trophozoite

- Amoeboid stage is active and feeding stage of plasmodium, it phagocytise hemoglobin quickly, grows up and occupies whole of the RBC approximately.
- Particularly, at this stage, reddish brown coloured granules are seen in the cytoplasm of plasmodium, these are called haemozoin granules.
- It is the non digested heme part of hemoglobin.
- At the same time bright yellow coloured granules appear in the cytoplasm of RBC.
- These are called **Schuffner's dots** which are probably waste product of plasmodium.
- These dots are used in diagnosis of malaria because they are most clear structures, that appear in blood.
- A stain known as **Romanovaski stain** is used to observe Schuffner's dots.
- There are two species of plasmodium that do not form Schuffner's dots.
- These are -In *P.ovale* Schuffner's dots known by **James dots**.

1. **Plasmodium Malariae :** They form Red coloured granules known as **Zeiman's** dots.
2. **Plasmodium falciparum :** They form green coloured **Maurer's dots.**
   - Both of these are also helpful in diagnosis of malaria.
   - Now schizogony occurs in trophozoite and 12-24 merozoites are formed.
   - They are arranged as petals of flower.
   - So plasmodium looks like a flower and hence this stage is known as **Rosette stage**.
   - Some cytoplasm in this stage remains undivisible.
   - Haemozoin granules are present in this cytoplasm.
   - Finally membrane of RBC and schizont bursts and all the material is free in blood plasma.
   - Merozoites infect new RBC and repeats the erythrocytic cycle again and again.
   - Burst RBC is called ghost RBC. These ghost RBC are uptaken by spleen from the blood and destroy it.
   - A special type of phagocyting cells called as macrophages are present in spleen.
   - These cells secrete an enzyme-lysolecithin which destroy ghost RBC.

Incubation period :

- The time lapse between infection of plasmodium and first attack of malaria is called incubation period.

- Plasmodium shows biological clock system, because erythrocytic cycle is completed exact with in 48-72 hours.
- In case of excessive malaria infection, spleen becomes large and swollen.
- This disease is called Megaly of spleen or spleen index.
- It is due to increase in number of macrophages, and lysolecithin causes swelling.
- Excessive malaria infection may also lead to anaemia, becaue more lysolecithin secretion occurs which reaches to blood and destructs the healthy RBC's.
- So decrease in number of healthy RBC causes Anaemia.
- This anaemia is called hemolytic anaemia. plasmodium also secrete haemolysin enzyme which destroy healthy R.B.C.

Post erythrocytic cycle :

- Sometimes merozoites formed by erythrocytic cycle escapes from blood and enters the liver cells.
- These merozoites remain inactive here. After a long time they become active and multiply in number.
- This causes malaria again. So after a long time malaria is repeated again. This is called Relapse of Malaria.
- Post erythrocytic cycle is not found in **Plasmodium falciparum.** So relapse of malaria do not occur.
- Longest relapse of malaria, found in palsmodium malariae may last upto 3 years.

GAMETOCYTE STAGE

- When many erythrocytic cycle have been completed, then merozoites enter the RBC and form a new stage called as gametocyte or Gamonts or Resistant Trophozoite schizont.
- Gametocyte is the last stage in human. Further development occurs in female Anopheles because high temp in human is unfavourable for gametocyte formation.
- There is biological clock system in plasmodium.
- It means that it form gametes when there is more probability of attack of female anopheles.
- So gametes are formed in night, (from late evening up to midnight.)
- Gametocytes which reach in female anopheles will develop and rest which are left in blood are destroyed by morning.
- Two type of gametocytes are formed.

(1) Micro gametocyte
(2) Macro gametocyte

	(1) Micro gametocyte		**(2) Macro gametocyte**
(a) **ratio**	1	**:**	2
(b) **Position and size of nucleus -**	big and central		Small and eccentric
(c) **Store food quantity -** -	less stored food		More stored food
(d) **Haemozoin granules -** -	less and diffused		more and central in position

LIFE CYCLE OF PLASMODIUM IN FEMALE ANOPHELES

Infection :

- Gametocyte is the infective stage of plasmodium for female anopheles.
- When it sucks blood, many stages reach in its crop, but only gametocyte stage remains rest of all become digested.

There are two type of cycles :

(1) Gametogony (Sexual cycle)
(2) Sporogony (Asexual cycle)

I. Gametogony : It is sexual cycle which has 3 stages.

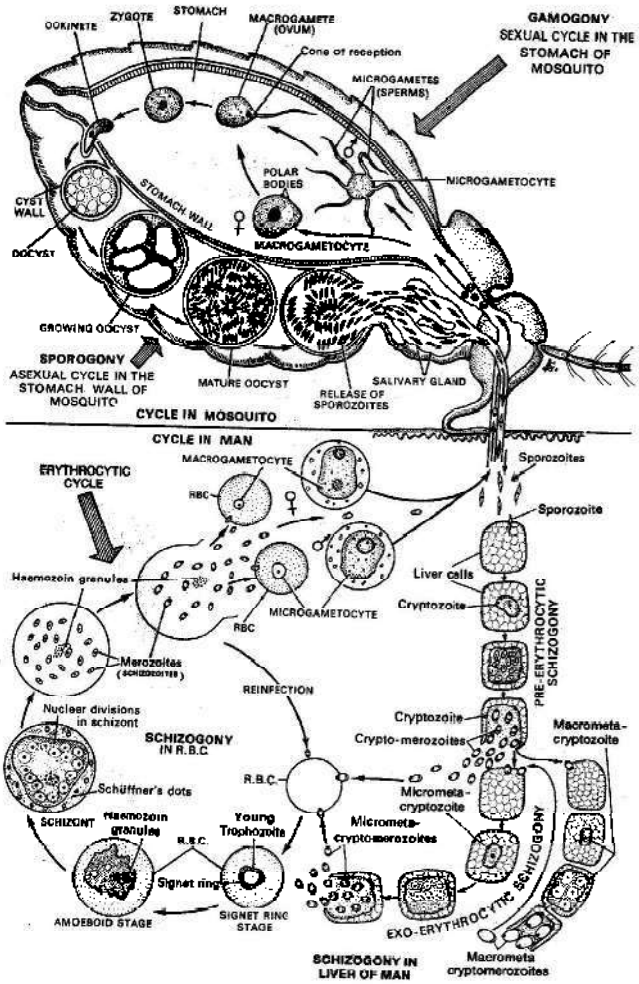
(a) Gametogenesis

(b) Fertilization

(c) Post zygotic stage

(a) Gametogenesis :

- Microgametocytes undergo the process of spermatogenesis in which its nucleus is divided into four haploid nuclei by meiotic division.
- Further mitosis occurs and these are converted into 8 nuclei.
- All nuclei are arranged on periphery.
- At the site of every nucleus, plasmalemma projects outward and eight spindle shaped projections are formed.
- Every projection contains a nucleus and small amount of cytoplasm.
- These projections are called sperms.
- Sperm formation process is called **exflagellation**.
- Every sperm detaches itself from microgametocyte by constricting at its base.
- So eight sperms are formed by a single microgametocyte.
- Macrogametocytes form ovum by the process of oogenesis in which meiosis occurs and one ovum and three polar bodies are formed.
- Polar bodies are destroyed further.



Life cycle of Plasmodium

(b) Fertilization :

- A projection appears on ovum, which is called **reception cone**.
- This is the penetration site of sperm, at the time of fertilization.
- The nucleus of the megagamete also comes to lie near its receptive cone.
- When a lashing microgamete comes in contact with a megagamete, the former penetrates the latter through its reception cone and fertilization takes place.
- Zygote is formed as a result of fertilization.
- Whole of this process up to zygote formation occurs in lumen of crop.
- Zygote can form in any type of mosquito e.g. male or female anopheles.
- **Culex and Aedes** etc. but further development of zygote is possible only in female anopheles.
- This is the host specialisation of plasmodium.

(c) Post Zygotic Stage :

- To understand this stage 2 theories had been given –

1. Old view :

- Proposed by "Grassi". This theory says that all zygotes are converted into long worm like structures called **ookinete or vermicule** with the help of gliding and wriggling movements.
- These ookinete enters the crop wall and are placed beneath the outermost layer called peritoneum of crop wall.

2. Modern view :

- Given by 'L.H. Ward'. According to this theory, some zygotes are converted into ookinete but they can not penetrate the crop wall and hence are digested by mosquito.
- Rest of the zygotes do amoeboid movement, enters the crop wall and placed below peritoneum.
- A thin and elastic coat is secreted around these zygotes, by both zygote and cells of crop wall.
- This stage is called **oocyst**. At this stage 50-100 small projections of oocyst are found on the crop wall.

II. SPOROGONY

- Oocyst takes nutrition from crop wall and develop into 5-6 times bigger structure called **sporont**.
- Many small vacuoles are now formed in the cytoplasm of sporont.
- Nucleus of sporont is converted by free nuclear divisions into approximately 10,000 nuclei, all these nuclei are arranged on periphery of vacuoles.
- Later on, cytoplasm is divided and converted into 10,000 parts around every nucleus, Like that 10,000 sporozoites are formed.
- This sporont is called as **sporocyst**. Outermost layer of crop and wall of sporont bursts and these sprozoites are now free in haemocoel of mosquito.
- Haemocoel is a blood filled cavity. This blood is colourless and is called **hemolymph.**
- All sporozoites are stored in salivary glands from haemolymph.
- About 2,00,000 sporozoites are stored in salivary glands of mosquito, which are further infected to human through saliva.
- Most common is - *Plasmodium vivax*
- very rare is - *Plasmodium ovale*

TYPES OF MALARIA

- Their types recognized on basis of periodicity of paroxysms.

(1) Tertian malaria or common ague :

- It is caused by *P. vivax*, *P. falciparum* and *P. ovale*. Reccurence of fever is after every. 48 hours.
- Vivax and ovale causes **'Benign Tertian Malaria'** with low death rate, becouse merozoites generally invade and destroy old and mature R.B.C.
- Malaria caused by **Plasmodium Falciparum** is called **lethal malaria**. It is also termed as sub tertian fever, tropical fever, cerebral fever, **black water fever**, Malignant fever or Aestivo-autumnale fever.
- This is the most dangerous malaria because infected. RBC adhere and form thrombus which may interfere the blood circulation.
- Carotid artery is feeding artery of brain. So when this artery is blocked by thrombus then brain may suffer from less blood circulation which is unfavourable for it.
- Longer duration of this condition may cause death.
- When thrombus is formed in coronary arteries (which gives nutrition to heart), heart attack may occur, loss of Haemoglobin through urine (Haematuria) occurs in which colour of urine changes from yellow to black.
- Hence, it is also called as **'black water fever'**.

(2) Quartan malaria :

- It is caused by *P. malariae.* Paroxysm occurs at intervals of about 72 hours.

– It generally leads to secondary complications, because of large scale destruction of young RBC.

(3) Quotidian malaria :

– In this, paroxysm are irregular and almost daily.

– It may result from secondary complications of malignant tertian or due to multiple or mixed infections by more than one species of Plasmodium.

(4) Relapse malaria :

– Exoerythrocytic cycles continue uninterrupted in *P. vivax, ovale, malariae* even after the disease is completely cured.

– Merozoites of these cycles, can any time attack RBC and cause a relapse of malaria.

– Malaria by *Plasmodium malariae* is difficult to diagnose because this species may remain dormant in liver for a very longer period.

HISTORY OF MALARIA

1. **Mucculoch :** Named Malaria (Malaria = Mal (Harmful) + air).
2. **Lancisi :** Suspect that there is any relation in between mud mosquito and malaria.
3. **Charles laveran :** Discovered **plasmodium.** He observed plasmodium first, in RBC of human and revealed that malaria is caused by plasmodium.
4. **Sir Ronald Ross :** Proved the relation between mosquito and malaria.
   – He saw oocyst first on crop of female anopheles.
   – About 25,000 mosquitoes were dissected by Sir Ronald Ross in his life.
   – He told that female anopheles is the carrier of plasmodium.
   – The discovery of Sir Ronald Ross was awarded by **Nobel prize on 29th of August 1902**.
   – Hence this day is celebrated as **"Malaria day".**
   – It was an incident that Sir Ronald Ross die of Malaria.
5. **Grassi :** Studied the life cycle of plasmodium in female anopheles.
6. **Mc. Collum :** Explained in detail the sexual cycle of plasmodium.
7. **Shortt, James, Huff & tate :** Studied the life cycle of **plasmodium** in human.
8. **Golgi & Celli :** Explained erythrocytic cycle. So this is also called golgi cycle.
9. **Schauddin :** Detailed study of ***Plasmodium vivax*** life cycle in human and mosquito.
10. **Rudzinska :** Study of ultra structure of plasmodium by electron microscope.
11. **Patric Manson :** Malaria by mosquito biting.
12. **E shortt** – Studied liver schizogony.

SYMPTOMS & PHASES OF MALARIA

– Toxic effects on body due to which symptoms of malaria appear.

– Initial symptoms of malaria - Nausea, constipation, bodypain, Dyspnoea, weakness in body.

– After 2 to 3 erythroytic cycles haemozoin granules increase in number and actual symptoms of malaria now begin to appear.

– This is called paroxysm of malaria. It has three stages.

1. **Rigor stage :** Alternate contraction and relaxation in muscles causes shivering and cold sensations.
2. **Febrile stage :** After some time, shivering stops and body temp rises due to contraction of muscles. Rise in temperature is beneficial for patient, because internal high temp is unfavourable for parasite plasmodium.
3. **Difer vescent stage :** After rise in temperature, excessive sweating occurs and body temperature decreases. Now patient considers himself healthy, but at this time, erythrocytic cycle starts again and fever is repeated at a constant interval of time.

CONTROL OF MALARIA

– We use two methods- [1] Direct - by killing plasmodium [2] Indirect - by killing mosquitoes

[1] Indirect : following procedures are used to kill mosquitoes.

[a] Insecticides like = DDT (It is now banned) Gamaxene, malathion etc. are sprayed.

[b] Biological control - This is the more suitable procedure. In this larvivorous fishes are used. They eat larva of mosquitoes. e.g. Gambussia Trout, minnows, stickle back

[2] Direct method : Plasmodium is destroyed by chemotherapy

[a] Old medicines like **Quinine** - it is obtained from **cinchona as quinine sulphate salt.** It destroys only those stages of plasmodium which are present in blood.

[b] Mapacrine - It destroys merozoites present in blood.

[c] Plaudrine and sulphadoxine - These medicines destroy all the stages either in blood or in liver. But are not generally used because they cause harm to liver cells.

SPECIAL POINTS

[1] **Malaria day- 29th August**

[2] Plasmodium is a member of class-**sporozoa**

[3] Monkey acts as Reservoir host of plasmodium

[4] Lysolecithin secreted by spleen destroys infected RBC's

[5] Normally primary host is the host in which parasite completes its sexual life cycle but in plasmodium. Human is primary host exceptionally. Although sexual cycle is completed in mosquito and asexual in human.

[6] Maximum amount of Haemozoin granules is present in gametocyte stage

[7] Temperature of malaria patient may rise up to 104-105° F

[8] Some other symptoms & side effects may appear from malaria like Anaemia, Jaundice, Megaly, Thrombosis, insomnia

[9] The most effective medicine for malaria is deraprim, it destroys gametocytes

[10] Number of lymphocytes is increased in malaria infection.

CONTROL OF MALARIA

Two Method :

1. INDIRECT METHOD	2. DIRECT METHOD
Use of pesticide for mosquito	**Use of medicine for Plasmodium**
* Mainly prepared by malathion	* Oldest medicine Quinine
Others	Quinine effective only in blood
* Kerosine oil	* **Sulpha drugs**
Most safe method – Biological control	Eg. : Metakelfin. Daraprim
Eg. :- Utricularia (Plant)	
Larvivorous Fishes	
Eg.:– Gambusia. Minnous. Stickle backs	
Danio. Mansonia	

CLASSIFICATION

[1] Division	**- Radiata**	– Radial symmetry
		– Tissue grade
		– Common digestive and body cavity. (gastrovascular cavity)
[2] Phylum	**- Cnidaria or**	– Mouth encircled by tentacles.
	- Coelenterata	– Stinging cells (Nematocyst) present
		– No aboral sense organ
[3] Class	**- Hydrozoa**	– Life cycle includes alternating polyp and medusa stages.
		– Medusa usually small with a velum (craspedote)
		– Mesogloea non cellular
[4] Order	**- Hydroidea**	– Polyp phase dominant
		– Medusa phase present/absent
[5] Suborder	**- Anthomedusae**	– Athecate polyp
		– Absence of balance vesicles
[6] Genus	**- Hydra**	– Tentacles 6 - 10
		– Stalk less developed

HISTORY OF DISCOVERY

[1] Hydra was discovered by Leeuwenhoek (1703)

[2] Hydra name was proposed by Linnaeus (1758)

[3] Full description of Hydra by Trembley (1744-1784)

DIFFERENT SPECIES OF HYDRA

– 20 species are known, four species more common in India

Species	Colour
H.viridissima (chlorohydra)	Green
H.fusca (oligactis)/Pelmatohydra	Brown
H.vulgaris	Colourless
H.gangetica	Pink

HABIT & HABITAT

– Carnivorous, Fresh water, Solitary, most of the time it remains attached to submerged stones, sticks, vegetation, Free Living, Regeneration & division of labour

EXTERNAL MORPHOLOGY

Size and Shape :

- Hydra's body is like a thin, cylindrical hollow tube, contractile in nature & possessing Radial symmetry.
- Hydra is a cylindrical polyp coelenterate.
- The polypoid body of Hydra is 3-4 mm to 1 cm in length.

Hydra body divided into two parts.

[a] Somewhat thinner basal or proximal part, called stalk or Peduncle and

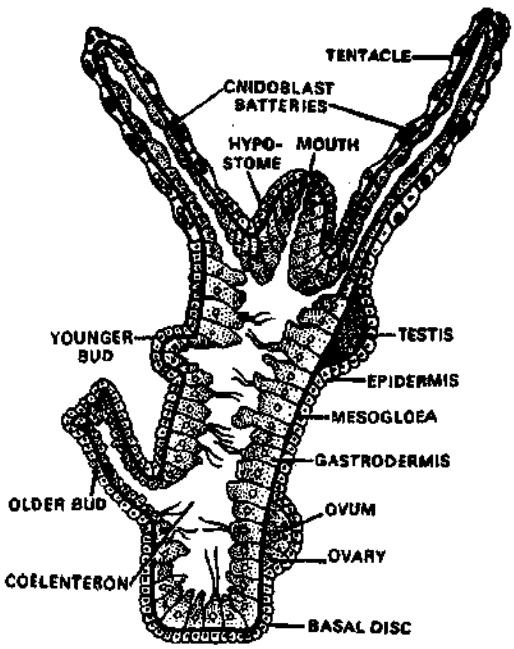
[b] The remaining thicker and Darker distal part called Gastric region.

(a) Stalk :

- The closed basal or proximal end of Body is flattened forming an adhesive basal disc for attachment to a Substratum.
- It consist of glandular zone which secretes adhesive substance for attachment and gas bubble for floating.

(b) Gastric region :

- Conical part of Gastric region is known as Hypostome or oral cone or Manubrium.
- 6 to 10 slender, thread like tentacles arise from the circular base line of hypostome.
- Tentacles help in feeding, Locomotion and Protection.
- Hydra have both unisexual and bisexual species.



Bud :

- During the favorable season Hydra develops one or more buds.
- A well developed bud possesses its own mouth, hypostome and tentacles.
- On detachment it gives rise to a new individual.

Gonads :

- During breeding season, **temporary gonads** in the form of small and solid protuberances, can also be seen upon the gastric region.
- Number of Testes in no. 1-8, conical in shape & situated in distal part.
- Ovaries round, number .1-2 & situated in Basal Region.

INTERNAL STRUCTURE

1. Coelenteron or Gastro Vascular Cavity
2. Body Wall

1. Coelenteron or gastro vascular cavity :

- Hydra has a single large internal cavity, surrounded by a thin body wall. The cavity is called Coelenteron or gastrovascular cavity.

– **Hydra :** Acoelomate. It communicates with the exterior only by terminal mouth. It also extends into the hollow tentacles.
– **Function :** Some extracellular digestion of food occurs in it.
– **Coelenteron :** Originates from Archenteron of Gastrula.

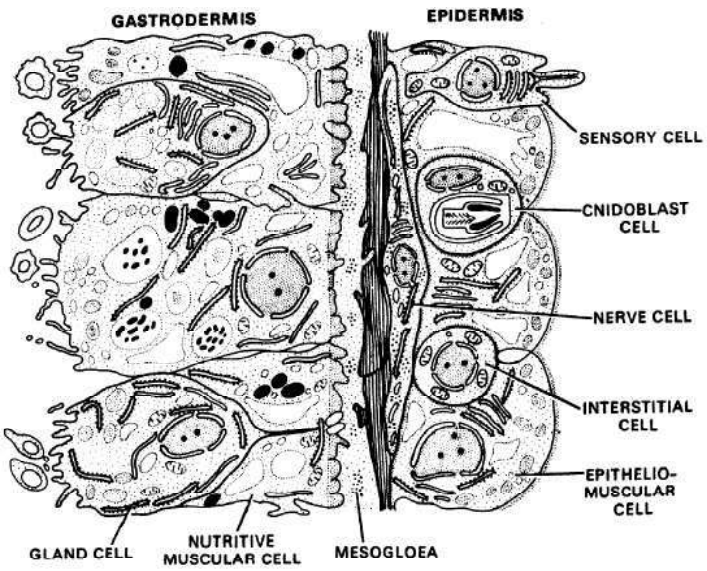
2. Body wall :

– Hydra's body wall has two epithelial layers. Hydra is Diploblastic.

[i] Epidermis or Ectoderm — Thinner, Semitransparent sensitive, help in protection.

[ii] Gastrodermis or Gastroderm — Thick, help in digestion

– Thin, elastic and nonliving cementing layer of mesogloea present in between Epidermis and gastrodermis.
– Mesogloea is a viscous transparent and jelly like mucopolysaccharide layer, secreted by cells of both epithellia. Absence of Mesoderm.
– Body of Hydra is covered by a thin and transparent cuticle. Cuticle is absent on basal disc.



T.S. of Body wall

[i] Epidermis

Histology of Epidermis :

– Cuboidal cells, Development from ectoderm of embryo, Function : Protection, sensory layer, 6 types of cells are present.

1. Epithelio-muscular Cells :

– Epithelio-muscular cells are Pear shaped or conical shaped.
– Epithelio-muscular cells is divided into two parts Outer flat part (Epithelium Part). Inner narrower (Muscular part).
– Two types of smooth myofibrils run within inner process and hence it is a muscular process. Most fibrils are thin but at least one is thick called **Myoneme**.
– Due to contraction of myoneme. Size of body of Hydra and that of tentacles decreases. Flat free end of epithelium bears Microvilli & contain fat globules and non contractile Vacuoles.
– The nucleus is large and subspherical, Mitochondria, Golgi body, endoplasmic reticulum are scattered. These cells contain membrane bound masses of mucus granules

Functions

[1] These form a continuous protective layer around the Body.
[2] The myofibrils of their Basal processes are contractile. Presumably, these contain Actin and myosin proteins and help in Contraction as like Vertebrate muscles.

[3] The basal processes form almost a continuous "Longitudinal muscle layer" upon the outer surface of mesogloea.

[4] These secrete mucus like material which forms an adhesive, cuticle like protective covering over epidermis.

[5] These help in locomotion & bending the body.

2. "Glandulo - muscular cells" :

- These form the epidermis of basal disc. These secrete abundant mucus for adherence of hydra with its substratum.
- Mucous is secreted by Golgi Body.
- Presence of endoplasmic reticulum and Microvilli.
- These cells have muscular process. Sometimes, these cells form Pseudopodia causing slow crawling or gliding of Hydra upon its substratum.

Function :

- Secrete adhesive material for the attachment of the animal to a substratum. Help in gliding.
- Help in floatation by the secretion of gas Bubbles.

3. Sensory cells

- These are narrow, spindle - shaped cells, wedged singly, here and there, between the epithelio muscular cells.
- The outer free end of each forms a shallow cup like depression, from which a sensory cilium projects out at body surface.
- These cells are more abundant in the epidermis of tentacles and hypostome.
- The cilium is formed of a group of fibrils arising from a basal granule.
- Another group of fibrils, called rootlets extend from the basal granule into the cytoplasm. 9 + 2 fibrils arrangement in cilium.
- The opposite inner end of each sensory cell is in direct contact with nerve cells.

Function :

- The sensory cells receive external stimuli and transmit the sensory impulses to the neurons.
- Sensory cells of Hydra are general receptors or are distinguished to receive various types (mechanical, chemical, thermal, photic etc.) of stimuli.

4. Interstitial cell :

- These cells are small and spherical or oval cells located in groups between the narrow basal parts of epithelio muscular cells. Diameter - 5µ.
- Structure-Distinct Nucleus and nucleolus, mitochondria, endoplasmic reticulum, Golgi body, ribosomes are abundant.
- These cells are undifferentiated, totipotent cells, capable of modifying into all other types of cells.
- These cells are not present in tentacles and basal disc.
- Most abundant at the base of tentacles in gastric region - growth zone.

Function :

- These cells are capable of modifying in any type of cells.

– According to Brien, all cells of hydra's body are renewed once in about 45 days from its interstitial cells.
– These cells help in growth. These cells help in Regeneration.
– Help in Budding and repair. These cells form germinal cells and Nematoblast.

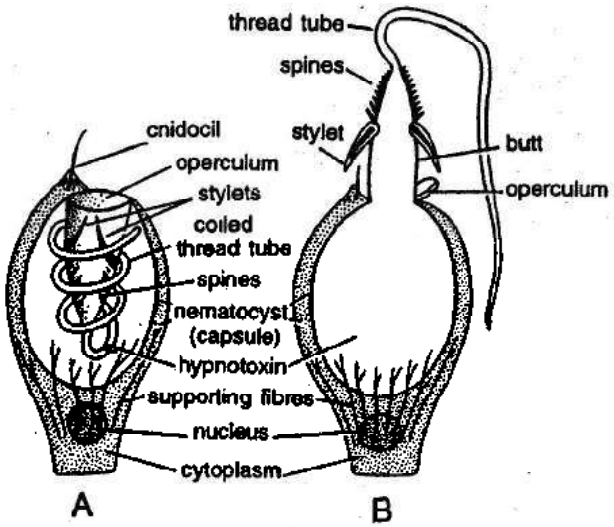
5. Nerve cells

– These cells are originated by interstitial cells.
– These cells are more numerous in the epidermis of basal parts of tentacles, hypostome and Basal disc.
– Other name is neuron. Their branched Processes (neurites) are not differentiated into afferent (dendrites) and efferent (axon) fibres and are intermingled to form a nerve net or Plexus just outside the epidermal muscular-layer.
– The cell bodies (cytons) of these neurons are small and contain, besides the nucleus and other usual organelles, several long and thick microtubules, extending even into the neurites.
– Microtubules maintain a chemical pathway between the nucleus and cytoplasm. Microtubules Absent in Basal disc of Hydra.

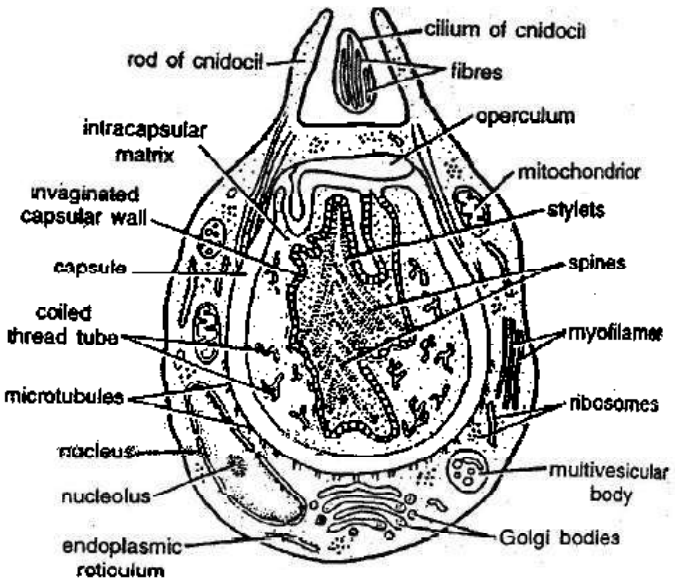
Function : Neurons transmit impulses.

6. "Nematoblast or cnidoblast" :

– These cells are present only in cnidaria group.
– These occur in entire epidermis except that of Basal disc.
– When fully developed, they migrate to the tentacles through the mesogloea by means of amoeboid movement.
– Projection in between the epithelio–muscle cells or lying inside the bodies of these cells (host cells), the cnidoblasts act as organs for offence and defence.
– Group of stinging cells present in tentacles are called battery.
– One battery have 10-12 stinging cells.
– These cells are formed by modification of interstial cells.
– Each cnidocyte possesses a unique type of large and centrally located sac like organelle, called nematocyst which pushes the cell cytoplasm to a thin Peripheral layer.



Cnidobast (Undischarged) **Cnidobast (discharged)**



Internal structure of cnidocyte

Structure of stinging cells :

– Cnidocytes have a nucleus, small golgi complex, scattered mitochondria, ribosomes, endoplasmic reticulum and some fat globules.

- Cnidocytes posseses sac like organelle called "nematocyst".
- Nematocyst is filled with a poisonous fluid called "Hypnotoxin" (in capsular fluid) which is mixture of Protein and Phenols.
- It is a stronger poison than snake venom.
- The free end of each cnidocyte at epidermal surface bears a small and stiff conical spine like projection, called cnidocil or trigger.
- A slender cilium forms the central axis or case of the Cnidocil. 20 or 21 fine tubular processes of the cell membrane itself extend around the cilium, forming the remaining part of Cnidocil.
- These are called "supporting rods of Cnidocil".
- Another set of 20 or 21 hollow rods called "supporting rods of cnidocyte" arise from around the base of cilium and fan out up to the equatorial plane of nematocyst.
- Nematocyst wall is thick & composed of a collagen like protein.
- At the tip of Nematocyst, an operculum is present.
- The invaginated capsular wall forms a very long and coiled tubule, called the "thread".
- The proximal part of the thread, extending up to the base of the capsule is fairly wide and termed as "Butt" or shaft.
- Thread bears, on its inner surface, three spiral rows of pointed spines, out of which the first of each row (3 in all) is very large and termed barb or stylet & other spines are smaller and called Barbules.
- The free distal ends of stylets and spines converge at the central axis of the butt, forming an overlapping pyramid.
- A thick and coiled bundle **" Thread of Lasso"** of contractile myofilaments extends from the region of nematocyst to the Basal end of the cell.

Origin of Nematocyst :

- Origin of Nematocyst by the Vacuole of Interstitial cells of epidermis.

Occurrence of nematocysts :

- Occur scattered, mostly singly throughout the epidermis of the body, absent on the basal disc.
- Abundant in the epidermis of the oral region and the tentacles.

Function of Nematocysts :

- The nematocyst are weapons of offence and defence of Hydra.
- They also serve in food capture, locomotion and anchorage.
- Main function of nematocyst is paralyzing the prey.

Discharge of Nematocyst :

- When properly stimulated, the nematocyst of a cnidocyte is discharged, i.e., its thread pushed, open the operculum and shoots out of Body surface in a twinking turning completely inside out like the sleeve of a shirt.
- Presence of Both Mechanical and chemical stimulation are required.
- The discharge of nematocyst is completely independent of Nervous control i.e. Cnidocytes are "Independent Effectors".
- Time of discharge = .3 – .5 part of second. Microfibrils of Microtubules (attached to capsule) also help in discharge of Nematocyst by increasing Internal Pressure.

– It is therefore discarded from tips of tentacles and aboral pore.
– Worn out nematoblasts are replaced within 48 hours.

Different views about Discharge of Nematocyst :

– According to **Iwanzoff (1895), Yanagita (1943)** water enters into the capsule from surrounding cytoplasm. A nematocyst is discharged due to increase in hydrostatic pressure of capsular fluid.
– According to **Will (1914), Picken (1953), Robson,** water diffusing into the capsule from cytoplasm, enormously swells like a Jelly. Intracapsular Substance causes discharge of the thread.
– According to **Jones (1974)** - The nematocyst are always in a state of tension. Stimulation of Cnidocil causing sudden opening of operculum. Hence the thread is discharged.
– Some others believe that contraction of myofibril exert pressure on capsule for its discharge.

Types of Nematocyst : On the basis of size, Thread structure and function.

(1) Stenoteles or penetrants
(2) Desmonemes or Volvents
(3) Streptoline glutinants or Holotrichous isorhizas
(4) Stereoline glutinants or Atrichous isorhizas

(1) Stenoteles or Penetrants :

– These are the largest (16μ) and most complicated type of nematocysts.
– Their thread is long with a Butt, Spiny, terminally open and coiled several times around the Butt.
– Thread is bearing three large stylets and three, rows of small spines at its stout base. Presence of Hypnotoxin.

Function :

[1] Penetrants or stenoteles are discharged upon enemies and preys suitable for food. The thread shoots out straight with such a force that it pierces into prey's body and injects the Hypnotoxin like a hypodermic needle.
[2] This paralyses and ultimately kills the prey.

(2) Desmonemes or Volvents :

– These are the smallest nematocysts (9μ).
– These are spherical or oval with a short, thick and terminally closed thread which is without butt, but bears a few spines.
– Within the capsule, the thread is coiled only once.
– Hypnotoxin is not present in capsule.

Function : They assist in food capture.

(3) Streptoline glutinants or Holotrichous isorhizas or Large glutinant :

– These are smaller (9μ) and elliptical.
– Their thread is long, thicker and terminally open, but it has a single spiral row of spines and no Butt.

Function :

– Holotrichous isorhizas usually discharge upon enemies and thus help in defence and offence.
– Their spiny threads also shoot out straight.

(4) Stereoline glutinants or Atrichous isorhizas or Small glutinant :

– These are smaller (9μ). Elliptical, spineless, open thread.

Function : These discharge during locomotion to adhere the tentacles with a Substratum.

Difference between Four nematocyst

S.No.	Cause of Difference	Stenoteles	Desmonemes	Streptoline	Stereoline
1	Size of filament	Pointed, Long	Round, Long	Round, Long	Round, Small
2	Bult	With spines	Absent	Absent	Absent
3	Terminal end of fibre	Open	Closed	Open	Open
4	Spines	Present	Present	Present	Absent
5	Material in capsule	Hypnotoxin ¯ Poisonous	×	Mucous substance and Hypnotoxin	Mucus substance
6	Function	Help in offence and defence	Round up aound pery	Help in defence and offence	Help in Locomotion

(II) Histology of Gastrodermis :

– Internal layer of body wall of Hydra. Thick. Columnar in shape. Origin - embryonic endoderm. 5 types of cells.

(1) Nutritive Muscle cells or Endothelial muscular cells :

– **Shape :** Club shaped. They form the Bulk of gastrodermis. Adjacent cells joined by Desmosomes.

– Basal ends of these cells are also drawn out into muscle processes lying upon inner surface of mesogloea and form a "Circular Muscle layer" upon mesogloea.

– Obviously, the body becomes thin and long on contraction of these processes.

– Each nutritive-muscular cell besides a nucleus and other organelles, also having several food vacuoles, fat globules, glycogen granules and irregular vacuoles.

– Its free end is covered by a thin, membrane like, film of a fibrous substance and bears several branched and interconnecting microvilli and a pair of flagella.

– Besides forming the lining of gastrovascular cavity, they bring about extension of body and tentacles by contracting their basal processes.

– The nutritive muscular cells ingest partially digested food from gastrovascular cavity by means of pseudopodia by phagocytosis method.

– Digestion occur intracellularly in food vacuoles.

– Nutritive muscular cells of green Hydra have zoochlorella Algae, Brown Hydra have Zoozanthellae Algae.

– These resemble the epithelio–muscular cells of the epidermis in all respect, except that their basal contractile processes are much more delicate and oriented at right angles to the long axis of the body.

Function :

– Help in Digestion. Beating of the flagella of these cells serves to circulate the fluid present in gastrovascular cavity and also churns the food.

- Internal lining of gastrovascular cavity.
- They form sphincter around mouth Green alga occurs in these cells exhibiting symbiosis.

(2) Gland cells :

- These are smaller, club shaped cells found singly between nutritive muscular cells.
- These are most numerous in the gastrodermis of hypostome, fewer in gastric region and rather scanty or either Absent in tentacles, stalk and basal disc.
- These also bear flagella and fewer Microvilli. These cells are of two types

Enzyme Secretory cells or Zymogen cell : Present in gastric region.

Mucous Secretory cells : Present in hypostome region

Function :

- Secretion of mucus lubricates the passage of food.
- Digestion of food. Gland cells are independent effector.

(3) Nerve cells :

- Like the epidermis, the gastrodermis also contains neurons in its deeper zone, but these are so scanty that their branched neurites form less developed nerve net. Non Polar.

(4) Sensory cells :

- Same as epidermis sensory cells.
- These are receptors of Internal stimulation.

(5) Interstitial cells :

- Same as epidermis Interstitial cells.
- These cells are capable of modifying into all other types of cells.

(III) Mesogloea :

- Non cellular layer. Mesogloea have proteinaceous matrix in which jelly like mucopolysaccharides occurs.
- Matrix have Elastin and Collagen fibers.

Nutrition :

(1) Food :

- Hydra is carnivorous. It feeds upon small aquatic Animals.
- It is especially fond of small crustacean like :- water fleas, cyclops, daphnia etc.
- If prey animal having glutathione then, hydra often swallows preys much larger than itself and, consequently, becomes highly inflated.

(2) Feeding :

- Hydra feeds only when it is attached to a substratum.
- It keeps its body extended and waves about its extended tentacles in all directions in search of a prey.
- As a prey brushes against a tentacles, thread of numerous desmonemes and possibly of atrichous isorhizas, shoot out at once and wrap around the Bristles and appendages of the prey to prevent its escape.
- Immediately, the threads of stenoteles and probably of holotrichous isorhizas also shoot out and penetrate into prey's body to inject "Hypnotoxin".

- The prey is consequently paralysed.
- Glutathione stimulates the Hydra to perform feeding operation.
- The tentacles holding the prey, contracts and bends towards the mouth.
- The latter opens to receive and swallow the prey.

Digestion :

- As food reaches into the gastric region.
- The zymogen cells of gastrodermis begin pouring out an alkaline secretion into the cavity.
- This secretion contains proteolytic enzymes which are said to split the prey's proteins in to Polypeptides.
- The prey's tissue consequently loosen and swell.
- The peristalsis and lashing movements of flagella of gastrodermal cells create churning movements in the fluid of gastrovascular cavity.
- The prey's Body is broken down into small fragments.
- Hydra is unable to digest starch.

The Digestion in Hydra is completed in two phases.

[i] Extracellular Phase in gastrovascular

[ii] Intracellular Phase in the food vacuoles (medium $\rightarrow$ first acidic and then Alkaline)

Egestion : Through mouth which also acts as Anus. Anus - Absent.

Nervous system :

- In Hydra, unpolarized nerve cells of epidermis form a nerve net just outside the basal processes of epitheliomuscular cells.
- It is unpolarized. Therefore transmit impulses equally well in all directions.
- Nerve net connected to sensory cells. Such a combination of muscle processes of epithelio–muscle cells, sensory cells and nerve net is referred to as neuro–muscular system.
- Cnidocyte and gland cells normally receive stimuli directly and respond as independent effectors.
- There is a layer of neurons just inside the basal processes of nutritive muscular cells of Gastrodermis.
- Most neurons form synapses with each other and other Body cells.

Muscular System :

- The contractile basal processes of epitheliomuscular cells of epidermis and nutritive muscular cells of gastrodermis respectively form longitudinal and circular muscle layers upon outer and inner surface of mesogloea.
- Myofibrils are smooth. Their Myosin and Actin proteins bring about the contraction of the processes probably by same mechanism as in vertebrate Muscles.
- The mesogloea functions like a skeletal axis. By filling the gastrovascular cavity with water through mouth, Hydra uses it also as a Hydraulic Skeleton for relaxation and extensions of Body.

Respiration :

- Through Body surface. Gaseous exchange by diffusion. Storage of energy in form of ATP.

Excretion :

- Through cell membrane. Excretory Substance - NH_3. Ammonotelic. Excrete Ammonia by Diffusion.

MOVEMENT AND LOCOMOTION

- Locomotion in Hydra is due to following reason
  - [a] In search of food.
  - [b] Protection
  - [c] Response to stimuli.

(1) Contraction & Expansion of Body

- When Hydra is hungry, it attaches to a substratum, exhibits contraction & expansion movement at intervals.
- This behaviour of Hydra is called as contraction burst.
- It is initiated by a pacemaker located near the base of the hypostome.
- These movement help to bring food organisms in contact with the tentacles which are waved all around in water.
- Its Body remains flexed due to contraction of circular muscle processes and the tentacles contract, extend, or Bend and move about in different directions in search of food.
- Periodically the Body suddenly contracts due to maximum contraction of longitudinal muscle Processes.

(2) Gliding :

- The glandulo-muscular cells of the epidermis of Basal disc sometimes form pseudopodia.
- Consequently, Hydra starts slowly gliding or crawling upon its substratum. Gliding - Slow movement.

(3) Floating :

- Sometimes, glandulo-muscular cells secrete a gas bubble, which remains stuck to the disc due to mucus.
- Consequently Hydra loses contact with its substratum, turns upside down and passively floats at water surface.
- It is now drifted hither and thither by water waves and winds.

(4) Walking :

- Occasionally, Hydra stand upside down and walks upon its Substratum using the tentacles as legs.
- During walking, the Body remains somewhat contracted and Both Body and tentacles remains stiff due to Hydraulic Skeleton.
- This Locomotion is cuttle fish like, Movement.

(5) Swimming :

- Tentacles of Hydra help in swimming.
- Peristaltic movement and lashing of tentacles help in Swimming.

(6) Looping :

- The Body first elongates, bends over to one side and fixes its tentacles to the substratum with the help of Atrichous isorhizas.
- Now the pedal disc glides close to the tentacles.
- Next, the tentacles are disengaged and the normal upright posture is regained.
- By repeating this caterpillar or leech like looping, Hydra rapidly locomotes in search of food.

(7) Somersaulting :

- The Body elongates, bends on to a side and fixes its tentacles to the substratum.
- Then the aboral end is released from the substratum and lifted up, so that the Body now stands upside down on its tentacles.
- Next, the Body again bends, fixes its pedal disc to the substratum, releases the tentacles and lifts up its oral end standing upright in normal position. Thus, the Hydra moves fast like an Acrobat.

(8) Climbing or Dragging :

- Hydra can even climb by attaching its long tentacles to some object, releasing the foot & then contracting the tentacles, so that the body is lifted up.

Behaviour of Hydra (Irritability) :

(1) Touch : Thigmotaxis. When touched by a rod or Needle, hydra's Body contract. i.e. Negative movement.

(2) Light : Phototaxis. Negative movement in both strong & dim light. Like to stay in moderate Light.

(3) Temperature : Hydra like 20-25°C temperature. Variation in temperature → Hydra show negative movements.

(4) Chemicals : Hydra show Negative Response to Harmful and strong chemicals. Show Positive Response to food.

(5) Water currents : No Response.

(6) Electric current : When a moving Hydra comes in contact with a weak electric current, it bends towards the cathode, but dies in a strong current. In a fixed Hydra the tentacles bend towards anode.

Internal stimuli :

- Hunger is an internal stimulus to which Hydra responds by extending and hectically waving its tentacles in all directions in search of food.
- If unsuccessful, it moves on to a new location.

Reproduction :

[1] Asexual Reproduction

[2] Sexual Reproduction

(1) Asexual reproduction :

- It occur in favourable condition. (in winters from OCT. NOV. to JAN.).
- Hydra reproduces asexually by Budding.
- Buds form upon the body near junction of stalk and gastric region.
- A bud first appears as a small bulge formed due to rapid proliferation of epidermal cells and cells of gastrodermis.
- Shortly, the gastrovascular cavity extends in to the bud, making it hollow.
- Cells now become arranged around the cavity of the bud, forming a regular two layered wall.
- Mesogloea is also secreted by the two cellular layers. As the bud grows further, its distal end starts modifying into a hypostome, and blunt tentacles appear one after the other around the base of hypostome.
- Eventually the hypostome acquires terminal mouth. Within two to three days, a bud becomes fully developed.

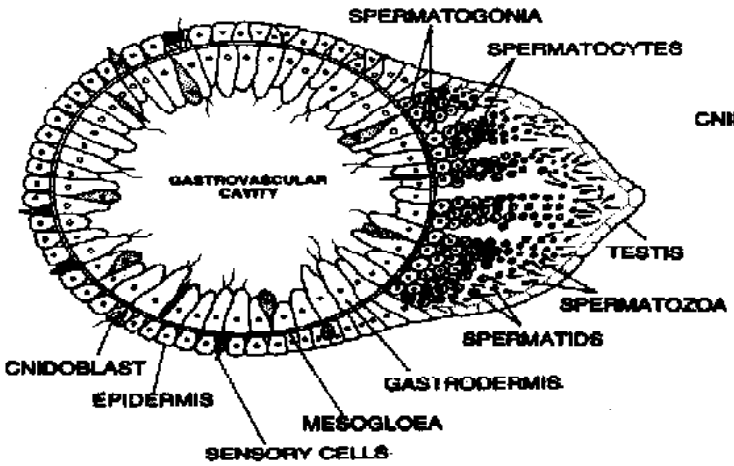
– Simultaneously to these changes, the proximal end of the bud progressively constricts until the bud is separated from parent's body.
– Several buds may form simultaneously when conditions are very favourable.

(2) Sexual reproduction :

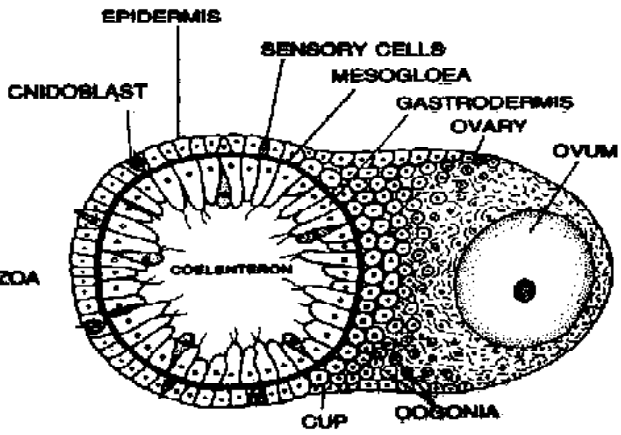
– Unfavourable Condition (From Feb, March to the end of summer).
– Towards the end of winter and start of summer Sexual Reproduction begins.
– Hydra have both Unisexual and Bisexual species.
– Hydra oligactis is unisexual but Hydra Viridis species is Bisexual- "Gonads"-Testes, Ovary.
– Temporary - found only in breeding season. A gonad is simply a group of modified Interstitial cells which migrate from other parts of body and collect beneath the epidermis. Gonidial ducts are absent.

Testes :

– Number -1 - 8, Situated near Hypostome region, Shape - conical, Testes are more numerous and always anterior to the ovaries. (Bisexual sp).
– Testes of unisexual Hydra are spherical and knob like, but those of Bisexual forms are conical with an apical nipple like cap for exit of sperms.



T.S. of Testes



T.S. of Ovari

– Process of Sperm formation is known as Spermatogenesis.
– The gonia of a testis, termed spermatogonia, multiply and grow into primary spermatocytes.
– Each primary spermatocyte undergoes two maturation division – first meiotic, second mitotic, yeilding haploid spermatid.
– This transforms into tailed sperm and this process known as spermateleosis.
– Mature sperms are shed in water either through a pore formed in the nipple of a testis or by rupture of overlying epidermis.
– Liberated sperms actively swim about by means of their tails.
– Protandry Condition - i.e. the testes form earlier than Ovaries and therefore sperms mature earlier than ova.

Ovaries :

– Number -1 to 2, Spherical and knob like, situated near stalk region.
– Each ovary form only one ovum. Formation of ova known as Oogenesis.

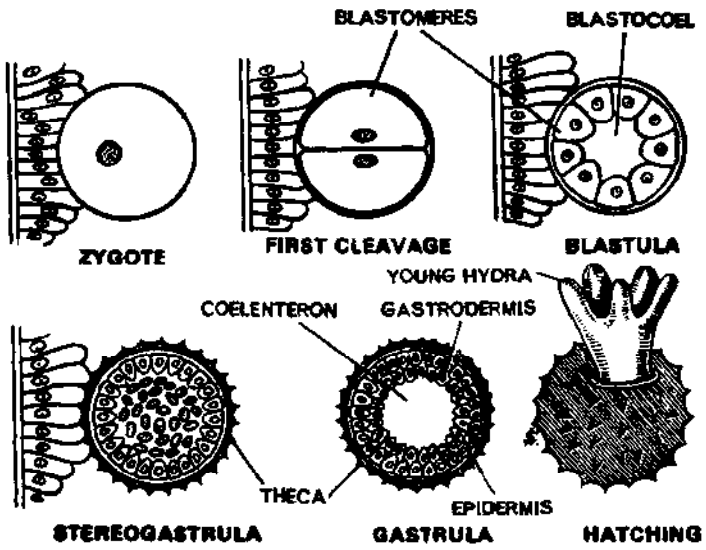
– The overlying epidermis ruptures and shrinks to a cup like Cushion or Calyx around the Base of the ovum exposing the ovum in water.

Fertilization :

– External fertilization. Cross fertilization. Bisexual Hydra have Protandrous condition, so cross fertilization promotes.
– An exposed ovum must be fertilized by a sperm within 24 hours, otherwise it dies and disintegrates.
– As the sperms, swim in the water, they come in contact with an ovum, they stick to it, but only one of these succeed in entering in to it.
– Only sperm head enters into the ovum, the tail is left outside.
– The sperm nucleus fuses with ovum nucleus. This is called fertilization which transforms the ovum into a diploid zygote.

DEVELOPMENT OF HYDRA

– Immediately after fertilization, the zygote starts dividing repeatedly by mitosis.
– This is called its segmentation or cleavage. Cleavage is holoblastic and equal.
– First two cleavages are vertical at right angles to each other.
– The third one is horizontal and equatorial.
– These three divisions results into formation of 8 equal embryonic cells or Blastomeres forming a Morula stage.



Stages of embryonic development and hatching in *Hydra*

– As cleavage proceeds further, the embryo acquires a fluid filled central blastocoel cavity.
– All Blastomeres arrange in a single layer around Blastocoel. This is the Blastula stage.
– Its cells multiply rapidly and soon obliterate the cavity by a process termed as delamination.
– The Blastula, thus changes into a solid gastrula stage called Stereogastrula.
– Outer layer of gastrula secretes a thick and sticky chitinous sheath called theca.
– The theca is Spherical or Spindle shaped and smooth or Spiny.
– Thecated stereogastrula drops off from the parent Hydra and sticks to the object on which it falls.
– When favourable condition come, stereogastrula undergoes certain changes.
– Thus the embryo becomes regular, hollow and double layered (diploblastic).
– The two cell layers collectively secrete the Mesogloea in between.
– A hypostome and tentacles also start forming. As the next winter approaches, the young Hydra hatches out of the theca and soon grows into an adult Hydra.

REGENERATION

- Regrowth of injured or lost parts is called Regeneration. Trembley (1874) discovered that Hydra has a tremendous Power of regeneration.
- According to Trembley if a Hydra is cut in to 1.6 mm pieces, then each piece regenerates into a complete hydra by growing the missing parts.
- Trembley eventually succeeded in Producing a 7- headed Hydra. When all the 7 heads were injured, they formed again by regeneration.
- Greek Mythology has reference to a 9-headed demon serpent named hyder. On this very basis, Linnaeus coined the name 'Hydra' for these Animals.

Grafting :

- Hydra has been extensively used in grafting experiments.
- Zoologists have been able to graft pieces of different Hydra of the same species together producing peculiar specimens.

IMMORTALITY IN HYDRA

- According to Brien (1955), Gansen (1951) and Lentz (1960) etc. Hydra is potentially Immortal. According to them, Hydra has a growth zone just below the level at which tentacles arise.
- Interstitial cells acting as an "Undifferentiated embryonic reserve continuously multiply and transform into other types of cells in the growth zone.
- Consequently, older cells are progressively pushed towards the pedal disc and tips of tentacles, from where these are continuously shed off. In this way, cells of the whole body of Hydra are replaced or renewed in about 45 days and there occurs no natural death of the Animal.

PHYSIOLOGICAL "DIVISION OF LABOUR"

- Milne - Edwards introduced the concept of "Physiological Division of labour" in multicellular organisms.
- It implies that, instead of all cells of body participating in all its vital activities, the cells become differently specialized for limited specific functions.
- Division of Labour also conserves energy in multicellular animals.

SPECIAL POINTS

- From the piece of the Hydra, whole body is formed, this process is known as Morphollaxis
- Among the coelenterates, hydra is one of the smallest polyps.
- Chlorohydra viridissima is called green hydra. It is green because of symbiotic association.
- The trigger needle of cnidoblast is called cnidocil.
- Hydra has a nervous system but no brain.
- Hydra has nerve cells but no nerves.
- In the development of hydra, there is no moulting or ecdysis occur.
- Larval stage absent in hydra.

ASCARIS

Ascaris is also known as round worm or thread worm.

CLASSIFICATION

Phylum - Aschelminthes or Nemathelminthes :

- The animals of this phylum are triploblastic and their body shows bilateral symmetry.
- The whole body is covered by thick cuticle.
- The unique characteristic feature of the animals of this phylum is "presence of Pseudocoel".
- Pseudocoel is originated by blastocoel.

Note : The worms of phylum Aschelminthes are "true-worms" only, rest of the worms are called false - worms.

Class - Phasmidia : Phasmids are present in the body of the animals. Well developed excretory system.

Order - Ascaroidia : Oral opening is triangular or triradiate, it is guarded by three lips.

Genus - Ascaris : All the species of Ascaris are endoparasite of ileum of mammals e.g.

Species - *Ascaris lumbricoides* : Endoparasite of ileum of man.

***Ascaris megacephala* :** Endoparasite of ileum of horse.

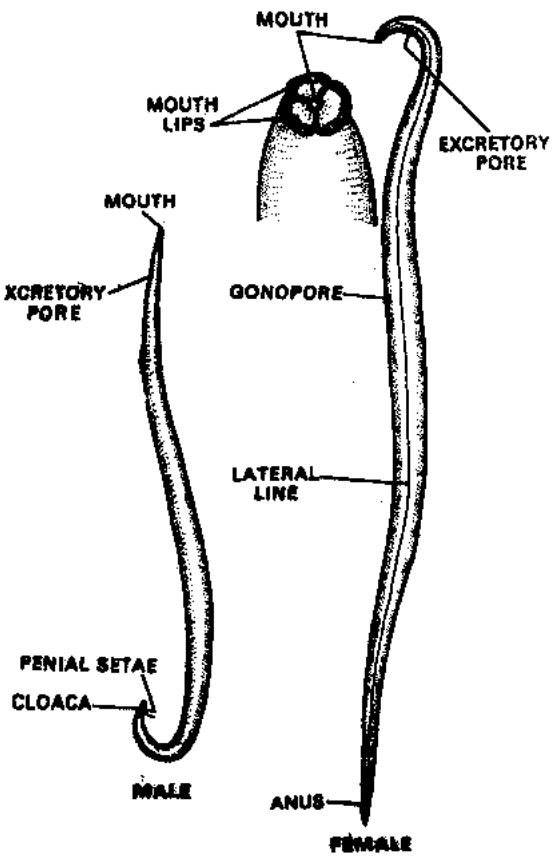
***Ascaris suam* :** Endoparasite of ileum of Pig.

HABIT & HABITAT

- The worms remain free in the intestine of the host and ingest the chyme of the host for nutrition. Nutrition is holozoic.

MORPHOLOGY (Shape, Size and Colour)

- The body of Ascaris is long, cylindrical and tapering at both the ends.
- It is pale - yellowish or pinkish in colour. Its colour shows due to body coelomic fluid.
- Sexual dimorphism is distinct in Ascaris.
- Male- Small and thin (15-30 cm long and 2-4 mm wide).
- Female - Long and stout (20-40 cm long and 6-8 mm wide).
- The tail end of male Ascaris is curved where as the body of female Ascaris is straight.
- Along with these differences, there are some more differences, in male and female Ascaris.



Ascaris lumbricoides (lateral view)

External features :

- The body of both (male and female) Ascarises is covered by thick coat of cuticle, this cuticle prevents the body of Ascaris from the digestive juices/enzymes.
- It is the main parasitic adaptation of Ascaris.
- Cuticle is permeable for water, gases and excretory matters.
- Cuticle has transverse striations/lines due to this the body of Ascaris appears segmented, but it is not true segmentation.
- So Ascaris is an example of **pseudosegmentation**.
- True segmentation is found in the animals of phylum Annelida.
- Body of Ascaris has 4 longitudinal lines, these are called Epidermal or Ectodermal lines, these lines are formed due to evagination of epidermis of bodywall.

Positions of these lines :

1. **Dorsal line :** Thin and whitish
2. **Ventral line :** Thin and whitish
3. **Lateral lines :** thick and brownish.

Mouth :

- At the anterior end of the body of male and female Ascaris both, having triangular mouth, it is guarded by three lips, one is dorsal and 2 ventrolateral lips.
- Each lip of Ascaris is formed by the fusion of 2 lips of embryonal stage.
- Lips in Ascaris are thick horny and tough like leather.
- On inner margin of each lip there are small teeth, these are called **Denticles**.
- Lips of Ascaris have receptors, so these lips are sensory in nature.

Pores of Ascaris :

- All pores in the body of Ascaris are mid-ventral in position.

Excretory pore :

- At a distance of 2mm from anterior end in both (male and female) excretory pore is present.
- With the help of this pore all excretory matters are thrown out side the body.

Genital Pores :

In females :

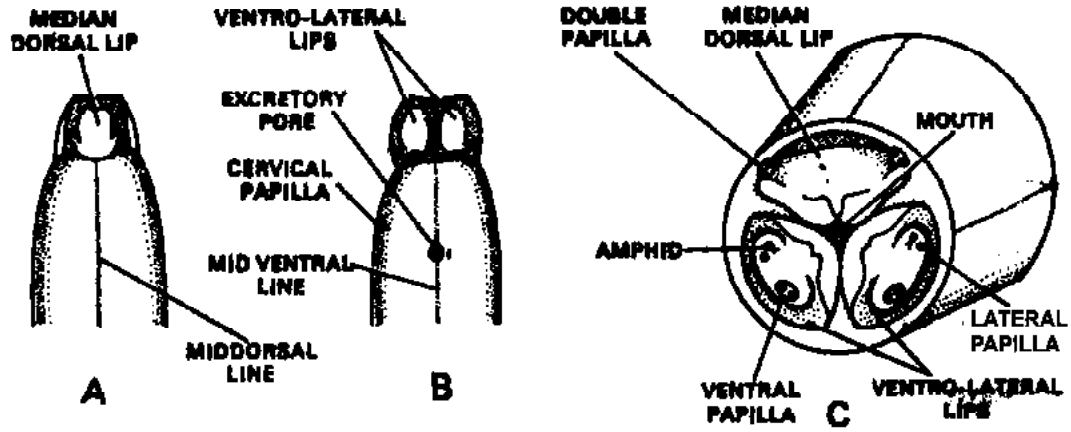
- At about 1/3rd distance from anterior end of body **gonopore** is present.
- Anus lies near the posterior end of the body.

In males :

- There is no separate gonopore in male Ascaris.
- Male Ascaris has a single **cloacal aperture** near posterior end which functions as anus and genital pore both.
- During copulation, 2 spine like structures emerge out from cloacal aperture known as **pineal setae** which help in copulation.

DIFFERENT TYPES OF RECEPTORS

1. **Labial papilla :**
   - These are Tangoreceptors (Sensitive to touch).
   - These are formed in the form of conical outgrowths on lips.
   - Dorsal lip has one pair of double papilla and each ventrolateral lip has one double and one single papilla.



***Ascaris lumbricoides;* Anterior end in dorsal (A), ventral (B) and end on (C) views.**

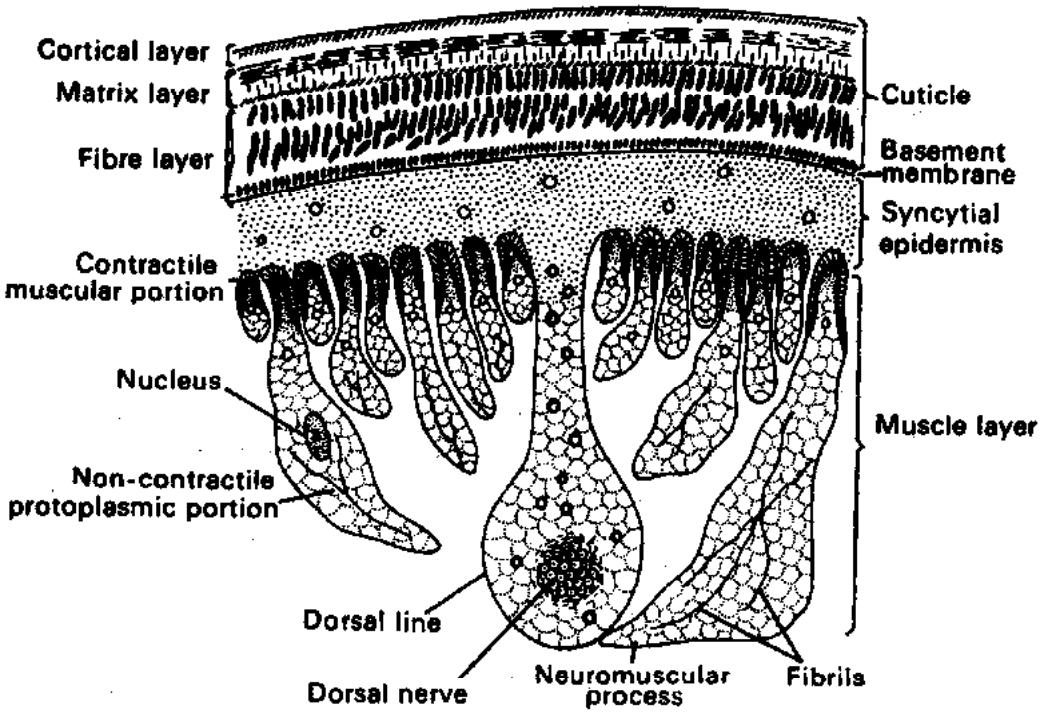
2. **Amphids :**
   - These are chemoreceptors i.e. olfactory or gustatory.
   - These are in the form of a depression on lips.
   - On each ventrolateral lip there is one amphid close to single papilla's underside.
3. **Cervical papilla :**
   - These are tangoreceptors, one pair, present on the lateral side of body at the level of excretory pore.
4. **Phasmids :**
   - These are unicellular, glandular chemoreceptors.
   - One pair of phasmids are present on the lateral side of the body at the posterior end and near anus in females and near cloacal aperture in males.
5. **Genital papilla :**
   - Tail of male Ascaris has 55 pairs of papillae called genital papillae.
   - Out of these 50 pairs are located before precloacal aperture and are called precloacal papillae.
   - Rest of 5 pair are located after post cloacal aperture and are called post cloacal papillae.
   - First 2 pair out of 5 pair papillae are double papillae and all other are single papillae.
   - Genital papillae help in copulation and due to these male Ascaris holds female Ascaris tightly.

Body wall : There are 3 main layers in body wall.

l. Cuticle

ll. Epidermis

lll. Muscle Layer



T.S. of body wall of Ascaris

I. Cuticle :

- The outermost layer is cuticle.
- Cuticle is thick and is secreted by epidermis.
- Cuticle is further subdivided into 5 sub layers.

1. Cortical layer :

- It is outermost sublayer and is made of keratin protein, polyphenols and quinones.
- In electronic microscopy, outermost part of cortical layer appears as composed of a very thin layer of lipids.

2. External Fibrilar layer : This sublayer is made of fibres of Elastin and provide flexibility to body wall.

3. Matrix or medula layer : It is a spongy layer, made of sulphur containing protein - matricine.

4. Internal Fibrilar layer : It is made of fibres of collagen.

5. Basement membrane : It is a innermost layer of cuticle which provides support to epidermis.

II. Epidermis :

- It is syncytial and multinucleated.
- Nuclei of syncytium are arranged in long rows along epidermal layer.
- Function of Epidermis :
  (a) Cuticle secretion.
  (b) Storage of food in form of glycogen and some amount of oil or fat.

III. Muscle Layer :

- It is the innermost layer of body wall.
- Body wall of Ascaris has only longitudinal muscle layer and circular muscle layer is absent, so Ascaris is almost incapable of changing its body length.

- It can change only 15% of its length with the help of longitudinal muscle layer.
- Ascaris can performs undulating or threshold movement with the help of longitudinal muscle layer in the ileum.
- This type of movement is a parasitic adapatation of body.
- With its help it counteracts the effect of peristalsis of ileum.
- Muscle layer of Ascaris is made up of giant cells, as cell division takes place during embryo stage only.
- Body growth after embryo stage takes place by cell enlargement, this phenomenon is termed as **Eutely** or **Nuclear consistency**.
- Each muscle cell is divided into 3 parts :

(i) Contractile part :

- This is a outer part and is made of Actin and Myocin.

(ii) Protoplasmic part :

- It is a broader part and contains cytoplasm and nucleus.
- It also contains non-contractile protein fibres.
- It stores food in the form of glycogen.

(iii) Neuro Muscular process :

- With its help muscle cells keep a contact with motor nerves of Ascaris.
- At 4 places epidermis of body wall forms inbulgings.
- From outside these bulgings appear in form of epidermal lines.
- Out of these 2 are lateral. 1 dorsal and 1 ventral.
- Each lateral line has 3 lateral nerves and each lateral line has 1 excretory canal.
- Brown colour of lateral line is due to excretory material is present, in the excretory canal.
- Due to epidermal lines, muscle layer of body wall is divided into **4 quadrants** called as longitudinal columns.
- Out of these 4, 2 are dorsolateral and 2 ventrolateral.
- Each quadrant or column has 150 muscle cells, so total no. of musle cells is 600.
- The process of muscle cells of dorsolateral are connected to dorsal nerve and ventrolateral are connected to ventral nerve.
- Arrangement of Muscle cells in muscle layer of Ascaris is called as "**Polymyarian**" and "**Coelomyarian**" because there are many muscle cells in each strip of quadrant an they extend well into the pseudocoel.
- Number and arrangement of muscle cells is a factor of taxonomic significance in Nematoda/ Aschelminthes.

BODY CAVITY

- Body cavity is called as Pseudocoel. In Ascaris, coelom is not true coelom. [True coelom is derived from mesoderm and surrounded on both sides by mesoderm.]

– Outer one is Parietal Peritonium and inner one is Visceral Peritonium.
– While in body cavity of Ascaris outer side muscle layer & innerside cuticle of ileum. So pseudocoel is found in Ascaris. Pseudocoel during young stage has **5 giant cells**.
– These are called **Pseudocoelomocytes**. These shrink in adult stage.
– Remnants of Pseudocoelomocytes in Ascaris are cell bodies which are of star shape.
– Adult Ascaris has 5 cell bodies out of which one is located on dorsal surface of pharynx and 4 on lateral lines at varied distance.
– Body cavity is filled with pink coloured Pseudocoelomic fluid or perienteric fluid.
– Which serves for the transportation of metabolites and keeps the body distended.
– Pseudocoel acts as a hydrostatic skeleton to keep the body in tension.
– Smell in pseudocoelomic fluid is due to fatty acid like butyric, valeric & caproic acid which form during aerobic respiration.

PHYSIOLOGY

Digestive System :

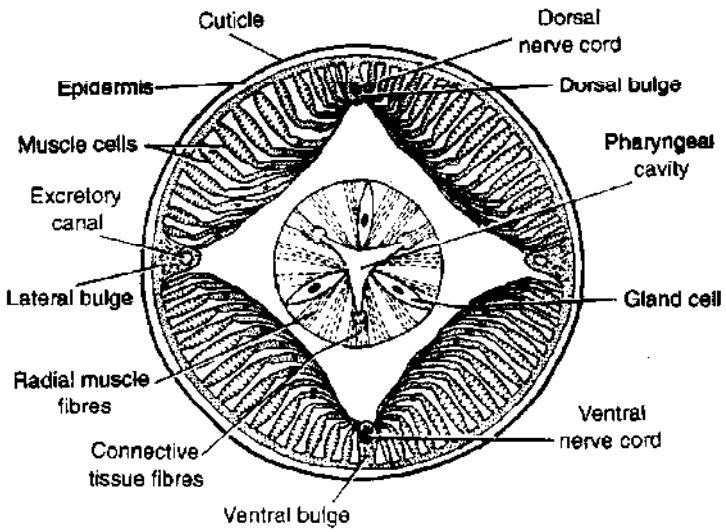
– It is poorly developed in Ascaris.
– Alimentary canal is simple because pre-digested food is feeded in it.

Mouth :

– Mouth opens in a small and thin walled Buccal cavity. Buccal Cavity - It opens in a thick walled pharynx.

Pharynx :

– Wall in pharynx is syncytial. Wall has radial muscles due to which pharynx has the capacity of contraction and expansion.
– In feeding, pharynx acts as a suction organ.
– Lumen of pharynx is triradiate.
– At every angle of lumen of pharynx, protein fibres are attached, these fibres are called marginal fibres, these fibres maintain the **triradiate shape** of lumen. 3 branched gland cells are associated with lumen of pharynx and these secret digestive juice.



T.S. of Ascaris through the region of pharynx

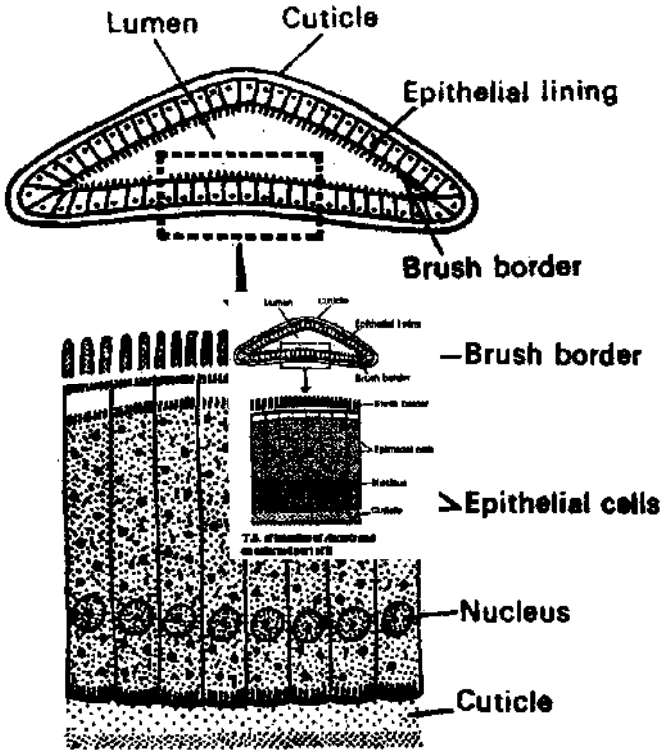
Intestine :

– Intestine is thin walled flat tubular structure, pharynx opens in intestine.
– There is a sphincter between pharynx and intestine to regulate the passage of food.
– Wall of intestine is made up of a single layer of endodermal columnar epithelial cells.

– On inner surface these cells have brush border of microvilli.
– On outer side these cells secret a thin cuticle.

Rectum :

– It is a farthest organ of alimentary canal. It's wall has mucous secreting rectal glands. 6 Rectal glands in male and 3 in female.
– In female, rectum directly opens out side, by anus.
– Some muscles controls opening and closing of anus, these are called **depresser ani muscles**.
– In male, rectum opens in a cloacal chamber and this chamber open outside the body through cloacal aperture.
– On the basis of origin, alimentary canal of ascaris may be divided into 3 parts.



T.S. of intestine of *Ascaris* and an enlarged part of it

1. Fore gut or stomodaeum : It is ectodermal in origin, is formed in embryo stage by the invagination of body wall. so cavity of fore gut is lined by a cuticle. foregut includes mouth to pharynx .
2. Mid gut or mesenteron : It is endodermal in origin.In ascaris, intestine is mid gut.
3. Hind gut or proctodaeum : Origin similar to fore-gut and has cuticle same as fore-gut.
   – In ascaris the portion from rectum to anus or cloacal aperture is hind-gut.

Food :

– Ascaris feeds on chyle i.e. liquid predigested food present in ileum of host. sometimes ascaris with the help of denticles, punctures the wall of ileum and feeds on blood.

Digestion :

– Digestion is mainly extracellular in the cavity of intestine. some digestion is intracellular.
– Digestion is completely **extracellular** in the cavity of intestine and is aided by the enzyme-proteases, amylase and lipase.
– Digested food is absorbed by intestinal cells and distributed by the pseudocoleomic fluid.
– Intestinal cells also engulf small solid particles and digest them **intracellularly**.
– Distribution of digested food is by pseudocoelomic fluid.

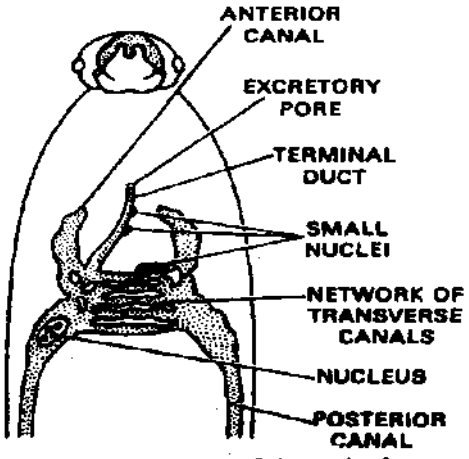
RESPIRATORY SYSTEM

– Respiration is of anaerobic type and its by products are some fatty acids like butyric acid, caproic acid and valerianic acid.

- Ascaris is facultative anaerobe. Aerobic respiration occur if O_2 is available. when O_2 is not available in host, anaerobic respiration occur.
- Aerobic respiration takes place in ascaris it is evident by presence of traces of haemoglobgin in body wall and body cavity.
- Besides body wall also has cytochromes.
- There is reddish - pink tinge in the colour of ascaris due to presence of haemoglobin and cytochromes.
- There are no respiratory organs found in ascaris.
- Glycogen is the respiratory material in ascaris, In anaerobic respiration, the glycogen breaks into CO_2 and fatty acid, these material escape by diffusion through body wall.

EXCRETORY SYSTEM

- It is a H-shaped canal system in ascaris.- It has 2 longitudinal excretory canals located inside the lateral lines in anterior side of body near pharynx.
- These 2 canals are interconnected by a transverse connection.
- These 2 canals interconnect to form a common duct which open outside of the body through excretory pore.
- The whole excretory system originates from a single **renette cell**.
- So excreory canals in ascaris are intracellular.



Excretory system of Ascaris shown only in anterior part of body

- Renette cell are mesodermal cell so Excretory System is mesodermal But terminal duct is Ectodermal Renette cell have 4 nuclei, 2 in common duct, 1 in transverse connection and 1 in left excretory canal.
- Ascaris mainly excretes urea so it is ureotelic it also excretes ammonia so it is also ammonotalic. But it is more ureotelic and less ammonotelic.

NERVOUS SYSTEM

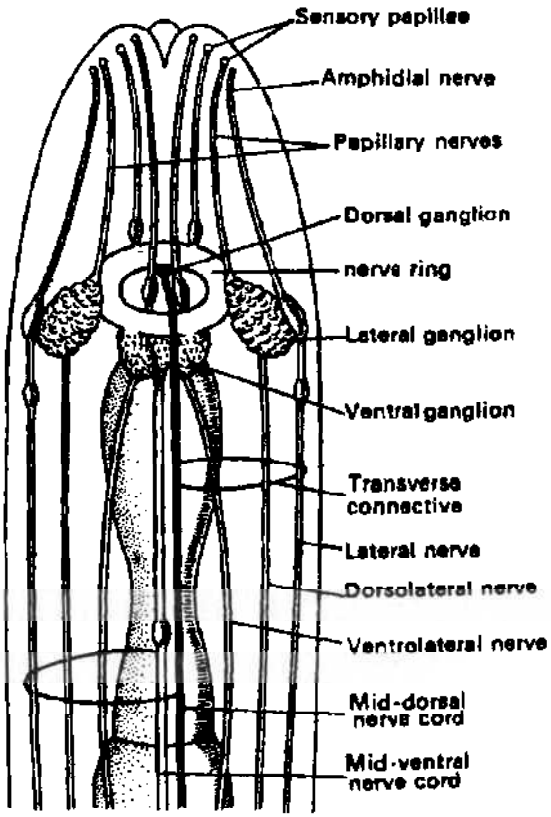
- It is made up of 162 nerve cells. There is a brain ring or nerve ring around pharynx. this ring acts like a brain. or circumpharyngeal ring .
- Brain ring has 7 ganglia associated to it. They are located as -
  1. Dorsal Ganglion
  2. Ventral Ganglia
  3. Lateral Ganglia
- Total no. of nerve ganglia are 7 but only 5 ganglia are visible because each lateral ganglion is formed by fusion of 2 ganglia.
- Brain ring or nerve ring supplies 8 nerves on anterior side of body. Their position.
  (i) 2 from dorsal side of ring

(ii) 2 from ventral side of ring

(iii) 2 from dorsolateral side of ring.

(iv) Last 2 from lateral ganglia - called the Amphidial Nerves.

- Amphidial nerves supply to the amphids of lips. Rest 6 nerves are called Papillary Nerves and supply labial papilla.
- On posterior side, ring supplies 8 thick nerves:
- 1 dorsal nerve which originates from dorsal ganglion of ring.- 1 ventral nerve cord which originates from ventral side of nerve ring. It is the thickest and ganglionated. It is main nerve of Ascaris.
- 1 pair ventro-lateral nerves which originate from ventral ganglion.
- 1 pair dorso-lateral nerves which originates from lateral ganglion.
- 1 pair lateral nerve also originate from lateral gangion.
- Only Dorsal nerve and ventral nerve are motor nerves and rest all 14 nerves (all 8 anterior and 6 posterior) are sensory.



NERVOUS SYSTEM

REPRODUCTIVE SYSTEM

- Ascaris is a unisexual animal. There is clear sexual dimorphism in male and female Ascaris.

Male Reproductive system :

- Male Ascaris has only one unpaired testis so it is called monorchic or monodelphic condition.

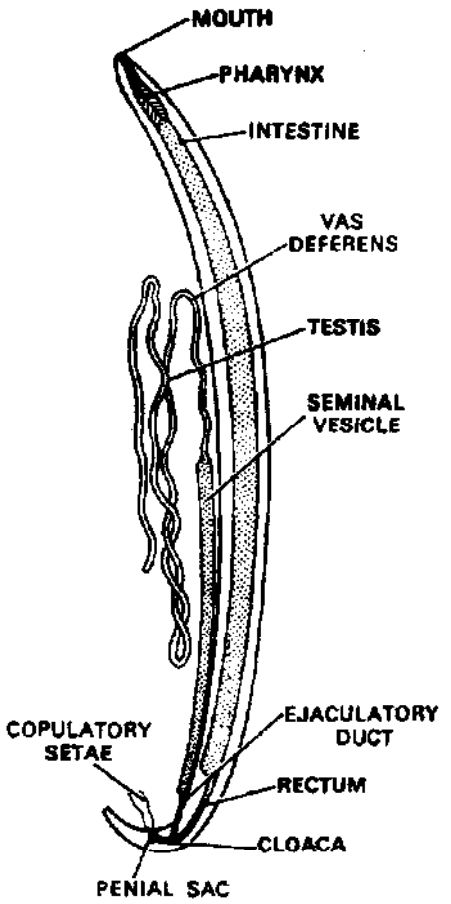
1. Testis : Single testis, long thread like thin and coiled. It is divided into 3 zones.

(i) Proximal part or Germinal part or Proliferation part :

- It has a large germinal at its tip. This cell by budding forms spermatogonia. Formation of spermatogonia is called Telogonic.

(ii) Growth zone : Here spermatogonia grows and primary spermatocytes are formed.

(iii) Maturation zone : Here maturation division takes place and sperms are formed.



Genitalia of male Ascaris

Wall of Testis :

- It is composed of simple cuboidal epithelium In cavity of testis there is a central rachis which is formed of semi solid cytoplasm.
- Rachis provides nutrition to sperms.
- Sperms of male Ascaris are tailless and amoeboid.
- Testis continues in a Vas-deferens.

2. Vas Deferens :

- In this central Rachis is absent.
- A special function in vas deferens of Ascaris takes place. i.e. structural maturation in testes i.e., sperm obtains activity and capacity of fertilization when pass through vas-deferens.

3. Seminal Vesicle :

- It is a long, cylindrical and thick tubular structure which stores sperm.

4. Ejaculatory Duct :

- It joins the rectum to form the cloaca.
- Prostate gland is located in side the ejaculatory duct and its secretion provides nutrition to sperm.

5. Pineal Sac :

- 2 big sacs are associated to cloacal chamber.
- These sacs are called pineal sac and each of it has 1 pineal setae.
- Pineal setae is found only in male Ascaris. 2 types of muscles are associated with penial setae.**Protractor muscle -** Paus out, **Retractor muscle -** Paus in
- Setae come out during copulation and they open female gonopore during copulation.

Female Reproductive System :

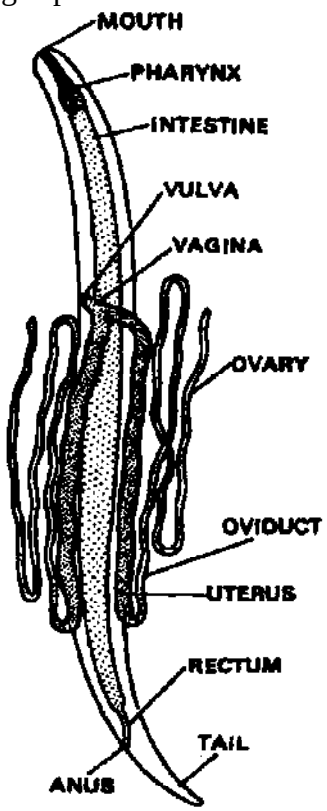
Ovary :

- Female reproductive organs are paired, it includes pair of ovary, oviduct and uterus and this condition is called as **Didelphic**.
- Structure of ovary is similar to male testes i.e. layered by cuboidal epithelium and central rachis is also present.
- Structure of oviduct is similar to that of vasa-deferens and it is deprived of central rachis.

Uterus :

- Each oviduct spreads at distal part to form uterus.
- Distal part of oviduct or proximal part of uterus is called Seminal Receptical.
- It stores sperms which received from male Ascaris after copulation.
- Fertization also takes place here where as in other animals fertilization occurs in anterior part of oviduct.
- Wall of uterus is muscular and glandular.This wall has 3 layers:

(i) Outermost - oblique muscle layer.



Female Reproductive System

(ii) Middle - circular muscle layer.

(iii) Innermost - Tufted cuboidal epithelium.

- It has tufts of cilia.
- Both uteri unite to form vagina which opens outside the body through female gonopore.

Copulation :

- Copulation takes place in ileum of host.
- During copulation male and female remains at right angle to each other.
- Male opens female gonopore with penial setae and transfers sperms.
- These sperms are collected in seminal receptical of female.

Fertilization :

- It takes places in seminal receptical.
- In Ascaris fertilization takes place at secondary oocyte stage.
- After fertilization a shell is formed around fertilized egg. this shell is 3 layered.

(i) Lipoidal layer : It is the innermost layer which is made of esterified glycosides and proteins.

(ii) Chitinoid Layer : It is made of chitin, glycogen, and protein. This layer is actually fertilization membrane.

(iii) Albumin Layer : It is outermost layer and is made up of albumin proteins.

- The lipoidal and chitinoid layers are secreted by egg itself and outermost layer of albumin is secreted by uterus.
- The shelled eggs are liberated by female Ascaris in ileum of host.
- A female Ascaris lays around 15000 to 2 lac eggs at a time and in whole life it lays 2.5 crore eggs.
- Shelled eggs are given out through excreta from the body of host.

DEVELOPMENT

- For further development, eggs require optimum temperature (30°C) and oxygen because embryo needs O_2 for respiration (obligate aerobes)- As soon as eggs come out, cleavage become start.
- Cleavage is **spiral**, **equal holoblastic** and **determinate**.
- Spiral cleavage is a distinguishing feature of phylum Aschelminthes.
- With in 10-14 days, a juvenile stage of Ascaris is formed which is called the Rhabditoid Larva.
- In next 7 days, this larva under goes 1 moulting which helps in growth of larva.
- After moulting II stage of larva is emerge out.
- Eggs with larva are called **embryonated eggs**.
- These embryonated eggs are **infectious stage** of Ascaris in man.
- Contaminated water or food helps them to reach in intestine of host.
- The embryonated eggs of Ascaris may survive outside hosts's body for 6-8 years.
- This long survival period is called as **cryptobiosis**.
- When embryonated eggs reaches duodenum of host, its shell is dissolved and larva becomes free (hatching).

– Hatching is induced by high CO_2 concentration, high temperature and alkaline PH.

– After hatching, II stage larva starts wondering in body of host this wondering is called visceral migration.

There is 2 types of migration occur -

1. First Migration :

IInd stage larva ➡ Duodenum wall ⟶ Blood Vessel ⟶ Hepatic Portal vein ⟶
Right auricle ⟵ post caval ⟵ hepatic vein ⟵ Liver ↲
↓
Right ventricle ⟶ pulmonary artery ⟶ Lungs ⟶ Alveoli wall

II stage larva :

– Penetrates/punctures the duodenum wall of host and enters the blood capillaries.
– This larva reaches liver through hepatic portal vein.
– From liver through hepatic vein and Post caval it reaches right auricle of heart.
– Then via pulmonary artry it enters into lungs.
– It takes 6-8 days for completing Ist visceral migration.
– In lungs it stays for about 10 days (In walls of alveoli).
– During its stay in lungs, it under goes 2 successive moultings.
– Ist time on 6^{th} day. and becomes III stage larva, then II moulting on 10^{th}day and forms IV stage larva. III stage larva is formed from II stage larva and ultimately IV stage larva is formed.

2. Second Migration

– IV Stage larva ⟶ Alveoli cavity ⟶ Bronchiole ⟶ Bronchus ⟶ Trachea.
Ileum ⟵ Duodenum ⟵ Stomach ⟵ Oesophagus ⟵ Buccopharyngeal Cavity ↲

– IV stage larva now moves to trachea via alveoli cavity. It enters Bucco pharyngeal cavity due to coughing. It ultimately reaches illeum passing through oesophagus stomach and Duodenum
– Free larva passes only once through oesophagus. The complete journey period is about 3 weeks.
– **Last IV moulting** of Larva takes place in **ileum** of host and it enters in V stage which is the adult stage of Ascaris. In next 6-8 weeks, it becomes sexually mature and starts reproduction.

CLEAVAGE

– Cleavage in Ascaris is determinate i.e. fate of each blastomere is definite.- 4 celled embryo of Ascaris is initially 'T' shpaed then changes it's shape to rhomboid shape, and has 4 blastomeres.
– 1 blastomere on dorsal side is called B.
– 1 on ventral side called **S_2 or EMST.**
– 1 on anterior side called **A and 1** on posterior side called **P_2.**

A and B : Forms whole ectoderm of body except posterior body.

EMST : Divides into two forms (2 blastomeres) i.e. E and MST. E forms endoderm of complete body.

– MST forms Mesoderm and Stomodaeum.

- **P_2 -** Divides into **P_3** and **C** blastomeres.
- P_3 again divides into **P_4** and **D**. C and D Together form ectoderm of posterior body and P_4 forms germ cells in gonads.

EFFECTS OF ASCARIS

- Life span of Ascaris in host is about 9-12 months. If infection does not occur during this period then disease automatically cured.- Infection of Ascaris in man is called Ascariasis.
- Larva and adult have different effects on human body.

EFFECTS OF ADULT ASCARIS

(i) Indigestion :

- Ascaris blocks the passage of bile duct and due to insufficient bile juice indigestion is there.
- Waste materials of ascaris destroy the protein digestive enzyme of host mainly trypsin.
- Indigestion causes insomnia, vomiting, nausea and abdominal pain, or severe infection can cause even fever.

(ii) Appendicitis :

- Some times it enters vermiform appendix of host so it swells and inflammation is called appendicitis.

(iii) Eosinophilia :

- Increased count of eosinophils in blood is called Eosinophilia.
- It causes allergy, this disease can also be caused by other worms.

EFFECT OF LARVA ASCARIS

- Larva causes enteritis or peptic ulcer, inflammation of lungs, liver damage which causes jaundice.
- Most harmful because of abberent migration. Some time it reaches kidneys, brain and spinal cord and dies there interfering normal activities of concerned organ.
- When it enters brain it leads to delirium. Mostly larva dies here and dead body is surrounded by calcified cyst. this cyst interfere normal activities of organs and causes damage.

Diagnosis and Therapy : Stool test confirms the Ascaris infection as eggs are present in excreta.

Treatment :

a- Oil of chenopodium	**b-** Decaris
c- Antipar	**d-** Vermisol
e- Piperazine	**f-** Santonin
g- Alcopar	**h-**Hexyl resorcinol etc.

PARASITIC ADAPTATIONS OF ASCARIS

- Body is long and narrow for easy accomodation in the intestine of the host.
- Since it feeds upon the chyme of the host it possesses gustatory receptors concentrated upon the lip

around the mouth.

- Cuticle is well adapted for protection.
- Muscle cells of its body wall contract against the pressure of pseudocoelomic fluid to bring about undulations of the body that counteract the force of peristalsis of host intestine . Thus pseudocoelomic fluid is well adapted for hydrostatic skeleton.
- Digestive system is simple, b'coz alomost predigested nutrients are available to the worm in the chyme of the host.
- The pharynx is adapted as a sucking and pumping organ to suck in the chyme and pump into the intestine.
- There are no special organs for locomotion & respiration. Respiration is mostly anaerobic
- Nervous system- and sensory organs are relatively simplified.

SPECIAL POINTS

- Body cavity of Ascaris is pseudocoel
- Salivary glands do not occur in Ascaris
- Reserve food is in the form of glycogen stored in syncytial epidermis
- Ascaris is dioecious or unisexual
- Monogenetic, no intermediate host
- Aberrant migration is the migration from lungs to brain, spinal cord, eyes etc.

EARTHWORM (PHERETIMA)

CLASSIFICATION

Kingdom	:	Animalia
Branch	:	Eumetazoa
Division	:	Bilateria
Subdivision	:	Protostomia
Section	:	Eucoelometa

Phylum : Annelida

- True coelomic body cavity arising as a split in mesoderm (schizocoel) and lined by mesodermal coelomic epithelium (Peritoneum).
- "Bilateral symmetry", triploblastic". Metamerically true segmented body - Body cavity segmented like body wall. Excretory organ - "Nephridia" , Nonchitinous body, Locomotion = "Setae"

Class : Oligochaeta

- Cephalization - absent. Head, eye, tentacles - absent. Setae in body wall. Clitellum = Permanent for "Cocoon formation". Usually hermaphrodite and no free living larval stage. Parapodia absent

Order : Terricola

(1) Clitellum Multilayered

(2) Terrestrial animals

Genus : Pheretima – (Termed by Kinberg) :

Female gonopore single. Male gonopore one pair.

Clitellar segments 14, 15, 16.

MOST COMMON SPECIES OF INDIA

"*P.Posthuma*" -North Indian earthworm

Discoverer - K.N. Bahl

Pheretima - In Japan, Srilanka and Australia

P. eutyphaeus - North Indian Earthworm

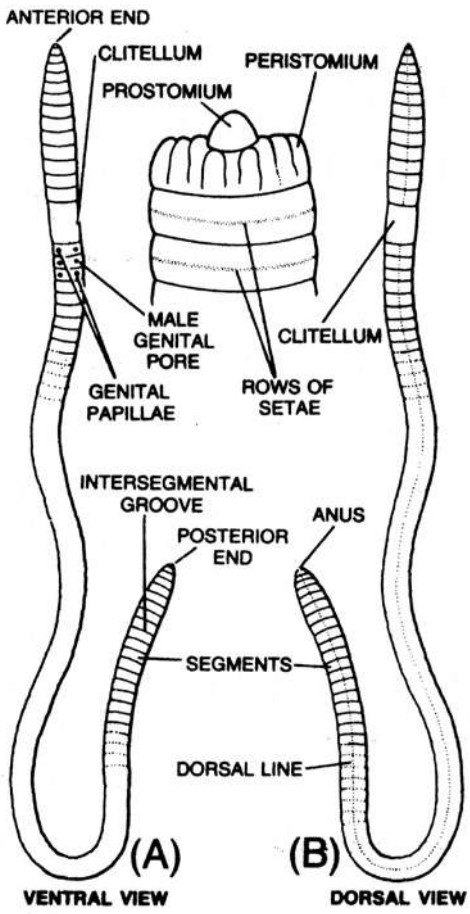
P. megascolex - South Indian earthworm-Longest with 3 m in length (In world megascolides australis is longest = 3.5 mtr)

P. drawida - South Indian earthworm

P. lumbricus - American and Europian earthworm.

HABIT AND HABITAT

- Fossorial (lives in burrows). Burrows found in moist soil, with more humus, maximum in garden soil, Nocturnal animals.
- Cutaneous respiration, absent in dry soil. It feeds on dead organic matter present in the soil.
- The food and soil are ingested together and the latter along with indigested food is finally egested in the form of worm casting.



A. Ventral view of *P. posthuma*;
B. Dorsal view of its anterior end

MORPHOLOGY

Shape - Bilaterally symmetrical animal. Body is cylindrical, elongated, pointed in front, blunt behind.

Colour - Glistening deep brown colour is annular row (= perichaetine arrangement) of about 80-120 minute, S-shaped and yellowish setae (made up of chitin) = Chaetae.

- Seta are half embedded in body wall and half projected backwards upon body surface. They help in locomotion.
- In lumbricus eight setae present on each segment. This arrangement of called lumbriching or octochaetine. This Setae found in pair.

Young Pheretima :

- Setae present on clitellum also. Middle part of setae is swollen = Nodulus or seta bulb.
- Lodged in a deep and narrow invagination of the epidermis called setal or setigerous sac.
- A Large cell known as "Formative Cell" is found at base of sac.
- It secretes seta. Circular Muscle layer divided into 2 parts at the place of seta. Outer circular muscle layer = "Protactor" muscles (1 Pair). Inner circular muscle layer = Retractor muscle (unpaired one).

Segmentation :

- Body of pheretima has "100-120" segments. Segments are known as Metameres (or somites).
- Inter segmental groove present between every two segments.

Clitellum :

- "14-15-16" segment have a pink coloured layer around them.
- This thick collar or girdle like thickening is known as "Cingulum" or clitellum. This is made up of glandular cells.

Mouth : First segment - "Peristomium, Peristomium bears a terminal slit like mouth.

- A dorsal fleshy lobe like process overhangs the mouth like a hood and is called **prostomium.**
- Prostomium helps in digging burrows. Photoreceptor also found in it.

Aperture :

- Spermathecal pores - in each of the four intersegmental grooves between segments 5/6, 6/7, 7/8, 8/9, there is a pair of ventro-lateral elliptical Spermathecal pores.
- Genital pore - First segment of clitellum or 14th segment has a "female gonopore". or female genital pore is located in the mid-ventral line of this 14th segment.
- 18th segment - "Ventro-lateral" - 1 pair of male gonopore. 17 and 19 segments - Pair of genital papilla. on ventro-lateral position. They help in binding two pheretima in ventro lateral condition at the time of copulation.
- Nephridiopores : They are 200–250 minute pores of integumentary nephridia scattered upon the surface of each segment except the first six. Upon clitellar segments, their number is about 2000 to 2500, so called **forest of nephridia**.
- Dorsal pores - Mid - dorsal pores in each intersegmental wall after twelvth segment.
- Dorsal pores absent in last groove.
- Body-fluid always oozes out from these pores. This fluid moistens and smoothens the skin for cutaneous respiration.

– When salt or alcohol is sprinkled on its body, the fluid rapidly oozes out and causes its death.

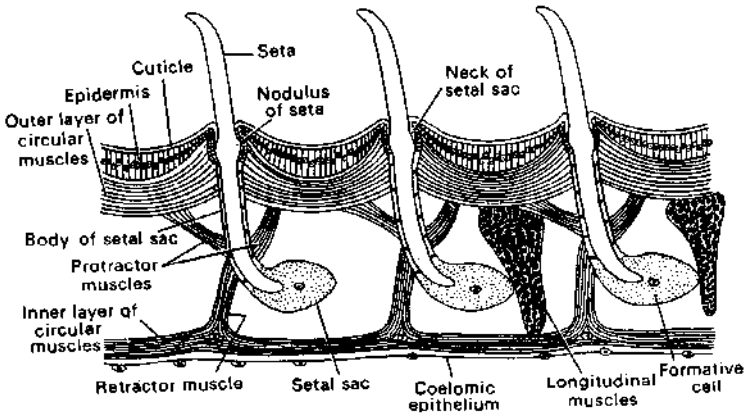
– Anus - A small and vertical slit like aperture at the end of last anal segment (Pygidium) is known as Anus.

BODY WALL

– 4 main layers

(a) Cuticle : "Thin" & semitransparent cuticle composed of white coloured irregularly arranged collagen fibres "Non chitinous" Protective covering, Pores present.

(b) Epidermis : Second Layer - Made up of columnar epithelial cells- 4 types of cells are found in epidermis.



(1) Supporting Cells : Narrow, ordinary, unspecialized epithelial cells. Forms major part. So these are main cells.

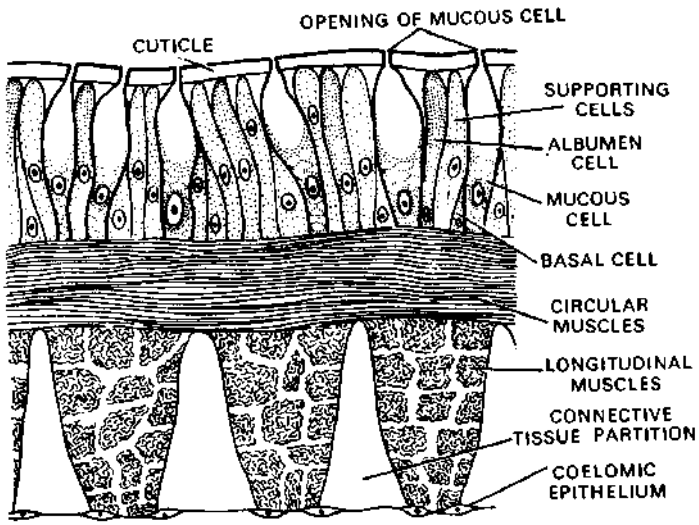
(2) Basal Cell : Shorter, Conical cells, wedged in between and narrower basal parts of other cells. Present at the base. Also known as replacement. cell, as it replaces the destroyed cells of epidermis.

(3) Sensory Cells : Narrow columnar cells occuring here and there.

– Each cell has small sensory hairs at its free end - Receives stimuli.

(4) Gland cells : Thicker cell interspersed between the supporting cells. They are of two types :

(i) Mucous Gland cell :



T.S. Body wall

– Numerous, Club - shaped. Secretes mucus which moistens & smoothens the body (moist & slimy).
– Also known as Goblet cells Each goblet cell opens by a minute ductule upon body surface through a minute pore.
– The mucus keeps the walls of burrows smoothen or lubricated.

(ii) Albuminous cell :

– Fewer, Narrower. Secrete nutritious substance in cocoons. Helps in excretion.

(c) Muscle Layers : Outer = Circular muscle layer Inner = Longitudinal muscle layers

Circular Muscle layer :

– Continuous layer around the body. Porphyrin pigment present.
– Brown colour is due to this pigment. Protects from ultra violet rays.
– This is obtained by the decomposition of chlorophyll.

Longitudinal Muscle Layers :

– (Discontinuous)- It is broken into several longitudinal strips of bands, separated from each other by thin connective tissue partitions.
– They appear elliptical or club shaped in transverse Section.

(d) Parietal Coelomic Epithelium (= peritoneum) : Inner Most layer :

– Found next to the longitudinal muscle layer. Thin, membrane like, originate from mesodermal epithelium of flattened squamous cells.
– Outer envelope of coelomic cavity and hence, called parietal or somatic layer of coelomic epithelium or peritoneum.

FUNCTION OF BODY WALL

(1) Provides fixed shape and size to the body.
(2) Provides protection:- mucous prevents harmful bacteria.
(3) Fluid moistens the body surface and facilitates in respiration.
(4) Seta and Muscles of body wall helps in locomotion.
(5) The sensory cells of epidermis work as the receptors. They compensate the absence of special sense organs in earthworm.

Body Cavity :

– Is "True Coelom" mesodermal in origin and lined by two layers of mesoderm. Outer layer (Parietal - Peritonium) Inner layer (Visceral - Peritonium).
– Space between two above layers is called Body Cavity.
– Body Cavity is segmented. Septa present between each two segments.
– They are known as intersegmental septa.
– First intersegmental septa between "4^{th}-5^{th}" segments. 9^{th} and 10^{th} segments do not have this septa. Ist septa is - thin and straight. Next 5 septa - Thick and funnel shaped. Rest all septa - Thin. First 9 septa are - non porous. All posterior septa - Porous. Each septa has "136 - pores".
– These pores are surrounded by Sphincter.
– Body cavity contains coelomic fluid which is - Milky and alkaline fluid.

– Matrix of watery plasma containing proteins and salts and minute nucleated cells or corpuscles. They are of 4 types

(1) Granulocytes or eliocytes or phagocytes :

– Oval - shaped or subspherical shaped with a concavity on one side and distinct folds on the other. Their one end is flattened.

– Function : Phagocytosis of Bacteria. Granular Cytoplasm present which serves to store nutrients.

(2) Amoebocyte cells : Irregular shaped and phagocytes bacteria.

(3) Mucocytes : Spiral cell. It has an expanded fan like part and a narrow, nucleated, stalk - like part. Function unknown.

(4) Leucocytes or circular cells : Flattened and circular cells with a wrinkled surface and clear, hyaline cytoplasm.

Function : Uncertain

(5) "Yellow cell or Chloragogen cell" : Analogous to liver of higher animals. Shape : Star shaped. Liver like functions. Found in the wall of alimentary canal and on maturity, it falls in the body cavity and gets destroyed.

FUNCTION OF COELOMIC FLUID

(1) Works as hydrostatic skeleton which facilitates locomotion.
(2) The fluid helps in respiration .
(3) Chloragogen cells help in storage of food and excretion too.
(4) Because of this fluid, the body of earthworm is lusturous.
(5) It keeps the body wall moist.

LOCOMOTION IN EARTHWORM

– Given by "Grey" and "Lismann". Lateral appendages absent.

(1) Setae - fix the body to substratum
(2) Muscular layer of body wall C.M.L. = elongates body L.M.L. (Shortens and thickens the body)

– Contraction (wave - like) moves the body in opposite direction of wave.

– In pheretima contraction in total 9 - segments takes place at a time.

(3) Body fluid - "Hydraulic - skeleton"
(4) Mucous = helps in locomotion on smooth surface.
(5) Speed of earthworm = 25 cm/min.

PHYSIOLOGY

Digestive system :

Buccal chamber :

– It is lined by cuticle and extends upto middle of the 3rd segment.

– It has sense organ for olfaction and taste. Because of Radial muscle the buccal cavity is reverted.

Pharynx :

– Dorsal wall of pharynx is thick and is known as "Pharyngeal bulb".

– In this cavity are present two lateral septa .

– These then divide the cavity into two chambers "incompletely".

– In Dorsal part - Dorsal Chamber - Salivary chamber.

– In the dorsal part of salivary chamber is present, saliva secreting cells known as "**Chromophil Cells**" which secrete mucus and proteases.

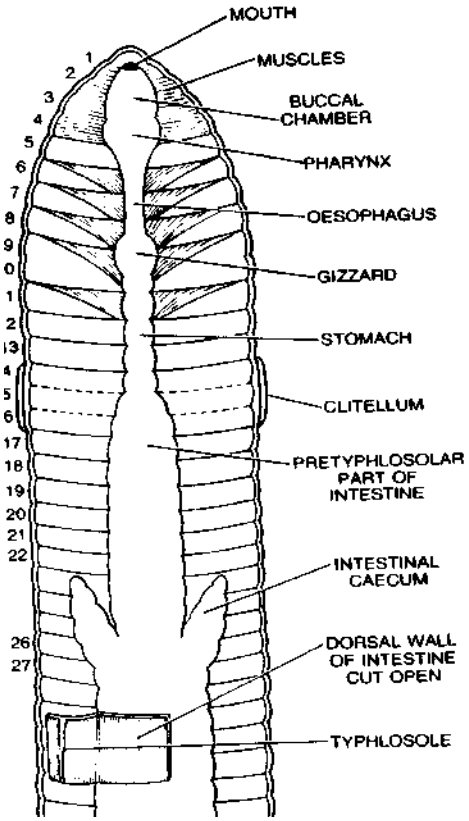
– In Ventral part - "Conducting Chamber" : This is a passage of food - Pharynx located in 3rd and 5th segment.

Oesophagus : 6-7 segment have oesophagus. Oesphagus opens into a thick walled "Gizzard".

Gizzard : This is located in 8th segment.

Stomach : In "9th - (13-14) th" segments. Sphincters present on both ends. Gland Cell in wall secretes "**Proteolytic**" Juices or enzymes.

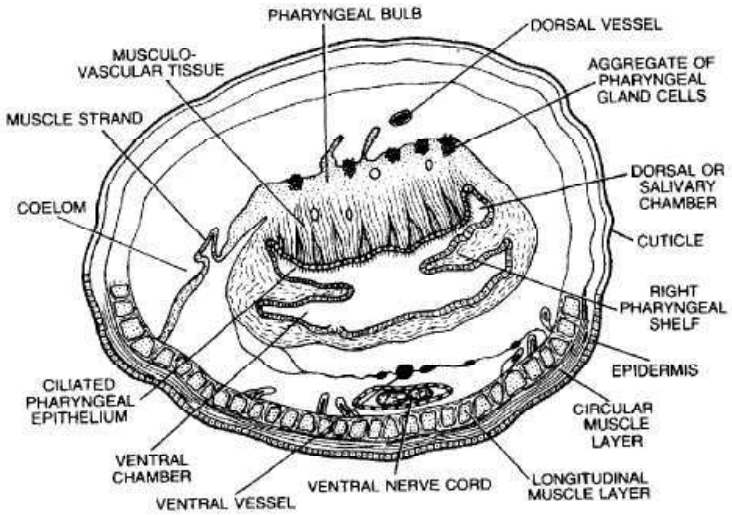
– In other earthworms (not in pheretima) "**Calciferous gland**" are found in wall of stomach. Calciferous gland - neutralise Humic acid by secreting lime.



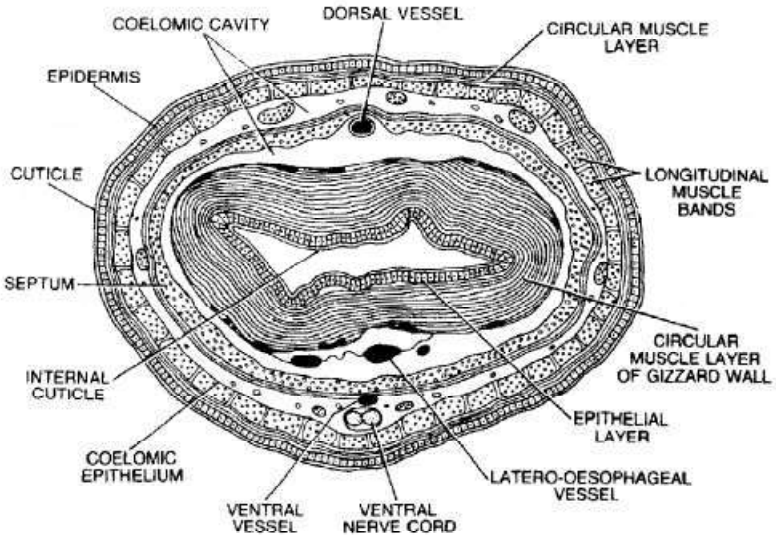
ALIMENTARY CANAL

Intestine :

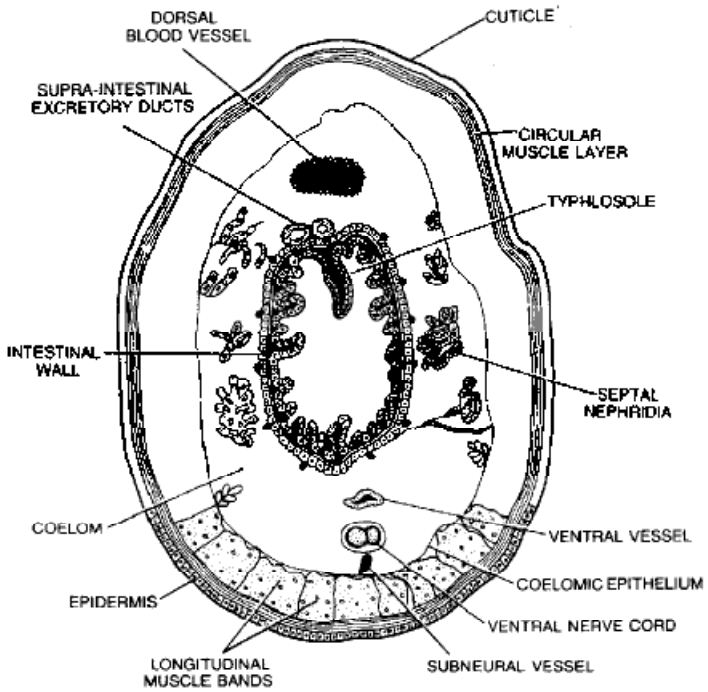
– Longest and widest part of alimentary canal.
– Extends behind from the beginning of 15th segment to the last 20-25 segments.
– This is somewhat compressed by each inter-segmental septum.
– It has a segmentally beaded appearance.
– Wall thin and highly vascular and glandular.
– It bears several villi-like internal longitudinal folds in most part.
– A specially large and prominent fold, called **typhlosole** hangs internally into the intestinal lumen from its mid-dorsal line.
– Beginning from the anterior end of **27th segment** and ending in front of the last 24 or 25 segments.
– Due to typhlosole, intestine is distinguished into **pretyphlosolar, typhlosolar and post-typhlosolar regions**.
– Last 20-25 segments contain rectum.
– Second longest part of alimentary canal.
– Two "blind duct" present in 26th segment attached to intestine.
– They are known as **intestinal caeca**.
– This is situated upto 22nd segment. Secretes digestive enzymes. Typhlosole & villi – Increases the absorption area in intestine.



T.S. of Pharynx



T.S. of Gizzard



T.S. of Intestine

HISTOLOGY OF ALIMENTARY CANAL WALL

(a) Outermost = Visceral peritonium :

– Type of coelomic –epithelium (Mesodermal cell). "Chloragogen cells" found in it. These are analogous to liver.

(1) Storage of food : (Glycogen + lipid) The yellow colour is due to stored lipids.

(2) "Deamination and Urea formation"

(3) Glycogenesis

(4) Lipogenesis : When the cell matures, it breaks from the visceral peritonium and falls into the body cavity where it gets decomposed.

(b) Longitudinal muscle layer – outside

(c) Circular muscle layer – Inside

- Muscle layer are less developed in intestine but In pharynx and gizzard, they are well development.
- Only circular muscle layer in gizzard-Longitudinal muscles are absent.

(d) Enteric epithelium – Ciliated columnar epithelium

- This is glandular in some parts e.g. in pharynx, stomach walls.
- Maximum glands in wall of intestine. A layer called cuticle is also found.

Cuticle : "Buccal cavity and gizzard" Wall of gizzard have thickest cuticle.

FEEDING AND FOOD

- "Omnivorous"

Food - Humus, dead insects, dead leaves and twigs.

In feeding - Buccal cavity helps maximally while pharynx help as sucking organ.

DIGESTION

- Starts in pharynx

Wall :

- Saliva (Mucous, protein digesting enzyme e.g. endopeptidase).
- This enzymes acts on protein and helps in the digestion of large protein molecules into smaller ones.
- Gizzard - Performs grinding Stomach - digestion same as in pharynx

Intestine - Maximum digestion takes place here.

(1) Amylase – Starch $\longrightarrow$ Maltose

(2) Maltase – Maltose $\longrightarrow$ Glucose

(3) Amylopepsin – Glycogen $\rightarrow$ Glucose

(4) Chitinase – Chitin $\rightarrow$ N. Acetyl glucosamine

(5) Cellulase – Cellulose $\rightarrow$ glucose

(6) Sucrase or invertase– Sucrose $\longrightarrow$ Glucose + Fructose

(7) Lipase – Fats $\longrightarrow$ fatty acid + glycerol

(8) Exopeptidase – Peptones and proteose $\longrightarrow$ Amino acid

Absorption :

- Takes place in intestine, mainly with the help of typhlosole.
- Absorption takes place after 26th segment.
- Blood distributes the digested food.

Defaecation :

- The wall of rectum absorbs water from the undigested substances.
- Faeces - in the form of dry pellets- "Castings".

RESPIRATORY SYSTEM

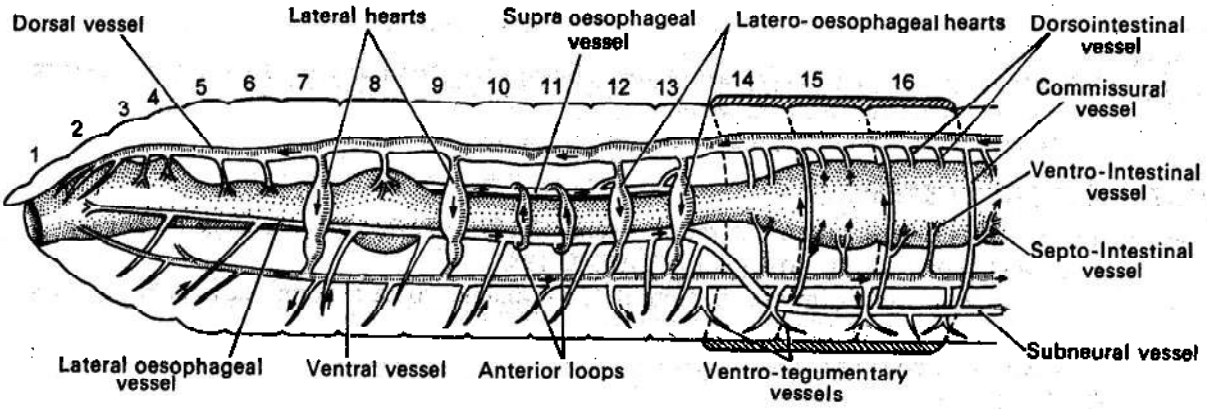
- "Cutaneous respiration" **Skin :** Well adapted for cutaneous respiration, it is thin, moist, highly vascular.
- A dense network of capillaries is present. **Normally –** Aerobic respiration.
- But can also live without oxygen for 30 hrs.

BLOOD VASCULAR SYSTEM [B.V.S.]

Closed : Vascular system. It consist of heart, true blood vessels and blood gland.

Blood : Red colour (Haemoglobin present) Hb - dissolved in plasma

R.B.C. : absent (Nonchordata) this Hb is known as "Erythrocruorin" or "Inter cellular" Hb.



Blood Vascular System [B.V.S.] of pheretima

Blood vessels :

1. Dorsal Vessel :

- Main Blood vessel. From the **3rd to last** segment at dorsal side of alimentary canal.
- It can be seen externally. Wall of dorsal vessel is muscular and lumen have valves.
- Flow of blood occurs from posterior to anterior side.
- Behind the 13th segment, it functions as "**Collecting Vessel**" from last segment to 14th segment.
- In each segment two pair of vessels arise from alimentary canal.
- These are "Dorso intestinal Vessels". These collect blood from alimentary canal and takes blood to dorsal vessel.
- Dorsal vessel in anterior part :- "Distributing Vessel".
- 3rd Segment - It gets branched into three branches.
- They supply blood to the wall of alimentary canal of first three segments.
- In 3, 4, 5, 6, 8th segments, dorsal vessels give out a pair of vessels.
- These supply blood to the wall of alimentary canal.

2. Ventral-Vessel :

- Extends from second to last segment.
- Present on the ventral side of alimentary canal. Wall - Non Muscular. Valve - Absent.
- Blood flows from - Anterior to posterior side.
- Ventral Vessel is a "distributive Vessel" in its whole length.
- V.V. in each segment gives out one pair of "Ventro Integumental Vessel".
- These (VIV) supply blood to body wall and related structures.
- Septa, nephridia, gonads, etc. get the blood supply.
- After 13th segment V.I.V. supplies blood to the posterior segments.
- After 13th segment, a small branch originates from the VIV. It is "septo nephridial" Vessel. It supplies blood to "Septal nephridia" and Inter Segmental septa.
- After 13th Segment, one "Ventro-Intestinal Vessel" comes out from V.V. in each segment which then supplies blood to alimentary canal.

– V.V. receives blood from dorsal vessel. The blood comes from dorsal vessel to ventral vessel by 4 pairs of "**lateral Hearts**".

Hearts :

– Present in 7, 9, 12, 13 segment. 7, 9, - "Lateral Hearts". 12, 13 - "Lateral oesophageal Heart".
– The hearts are muscular and have valves. Lateral Hearts - have 4 pair of Valves. Lateral oesophageal Heart - "3 pairs of Valves". Heart supplies blood from dorsal vessel to ventral vessel.

3. Lateral oesophageal vessel :

– These are 2 vessels lying on either ventro lateral side of the gut, running from anterior end of the body, upto the 13th segment.
– It is a collecting vessel, non muscular. Valves are absent in it.
– Blood flows from anterior to the posterior region.
– In each segment, this collect blood from the body wall septa, nephridia, and reproductive organs, including seminal vesicles.

4. Subneural Vessel :

– It extends from last segment to 14th segment. Ventral side of Nerve Cord.
– In 14th segment it branches into two parts.
– These are "Lateral oesophageal vessel".
– Both branches are situated upto the 2nd segment in the lateral side of alimentary canal.
– S.N.V. do not have muscular wall.
– It is without valves and blood flows from forward to backward.
– It act as "Collecting Vessel" along whole length of animal.
– S.N.V. collects blood only from Body wall. S.N.V. - 1 Pair of commissural Vessel comes out from each segment.
– This supplies blood to "dorsal Vessel."

Commisural Vessel :

– Collects blood from "Septa" and Septal nephridia.
– From each commissural, one "Septo - Intestinal Vessel" comes out.
– They supply blood to alimentary canal.
– Commissural Vessel - is present at posterior face of septa (Intersegmental plates).

5. Supra Oesophageal Vessel :

– In 9-13th segments, on dorsal surface of alimentary canal i.e. on stomach.
– Collects blood from "Gizzard wall" and "Stomach wall".
– In 10th and 11th segments are situated 2 pair of "anterior loops".
– They take blood from L.O.V. to S.O.V. Blood also reach from L.O.V. to S.O.V. by a dozen looplike ring vessels.
– Blood collected in S.O.V. reaches the Lateral - Oesophageal heart.
– From L.O.H. the blood reaches the ventral vessel.

Blood Glands :

– 3 Pairs of blood glands. Situated on dorsal part of alimentary canal in 4, 5, 6, segments.
– They form Hb, Blood cell (W.B.C.) / Leucocytes.

Lymph glands :

– On dorsal part of alimentary canal. From 26th segment to last segment. 1 (one) pair in each segment.
– They form phagocytes and pour them into body cavity.

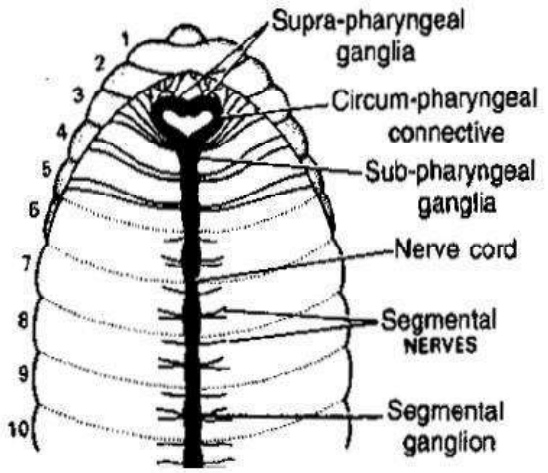
NERVOUS SYSTEM

Central Nervous System :

(1) Brain Ring (2) Nerve Cord

(1) Brain Ring :

- This is present around pharynx.
- One pair of supra-pharyngeal ganglion are present in 3rd segment at dorsal surface of pharynx.
- These are fused to form cerebral ganglion.
- It is also known as brain of pheretima.
- On the ventral side in 4th segment, "sub-pharyngeal ganglion" are present (below the pharynx).
- Nervous strip joins both the two ganglia known as "circum pharyngeal connective".



NERVOUS SYSTEM

Nerve Cord :

- A ventral nerve cord comes out from sub-pharyngeal-ganglia.
- Ventral nerve cord extends upto last segment on ventral side of alimentary canal. Nerve cord in each segment has one segmental ganglion.
- Ventral Nerve cord of Pheretima - double but appears to be single because it has only one common integument around it. The integument has three layers :

[1] Visceral Peritonium (outer).

[2] Longitudinal Muscle layer.

[3] Epineurium (inner most).

- 4 Giant cells on dorsal surface of Nerve cords.
- These giant cells start from 4th segment and lasts upto last segment.
- They are known as "**Neuro-cords**". This is a unique character of Pheretima.
- Pheretima gives rapid - response because of Neuro cords.
- All Ganglia of Pheretima - formed by fusion of "2 ganglion" in embryonic stage.

Peripheral - Nervous System :

- Supra - Pharyngeal ganglia gives out 8-10 pairs of nerves.
- Circum Pharyngeal connective 2 pairs of nerve.
- Sub pharyngeal - 3 pairs of nerves. Nerve Cords - 3 pair nerves in each segment, that arises as:
- 2 pairs from ganglia and 1 pair directly from nerve cord. "All Nerves" - Mixed types of nerves (Sensory + Motor + Adjustor).

Autonomous nervous system :

- This includes the nerve plexuses located in gut wall and some other internal organs.

Receptor : 3 types

[1] Epidermal receptors : In epidermis - tangoreceptors

[2] Buccal receptors : in Buccal cavity ; Chemoreceptors - ("Olfactory + gustatory)

[3] Photoreceptors : or "ocelli" or "little eyes" Maximum in prostomium and peristomium on dorsal side.

– Each photoreceptor have a large optic cell. Inside optic cell there is an "L" shaped. lense or phaosome.

– A network of nerve fibers is associated with lens. This network is is known as"Retinella".

– Nerve fibers - combine to form an optic nerve. They take sensory impulses to supra pharyngeal ganglia. "Alimentary Canal - In the wall of alimentary canal, two network (Plexus) of blood capillaries are present .

(i) Outer plexus - at surface of wall of alimentary canal between visceral peritoneum and longitudinal muscles layer.

(ii) Inner plexus - In the depth of wall of alimentary canal between circular muscle layer and "Enteric Epithelium"

EXCRETORY SYSTEM

– E. Organ - "Nephridia" 3 types of Nephridia

Septal Nephridia :

– Found on "inter segmental septa". Starting from 15-16 segment.

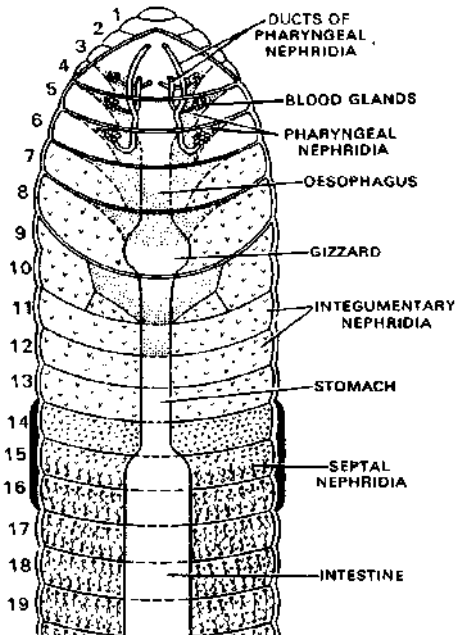
– All posterior septa have nephridia.

– Arranged in two rows on each plane of septa.

– Each row has 20-25 nephridia". 40-50 nephridia on each face of septa.

– Septal nephridia on one septa (80-100).

– In 15th and last segment, there are 40-50 septal nephridia



Types & location of nephridia

Structure of septal nephridia : Consist of 4 parts

(i) Nephrostome : A slit like hole is surrounded by two lips. Upper lip - (8-9 marginal cells) .Lower lip - (made up of 4-5 cells). Nephrostome - Intracellular hole in a large central cell. It is a ciliated funnel communicating with the coelom.

(ii) Neck : After nephrostome, this part is a straight tube like structure. Inside the neck is aciliated canal, nephrostome opens into the ciliated canal.

(iii) Body of the nephridia : Made up of 2 parts

(a) Twisted loop

(b) Straight lobe

– Twisted loop consists of proximal and distal limbs which are twisted. 9 to 13 times around each other like a rope.

– At the base of the nephridium, the straight lobe itself continues as the distal limb of twisted loop, while the proximal limb is formed by fusion of neck and terminal duct.

– In apical part of twisted lobes, there are only 2 non ciliated canals.

– Straight lobe has 4 canals - 2 ciliated, 2 non cilliated.

– All types of canals found in Nephridia are intra-cellular.

(iv) Terminal duct : Last part of nephridia. One ciliated canal inside the terminal duct. Nephridia absorbs body fluid with the help of nephrostome.

- In twisted loops - reabsorption process takes place, useful material absorbed and poured into the body cavity.
- All excretory substances get concentrated and reach the "**Terminal-duct**".
- All terminal ducts present at the lateral side of septa fuses and forms a septal nephridial duct. It is formed in the posterior part of septum.
- In 15th segment, septal nephridial duct is absent it first seen in 16th segment.
- Two large ducts are present at the dorsal side of alimentary canal. From 15th to last segment they are known as supra intestinal duct. S.N.D. - opens in S.I. Excretory duct.

Supra : Intestinal excretory duct open through a small pore in each segment into alimentary canal.

- Alimentary canal absorbs water from excretory materials. Excretory substances with undigested food is thrown outside from anus.
- Septal nephridia - "**Endonephiric**" or "**Entero nephric**".
- In order to check the loss of water, excretory substances are thrown into alimentary canal. So septal nephridia help in "Osmoregulation" because septal nephridia have nephrostome, it is also known as **metanephridia**.
- These are large in size but less in number. That is why, also known as **holonephridia**.

(2) Integumentary nephridia : Present on the internal surface of body wall. After 6th segment - each segment has 200-250 nephridia.

- In clitellar segments they are 10 times (2000-2500). They are known as "**Forest of nephridia**".
- Small in size so - they are known as "**Meronephridia**". Nephrostome absent - called - "**Protonephridia**".
- If Nephrostome present - Meta nephiridia e.g. septal nephridia.
- Twisted loop 'V' shaped. Their terminal duct - opens outside the body so are "Exonephric".

(3) Pharyngeal Nephridia : Present on dorsal side of alimentary canal. In 4^{th} 5^{th} 6^{th} segments they are mixed with blood glands.

- In each group :- 100 nephridia. Total 600 nephridia.
- Size is same as septal nephridia. Structure is same as integumentary nephridia. Terminal ducts of each group unite to form a common duct. The two common ducts of 6th segment extend forwards and open into the buccal chamber in the second segment.
- Common ducts of 4-5th segment open in pharynx lying in 4^{th} segment while of 6^{th} segment open in Buccal cavity lying in 2^{nd} segment.
- According to modern scientists - They are not related with excretion but perform the function of digestive glands.
- Known as "peptonephridia".
- Septal and pharyngeal nephridia are enteronephric (Finally excretory product poured into intestine).
- Pheretima - **"ureotelic"** When water content is more than **"Ammonotelic"**.

REPRODUCTIVE SYSTEM

- Earth worm is "Monoecious" - hermaphrodite. Reproductive Organ - Present on Ventral side of alimentary canal.

Male Reproductive Organ : 10th & 11th segment has testes sac.

– Testes Sac. - Formed by coelomic cavity. Each testes sac has a pair of testes.
– Free end of testes is divided in 4 lobes. These lobes produce spermatogonia
– Testes - **Mesodermal in Origin.** Ist testes sac - smaller IInd testes sac - larger
– A pair of seminal vesicles associated with each testes sac. I pair - 11th segment - smaller seminal vesicle. II pair - 12th segment - large seminal vesicle
– Each seminal vesicle is connected to testis sac by a pair of tubules. Spermatogenesis - in "Seminal Vesicle" Testes forms only spermatogonia. Monocystic protozoa, found in testes or seminal vesicle. They destroy the sperm - "Male sterility.
– From each testes sac, arises a pair of vasa deferentia. They extend upto 18th segment. A pair of prostate gland found from 17th to 20th segment. Vasa deferentia along with duct of prostate gland open via male genital pore.
– Three ducts open in male genital pore. 2 Vasa deferentia and one prostate gland duct.
– Male gential pore is a group of three pores.

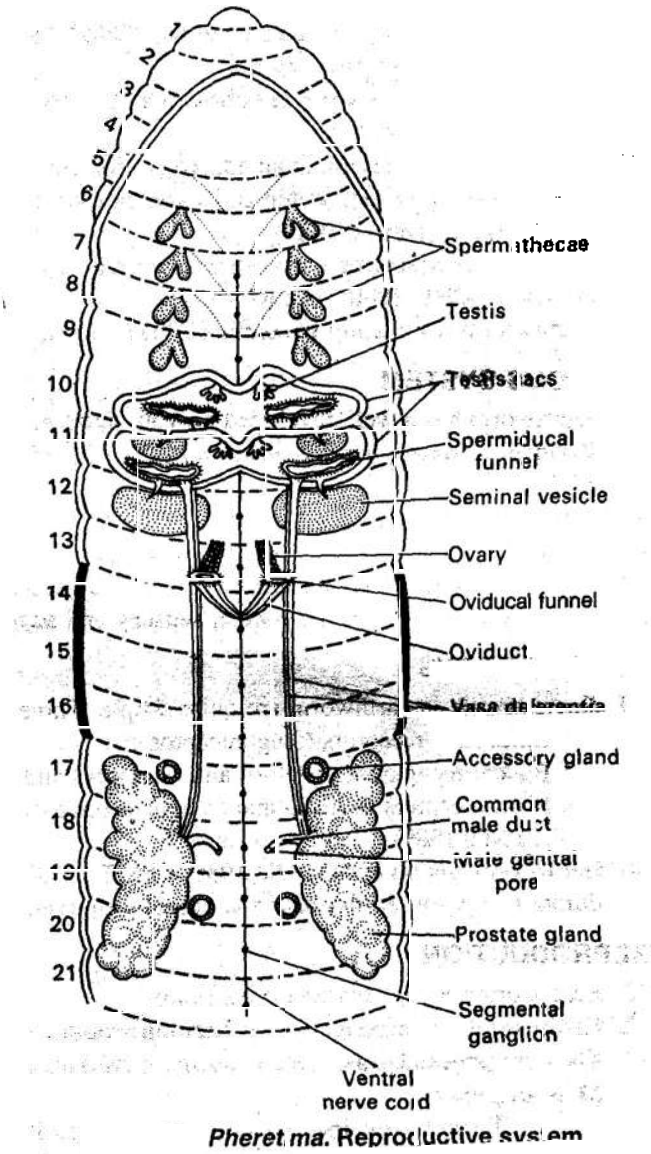
Female reproductive system : Located in 13th segments, is one pair of ovary. They are connected to Intersegmental septa.

– The free end of ovary is divided into many lobes. In each lobe are found, rows of eggs. Eggs - "**Acropetal order**". Two oviducts are located beneath ovary. Both oviduct combines and opens outside the body by female genital pore in Ist clitellar segment.
– Spermatheca - from 6th to 9th segments, one pair in each. Two part of spermatheca.
  1. Ampula 2. Neck
– A duct is associated with the neck. This is known as **diverticulum**.
– After copulation, sperms are stored in it.
– "**Ampulla** - Secretes nutritive liquid, this provides nutrition to sperms.

Accessary glands : One pair in 17th and 19th segment. These open outside the body at the apex of genital papilla. Their secretion helps to bind two Pheretima during copulation.

Copulation : Breeding season - In the night of rainy season.

– The two Pheretima come closer to each other and lie in opposite direction 18th segment of one comes in contact with 5th 6th segments of other Pheretima.
– A small tube (papilla) is formed around the male genital aperture. These are known as copulation tubes or copulation pegs.



Pheretima. Reproductive system

– The copulation tubes of one earthworm inserts into spermathecal pore of other. Then, the transfer of sperms takes place.
– Spermatheca gets filled with sperms in 1 hour.

Cocoon Formation : Pheretima is **Protandrous**.

– A slimy fluid is secreted by glandular cells of clitellum. This then comes in contact with air and forms a pouch around clitelum. This is known as cocoon.
– The eggs comes out from female genital pores and gets filled up in cocoon.
– Earth worm wriggles back side and cocoon proceeds towards front side.
– When cocoons passes over the spermatheca, the sperms get filled in it.
– Nutritive fluid is given by albumen gland of epidermis. Pheretima completely wriggles out from the cocoon.
– Fertilization takes place in cocoon only .
– This is known as "**External fertilization**".
– Only one egg develops and rest gets destroyed.

DEVELOPMENT

– In 2-3 weeks". Pheretima gets fully developed and they comes out by Hatching.
– They do not have clitellum. Soon, they develop clitellum. In young earthworm,
– setae present in clitellar part. Cleavage - "**unequal**" "**Holoblastic**" **Spiral, determinate**.

Gastrulation :

– Invagination". "Neurohormone" - Secreted from Supra pharyngeal ganglion.
– These hormones control regeneration of injured tissue, development of clitellum, and other accessory sexual organs, maturation of gametes, cocoon-formation and shedding of gametes etc.

REGENERATION AND GRAFTING

– Earthworm do not reproduces asexually, but they have great capacity for regeneration.
– It is observed that if a worm is cut into two parts accidentally, the anterior half will develop a tail, but in the posterior half, the head can be formed only if 4 to 6 anterior segments are removed.
– Grafting is also possible in the earthworm. A cut part of an earthworm can be grafted to another worm.

ECONOMIC SIGNIFICANCE OF PHERETIMA & OTHER EARTHWORMS

[1] Pheretima used to cure Rheumatism, piles Asthma, Pyorrhoea impotency, Ulcer, Jaundice etc. Losses : it harms the root of Betal. Natural life cycle of pheretima - 3.5 to 10.5 years.
[2] The burrows makes the soil (land) porous.
[3] They are natural ploughman of land. So they are friends of farmers.
[4] They act as Bait for fishing process.
[5] They are also used for class study because of easy availability and convenient size for dissection.

Harms caused by Earthworms :

[1] Increases soil erosion, Pheretima elongata - harms the roots of Betal plant. Some earthworms also harm the plants of paddy and "Elaichi plants - e.g. "Malabaria padudicola"
[2] A sporozoan protozoa - Monocystis - resides in seminal vesicles and testes as a parasite.

[3] Acts as hosts for transmission of some parasites (e.g. gape worm of chickens)

[4] Some times they get burried with dead bodies. Thus they bring up the infection and harmful microbes with them on the surface.

SPECIAL POINTS

- Nephridia of Earthworm are analogous to kidney of vertebrates .
- Metamorphosis absent in Earthworm.
- Fertilization takes place in cocoon.
- Nephridia are mesodermal in origin.
- Life cycle - 3½ to 10 years.
- Larval stage absent in Earthworm.
- Some earthworm serve intermediate hosts for some parasites such as tapeworm of chicken and long nematode of pigs.
- The nephridia extract H_2O and excretory substance from both blood and coelomic fluid by ultra filtration.
- If the skin of the earthworm dries, it cannot respire. It will then die due to asphyxia.
- The absorptive area of earthworm is more than its volume, so earthworm does not require any respiratory organ.

COCKROACH

CLASSIFICATION

Phylum : **Arthropoda** :**Largest Phylum :** 90% animal out of total animals belong to this phylum
Body Segmented.
Jointed appendages
Blood containing cavity called"Haemocoel"
Exoskeleton made up of chitin

Subphylum : **Mandibulata** : having mandibulate (biting and chewing) type of mouthparts

Class : **Insecta** : Largest class
75% animals included in this class.
Body is distinctly divided into head, thorax and abdomen.
Three pair of legs [Hexapoda]

Subclass : **Pterigota** - Two pairs of wings.

Super order : **Exopterygota** : wings arise externally from body surface.

Order : **Orthropetra**. Wings dissimilar type.

Genus : **Peripleneta** : Body relatively large and flattened, antennae long.

Common cockroaches of India

Peripleneta americana, also known as "Common Cockroach" or "American Cockroach, or Ship cockroach or Bombay canary. *Blatta (Stylopaga) orientalis*. *Blattella germanica* - smallest cockroach. Male Blatta have wings - female wingless. Blatta name - Linnaeus. Periplaneta - "Burmeister"

SPECIAL FEATURES

– Body is dorsoventrally flattened. "Nocturnal Animal". Cursorial animal - fast runner and less capacity of flight (On 25º C Ave. 130 cm/ sec.). Body divided into three parts called "Tegmeta".

3-Tegmeta	**Head**	**Thorax**	**Abdomen**	
Embryo stage	6 segment	3	11	**Total = 20**
Adult stage	1	3	10	**Total 14 segment**

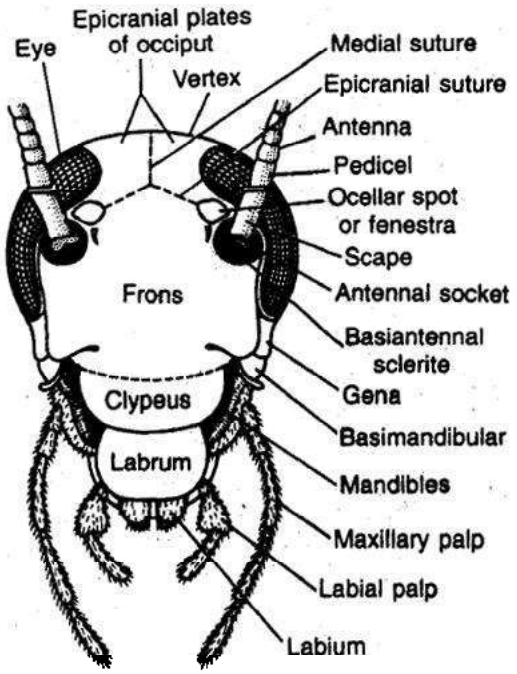
– Exo skeleton made up of chitin plates occured in each segment. Chitin plate called "Sclerites".
– Sclerites join with each other by "Membrane" called "Articular a Arthroidal Membrane."
– Sclerites of dorsal side - tergum or tergite. Sclerites of Ventral side - Sternum or sternite. Sclerites of Lateral side- Pleurons or pleurites.
– Dioecious and oviparous.

MORPHOLOGY

1. Head

– "Hypognathus Condition : Bent downwards at an angle of 90° from the long axis of body.
– Sclerites of the head are join fully and form Head capsule.
– Top part of Head is called "Vertex" and on the vertex a chitin plate is present called as "Occiput".
– An inverted Y-shaped epicranial or medial structure divides the occiput into right and left part called as "Epicranial plates".

– On the lateral side of Head apex, 1 pair of compund eyes are present.
– Each compound eye made up of 2000 units called "Omatidia".
– A small light coloured spot called Fenestra or **Ocellar spot** is located upon dorsal surface close to each eye.
– In insect it function as a **photoreceptor organ**. In Cockroach eyes are inactive and called as "Vestigial simple eye".
– Lateral side of Head apex bear 1 pair of Antennae.
– These are the main receptors of touch, temp, vibration in cockroach.



Anterior View of Head

II segment of Head - Antennae
III segment of Head - Labrum
IV segment of Head - Mandibles
V segment of Head - I Maxillae
VI segment of Head - II Maxillae (Labium)
I segment do not from appendages

Antennae :

– Long filliform, unbranched.Each antenna extending forwards from an antennal socket located dorsally upon head capsule near the compound eye of its side. These are free moving.

Made up of 3-main segments :

[1] Scape [2] Pedicel [3] Flagellum- Several Segment, "Sensory setae"

– A big chitin plate situated below the vertex called frons or Forehead.
– Two long Flattened chitin plates situated on lateral side called "gena" or "Cheeck".
– A big chitin plate present in anterior part of frons called "Clypeus".
– A movable chitin plate joined with anterior part of clypeus known as "Labrum" or "Upper lip".
– A big pore situated in the ventral part of head called "Occipetal Foramen".
– Neck joined with head on the "Occipetal Foramen".
– Occipetal foramen - surrounded by two pair of chitin plate.
  Internal : Post Occiput
  External : Post Gena

Mouth :

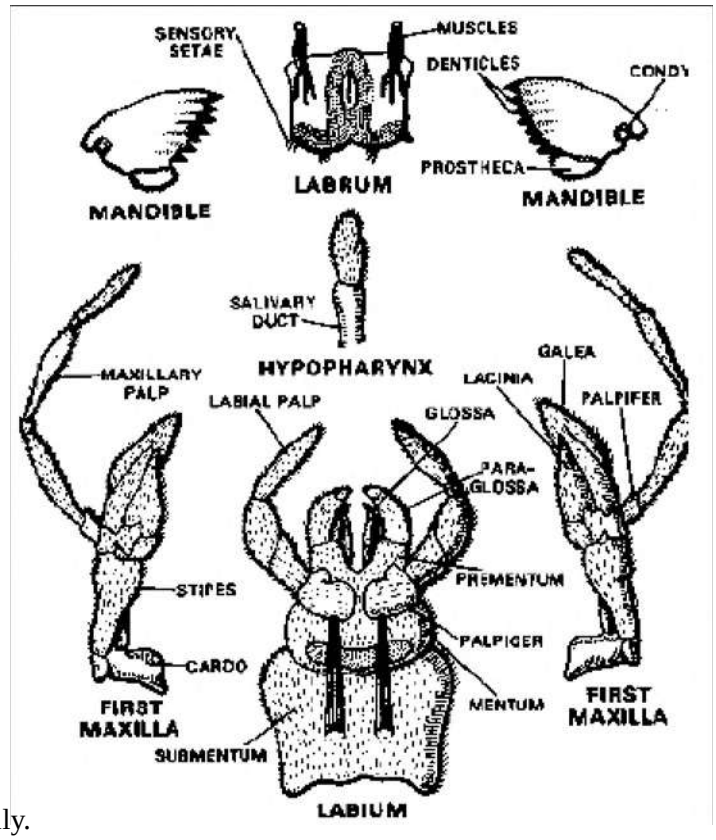
– A mouth situated in the anterior side of head which is surrounded by many chitinous structure called "Mouth Parts".
– Mouth part : According to food habits. "Mouth Parts of Cockroach" : "Bitting and chewing type" .
– A cavity formed due to mouth parts called "Preoral Cavity" or "Cibarium".

[A] Labrum or Upper lip :

– Board and flattened terminal sclerite of the dorsal side of head capsule, moving, articulated to the clypeus.
– It dorsally overhangs the mouth and hence referred to as "Upper lip".
– Several gustatory sensory setae are located on both sides of the Indentation.

[B] Mandibles :

- Jaw. 1-pair of mandibles. They form the lateral wall of preoral cavity.
- Their Margins towards the mouth are serrated in to three large and a few small, strong and pointed teeth like processes called Denticles.
- Horizontal movement occurs in mandibles.
- Abductor and adductor muscle associated with mandibles.
- A soft structure present at base of mandibles called "Prostheca". Prostheca have sensory setae.



[C] First Maxillae : One-pair and form lateral wall of preoral cavity.Three parts.

[a] Protopodite : articulates maxillae with head capsule

[i] Cardo [ii] Stipe

[b] endopodite : Surrounds preoral cavity laterally.

(Lacinia" - inner part : spine attached on free end. It helps in chewing food outer - Galea

[c] Exopodite : "Maxillary palp"

[i] Made up of five segment

[ii] First segment joined on stipe called "Palpifer"

[iii] Setae present on maxillary palp, it is sensory for touch, olfaction and Gustation.

[iv] With the help of maxillary palp cockroach pickup its food and put it in preoral cavity for chewing. Maxillary palps also used as brush to clean antenna and wing.

[D] IInd Maxillae or "Labium" or lower lip :

[i] Form floor of preoral cavity

[ii] Cover Ventral side.

[iii] Made up of three flate chitin plate, i.e. Submentum, Mentum, Prementum.

[iv] All three plates denote "Protopodite".

Three pair of appendages join to form prementum :

- 1-pair - Labial palps - which join to Prementum with the help of chitin peice called "Palpiger".
- These represent "Exopodite". These are 3 segmented structure and have touch, Gustatory, olfactory setae.
- 1-pair glossae- Two segmented structure. 1-pair para Glossa.
- Glossa + para glossa - "**Ligula**". These are "Endopidite". These prevent outwarding of food from pre oral cavity.
- Labium are one pair in embryo stage. Both Labium become fuse in adult stage.

[E] Hypopharynx : or "**Lingua**" **:**

- This is a small, cylindrical mouth part, sandwitch between first maxillae on the sides and covered by Labrum and labium respectively on dorsal and ventral sides.

– It bears several sensory setae at its free end, and the opening of common salivary duct occur upon its basal part (Called Salivarium).

"Neck" - 'Soft Neck". or "Cervicum"

– 8 - chitin plates form exo-skeleton of neck. 2 - tergum, 2 - sternum, 2 pairs - pleurons

2. Thorax :

– Three segemented (Prothorax, Mesothorax, Metathorax).

– Exoskeleton of each segment made up of 4-chitin plate 1-tergum, 1-sternum and one pair pleurone. tergum of thorax - "Notum"

Prothorax	-	Pronotum
Mesothorax	-	Mesonotum Pronotum is "Largest notum" covers neck
Metathorax	-	Metanotum

Legs : One-pair of legs present in each segment of Thorax. 3-pairs of legs (6 legs) legs - five main segment.

[A] Segment - "Coxa" : Broadest segment

[B] Segment - Trochanter : Smallest segment

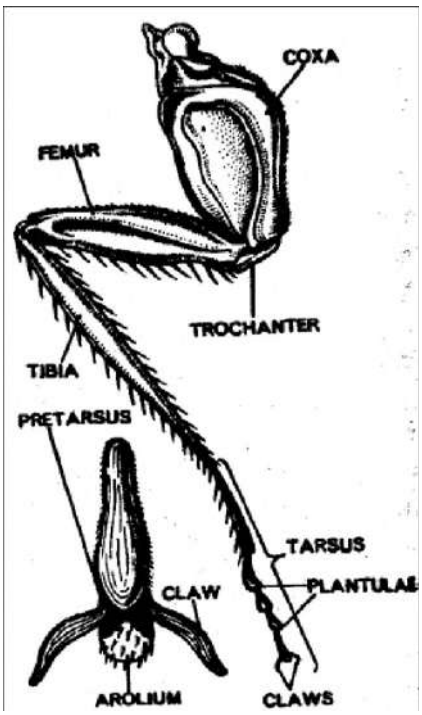
[C] Long segment - femur

[D] Tibia - longest segment

[E] Tarsus - tarsus made up of five subsegments, a piece of chitin on end segment is present called as "Pretarsus" two structure

[i] Arolium or Pulvilus : These are adhesive pads

[ii] One pair claws : Move on the smooth surface by the help of "Arolium" and on rough surface with the help of claws.



In Blatta :

– Arolium is absent. Small pads present in between of tarsus segment called "Plantuli".

– Cockroach climb on the wall by the help of plantuli and Arolium.

– Tactile setae present on each segment of legs.

Wings - 2-pair wing :

[1] Fore wings : Present on mesothorax, these are long, narrow, leathery, strong .

– Fore wings are so long so cover full abdomen, In male these are projecting out ward.

– These are called as Elytra or Tegmina. It helps in protection

[2] Hind wings : Present on Metathorax, these are small, broad, thin, soft.

– These wings helps in flight. Wing originate as evagination of body wall and made up of two layers of cuticle.

– A network of fine tubules called "Nurvures" is present between two layers.

– Haemocoel is filled with haemocoelomic fluid. Tubules communicate with haemocoel which circulates in tubules provide nutrition to the wings.

– After ageing these tubules become dry and provide strongness to wings.

– Two-pair Muscles connected to each wing. 1-pair to tergum, 1-pair to sternum

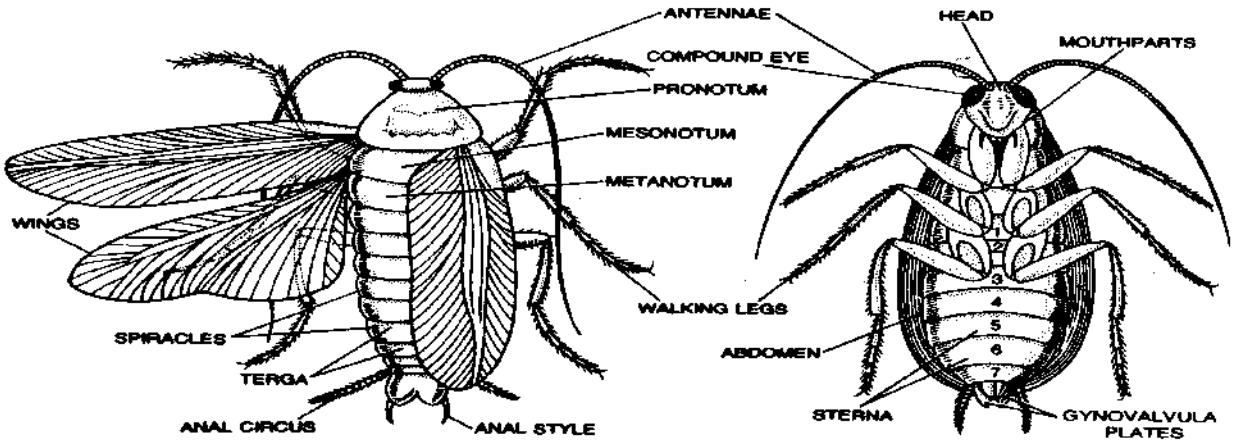
These are called flight muscle. These are not more active in cockroach. i.e.

(1) Tergosternal Muscles (2) Dorsolongi tudinal muscle

(3) Anterior Pleural muscle (4) Basalar Muscle

3 Abdomen : 10 segmented. 9 segment in male. 7 segment in female.

- Remaining segment : "modified and reduced. Each segment of Abdomen having 1- tergum, 1- sternum, 2- pleurons.



(A) Male in dorsal view **(B) Female in ventral view**

- 7th tergum is largest in male and female and covers 8th and 9th terga. 10th tergum - bowl shaped and Bifurcated. From 10th tergum 1 pair - "Anal Cerci" arise. Each "Anal Cerci" - "15 segmented" : These are main sound receptor.
- Sternum - In male - 9 sternum In female - 7 sternum
- One-pairs of spine like structure projected from 9th sternum of male called "Analstyles". These are nonsegmented and help in copulation. 7th sternum of female - special type of Boat shaped. Free end - divided in to two plates
- Plates : "Gynavalvular plates" or "Apical lobs".
- These plates surround a pore called "Ootheca pore".
- All characters of sexual dimorphism in cockroach present in abdomen. Stink gland present in between 5th and 6th tergum, it produce smell - which repel the enemies. Striated muscles occurs in insect.

Endoskeleton :

- Made up of chitin plates called "Apodemes". Apodemes formed from invagination of Sclerites.
- Apodemes : Provide attachment surface to muscles of cockroach.
- 1-Apodem in head - Tentorium (Tentorium - Tent like).
- 3- pairs of arms attached to tentorium. Plate like apodems occure in each segment of thorax. Apodemes absent in Abdomen.

BODY WALL

Made up of three layers :

(i) Outermost - thick cuticle.

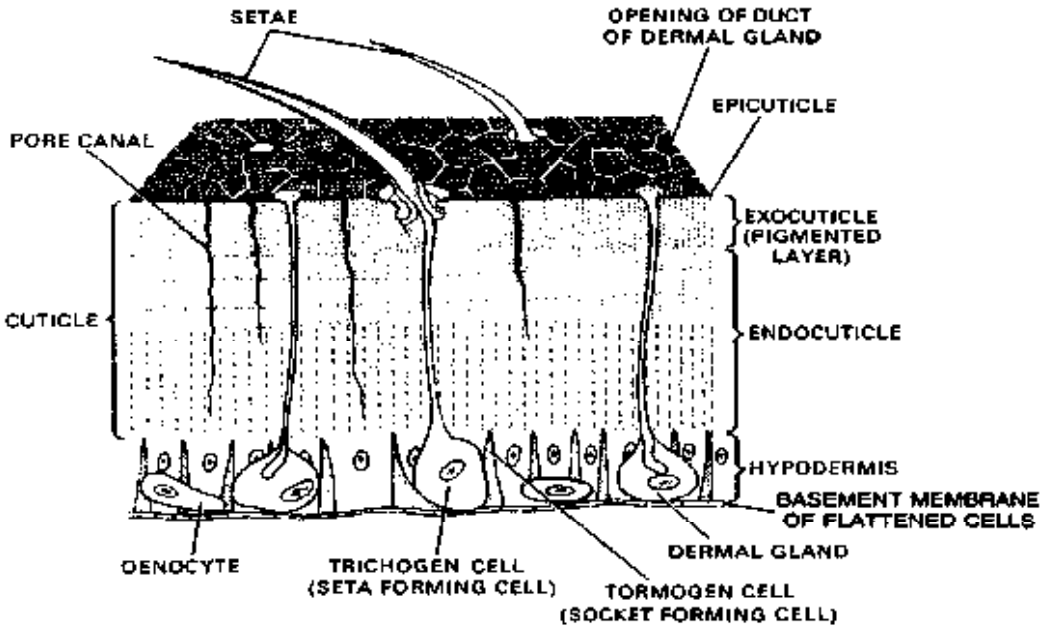
(ii) Hypodermis

(iii) Inner most - basement layer

(i) Outermost cuticle : It differentiated into two parts. Outer - Epicuticle, Inner - Procuticle.

Epicuticle : Chitin - absent, made up of brown scleroprotein. A waxy layer occurs on epicuticle.

Procuticle : Made up of alternate layer of protein and chitin.



T.S. of Body wall

Procuticle : Two parts [a] Outer - thin exocuticle

[b] Inner - thick endocuticle

[a] Exocuticle : Attached with protein, and granules of Quinone and Melanin, dark in colour.

[b] Endocuticle : Melanin and Quinone- absent, light coloured.

– Epicuticle and Exocuticle - Discontinuous, absent in joints of sclerites.

– Endocuticle : Continuous, endocutile become thin in joints and form Articular Membrane.

(ii) Hypodermis (Epidermis) : Made up of columnar epithelium . It contains some special cells.

[i] Dermal gland cell : Secretion of chitinase and proteinase enzyme at the time of moulting. They separate old cuticle from body and secrete new cuticle.

[ii] Trichogen cell : elongated cell and reach up to the epicuticle.

– These secrete "sensory setae" on Epicuticle.

[iii] Tormogen cell : long, cup like cell.

– These cells secrete flexible membrane on the base of setae.

[iv] Neurosensory cell : These situated in the invagination of tormogen cell. One end of Neurosensory cells join setae and other end join with nerves.

– Trichogen + Tormogen + neurosensory cell : All three form sensory unit called "Sensilla".

[v] Oenocytes : Function - uncertain perhaps these secrete wax on epicuticle

(iii) Inner Most Layer : "Basement Layer" – "Simple squamous epithelium."

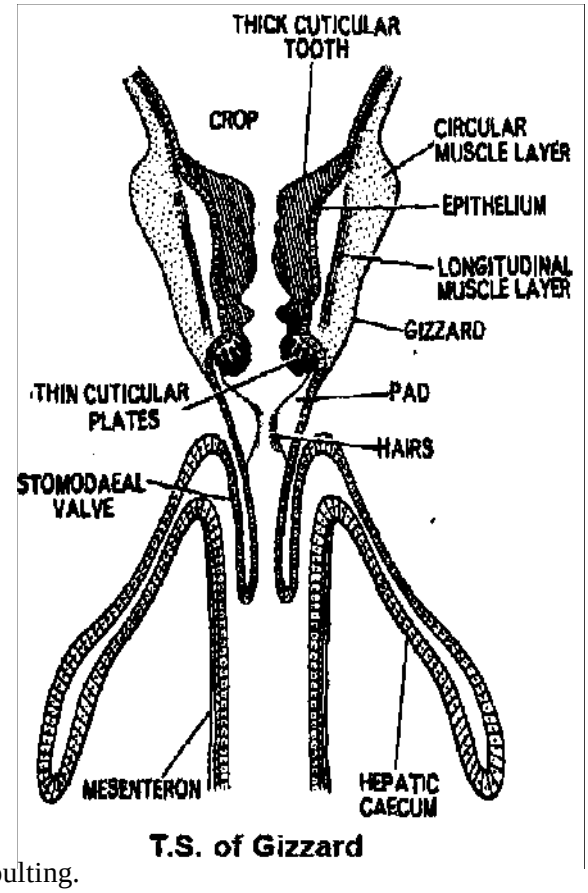
Body cavity :

– Called Heamocoel Blood filled cavity. Blood of cockroach - "Heamolymph". "Blood almost colourless. Blood not related with respiration.

– Trehalose sugar in blood - Disaccharide.

Haemocoel :

- Not true coelom. It is a "large blood sinus".
- In embryo stage several small blood sinuses" fuse and form "Large Blood sinus".
- All arthropods : "True coelomate" But coelom is highly reduced and found only in the form of cavity of Gonads".
- Cavity of Gonads : "True Coelom"
- Large fat body present in Haemocoel of cockroach. Analogous of liver of higher animals



T.S. of Gizzard

Four types of cells are present in fat body :

[i] **Trophocytes :** These store food in the form of glycogen + protein + fats.

[ii] **Mycetocytes :** Presence of "Symbiotic Bacteria".

- These symbiotic bacteria synthesize amino acid and vitamin.
- These change glucose in to glycogen (glycogenesis).
- Possibly "Uric Acid" is converted into protein.
- This reaction is called as "reverseassimilation".

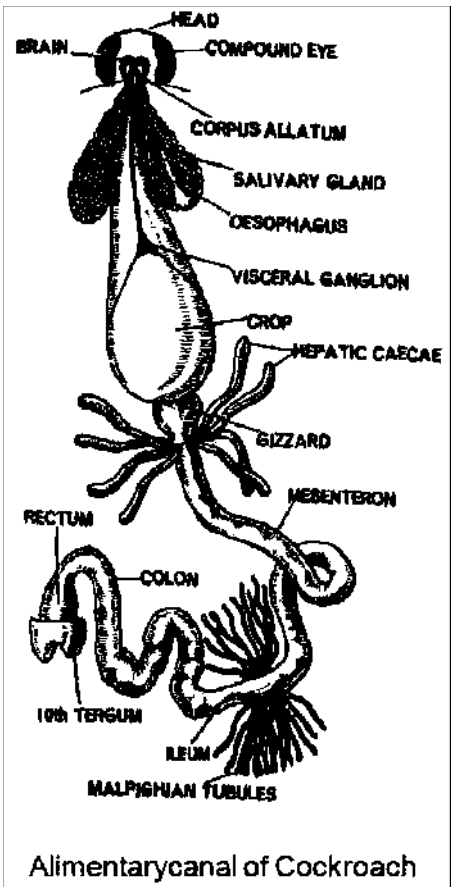
[iii] **Oenocytes :** These cells related with metabolism of moulting.

[iv] **Urate cell :** Absorption of extretory material from heamocoel and storage in the form of "Uric Acid" so called "Storage excretion".

Digestive system : Alimentary canal divided into 3 - parts–

[1] Fore gut (Stomodaeum) : Ectodermal" : Formed by the Invagination of Body wall. Lined with cuticle.

- Fore gut include mouth to gizzard. Mouth open in the small buccal cavity.
- Buccal Cavity - opens in tubular pharynx.
- Pharynx - open near occipetal foramen in "Oesophagus" thro' sphincter.
- Sphincter is present between pharynx and oesophagus.
- In thorax, oesophagus expand and called "Crop". Crop opens into thick walled gizzard.
- Wall of Gizzard - "circular muscle "layer" well developed. Cavity of gizzard called - "Armarium".
- Six cuticular teeth occur in cavity. These made up of longitudinal muscle layer and sharp cuticle.
- Fine grinding of food. Cuticular hairs present in the posterior part of gizzard, these form "sieve".
- Grinding occur in upper part, filteration in lower part.



Alimentarycanal of Cockroach

(2) "Mesenteron" or "Mid gut" (endodermal epithelium) cuticle absent :

Anterior Part - Cardia. Gizzard open in cardia by "stomodial valve".

- Eight small and tubular, finger like blind processes called hepatic caeca, project freely into the haemocoel form the front end of Cardia.
- These secrete "Digestive Juice" . Muscular wall of mesenteron. Inner - circular muscle. Outer - longitudinal muscle, cavity lined by endodermal epithelium.

(3) "Hind gut or Proctodaeum" :

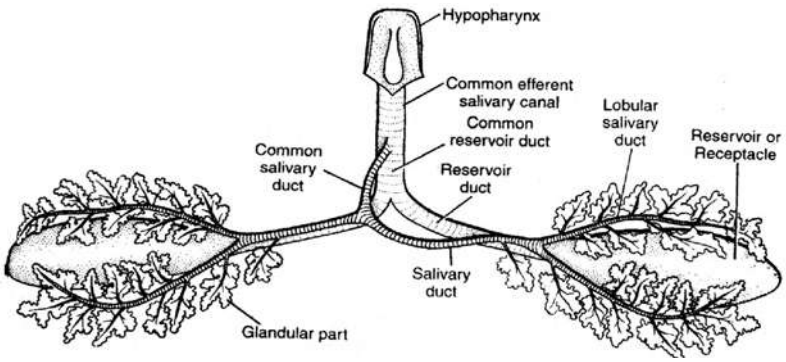
- Ectodermal epithelium is found and lined with cuticle.
- Thin tubules attached at the junction of hind gut and mid gut called "Malphighian tubules" these are excretory organ.
- Hind gut - first part Ileum Its wall is thin and internally folded. Its cuticle bear minute spines which serve to break the peritrophic membrane. Colon - longest and broader part.
- Rectum - last part, oval shaped and internally folded wall. Its wall - 6 folds - called rectal papillae.
- These absorb water. Anus : at the end of 10th abdominal segment. Which is surrounded by 2 plates called podial plates.

Salivary gland :

- 1-pair and attached with oesophagus and present in thorax.
- Two parts of each salivary gland.

[1] Reservoir part : Cylindrical and storage of saliva.

[2] Glandular part : Leaf like and Bifurcated. Synthesis of saliva occurs in this part, each part have separate tubules.



Salivary gland of cockroach

Reservoir duct	**and**	**Glandular duct**
Reservoir duct of both side fused to form "common reservoir duct"		glandular duct of both side fused to form "common glandular duct"

- Both common ducts fuse to forms efferent salivary duct.
- This duct open in preoral cavity at base of hypopharynx.
- Rings of cuticle occur in wall of duct of salivary gland.
- Which prevents these tubules from collapsing.

Saliva : "Carbohydarate-digestive enzymes". ex. Amylase, chitinase cellulase.

Food "Omnivorous" : Bread, food grain, vegetable, wood, clothes, Insects (dead), Nymph, moulted Exoskeleton. Identification of food by the help of Antenna.

Digestion : Most of the food digest in crop. Start from preoral cavity.

Saliva : Enzymes of saliva act upon the food till it reaches the crops. Digestion of carbohydrate takes place.

In crop : Heaptic caeca - Complete digestive juice reaches in crop through the gizzard.

Gizzard : Food throughly grinded in to a paste by the thick and sharp edged cuticle of internal folds and grooves.

– Grinded food enter in to the midgut through stomodial valve.

Wall of Cardia :

– A membrane secreted around the food called peritrophic membrane.
– It is made up of Glycogen + Protein. It serves to protect the wall of midgut from friction with food particles.
– This membrane is permeable to digestive enzyme and digestive food.
– Undigested food with peritrophic membrane enter into the Ileum.
– Spine which is present in the wall of ileum- break the peritrophic membrane, so undigested substance free in Ileum, Digestion completed in the anterior part of midgut.
– Absorpiton of digested food occurs in the posterior part of mid gut.
– Maximum absorption of H_2O occur in rectum by rectal papilla.
– Distribution of Digested food : By "Heamocoelomic fluid"

Respiratory system :

– Respiratory organ - "Respiratory tubules".
– Network of respiratory tubules found in the body.
– This network open out side the body by the spiracles".

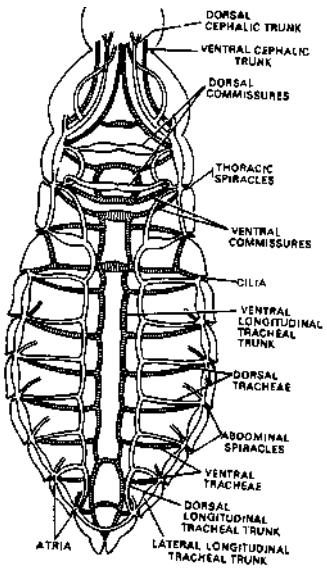
10-pair spiracles/stigmata :

2-pair on thorax : 1 pair between prothorax and mesothorax, 1 pair between mesothorax and metathorax

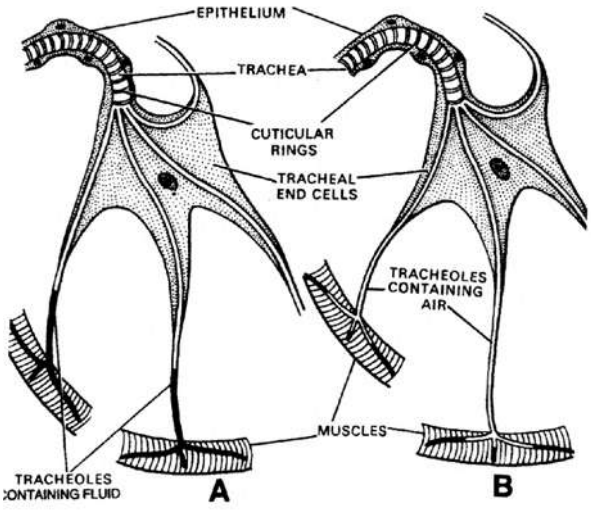
8-pair on Abdomen, on first 8 abdominal segment.

All spiracles **:** Present on "Pleurone"

– First pair of spiracle of abdomen situated on lateral side of "tergum".
– Each spiracles surrounded by a ring shaped sclerites called "Peritreme".
– Each spiracle is guarded by a valve and bears cilia like bristles for filtering the incoming air.
– Valve absent in 1-pair spiracles of thorax and abdomen both.
– Each spiracles open into chamber called "Atrium" or tracheal chamber.
– The tracheal chambers are connected with several main tracheal trunks which repeatedly branch in to a diffuse network of small trachea.



Respiratory Tubules of cock



Tracheoles

- Last branches of trachea called "Tracheal Capillaries" or "tracheoles" Tracheal capillaries - "**Intra - cellular**". Tracheal capillaris closed in a cell called as "Tracheal end cell".
- Long process found in tracheal end cell.
- These process deeply merge in tissues of body.
- Each cell of body is directly in contact with processes Blood not related with respiration.
- In Blood respiratory pigment absent.
- During day time - cockroach is less active so osmotic pressure of tissue fluid - low.
- Tissue fluid rises in to tracheoles. Exchange of gases occur during day time by the tissue fluid.
- Cockroach is more active in night so O.P. of tissue fluid is high so, tissue fluid do not enter into tracheoles.
- Direct exchange of gases take place.

HISTOLOGY

Respiratory Tubules :

- Ectodermal cuticle on inner side and ectodermal epithelium lines outerside of wall.
- Spiral rings of chitin occur in the wall of respiratory tubules.
- They prevent collapsing of wall. Spiral rings also called as "Tenidia".
- Spiral rings absent in tracheal capillaries.
- There are 6 longitudinal tracheal tubes, 2 dorsal, 2 ventral and 2 lateral which are interconnected by transverse commissure.

Breathing :

- Several tergo - sternal muscles extend between the tergites and sternites of all abdominal segments.
- When the abdomen expands, atmospheric air gets filled in the tracheal system through spiracles.
- This is Inspiration. When the abdomen contracts, the air is forced out.
- This is Expiration. Expiration take place through first pairs of spiracles of thorax.
- The spiracular valves control and regulate the in and out passages of the air and abdomen.
- The cuticle of cockroach is very permeable to CO_2, but not to O_2. Most of the CO_2 diffuse out side from body wall, rest CO_2 go out through spiracles.

Blood Vascular System

- "Open types" or "Lacunar types" blood filled in blood sinuses.
- True blood vessel - absent. Largest blood sinus - "Haemocoel". Blood of cockroach - "Haemolymph". Colourless - plasma Blood corpuscles (Haematocytes)

Haematocytes : Function :

(i) Phagocytosis of Bacteria

[ii] Related with blood clotting.

Blood - Function :

(i) Not related with respiration because respiratory pigment is absent.

(ii) It works as "Hydrolic Skeleton".

(iii) Exchange of food, hormones and excretory materials.

Two horizontal septa :

(1) Dorsal diaphragm

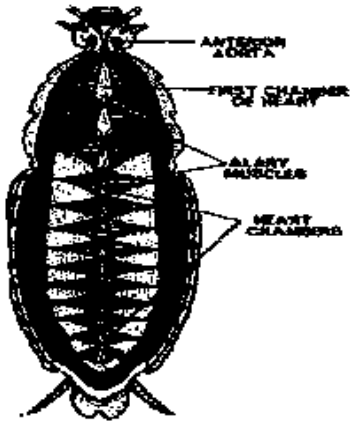
(2) Ventral diaphragm - these have pores called "Fenestrae"

Diaphragms divide the haemocoel in three chambers i.e.

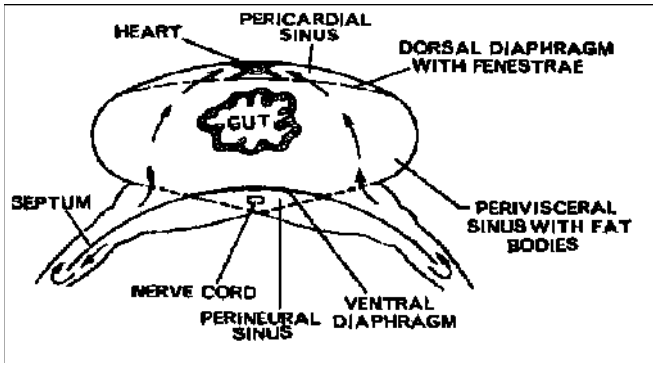
(1) P.C.S. have heart in Dorsal part (Peri cardial sinus)

(2) Middle sinus - P. Visceral sinus it have alimentary canal and fat body.

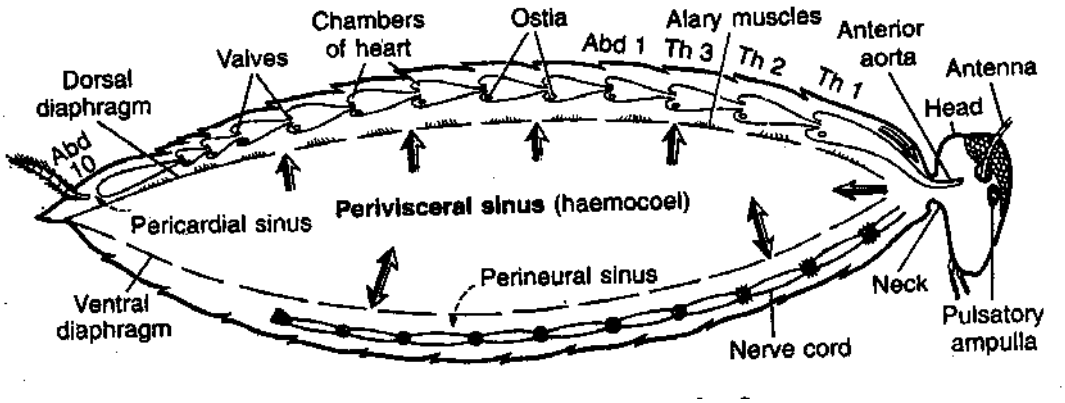
(3) Ventral Chamber - Perineural sinus have nerve cord.



Alarymuscles



T.S. of thoracic segment



Circulation of blood (L.S.)

Heart of Cockroach :

- Divided in to 13 chamber. Chamber - inverted funnel like.
- Each chamber connected with P.C.S. by 1-pair of pores, called "Ostia".
- These pores act as valve. Blood enters from P.C. Sinus to heart through Ostia.
- Each posterior chamber of Heart connected with anterior chamber by a valve like pore.
- These pore help in flow of blood from posterior to anterior part.
- Heart wall is two layered - Outer layer-Fibrous connective tissue, Inner layer- Muscular.
- Special type of cells attached with heart wall called "Nephrocytes".

Functions of nephrocytes :

(i) These control Heart beat. **Heart Beat - 49 heartbeat/minute**

(ii) "Storage excretion" storage of excretory substance in the form of "uric Acid.

Blood vessels :

- First chamber of heart in the form of long tubule called "Anterior Aorta" It opens into head sinus. Beside Anterior Aorta.
- Second blood vessel arises from heart chamber of mesothorax and 3-6 from heart chamber of abdominal segments. These are not true blood vessels because

- (a) These are not divided into capillaries
- (b) Having open ends. 13-pair fan like muscles present in P.C.S. called Alary Muscles.
- One end which is pointed is attached to tergum and other end is broad - connected to dorsal diaphragm.
- These also fused with heart wall these help in "Blood circulation".
- Tergosternal muscle also help in blood circulation mainly these concerned with respiration. "Pulsatile Ampulla" present at base of each Antennae and base of each wing.
- Pulsatile Ampulla help in blood circulation in Antenna and wings.

Passage of B. circulation :

- From P.V.S. blood goes to paricardial sinus and then by ostia blood enter into heart (in Diastole).
- Systole phase - when the heart is filled, it contracts from behind to forwards and blood enters in head sinus by Anterior Aorta.
- From Head sinus $\rightarrow$ In neck $\rightarrow$ "P.N. Sinus". Oesophagus prevents flow of blood into P.V. sinus.
- Two path of blood flow from P.N.S. to P.V.S.
  [a] By fenestrae
  [b] Through legs
- A vertical septa present in cavity of legs, these septa divide cavity of legs in two chamber :

Dorsal chamber - Connected with p. visceral sinus

Ventral Chamber - Connected with P. Neural sinus

Excretory System :

- Main excretory organ - Malpighian tubules.
- These associated with Alimentary canal at the junction of midgut and hind gut. 90-tubules (60-120).
- Arrange in group of six to eight and each group have 15 tubules.
- These are"Ectodermal". **Two parts of malpighian tubule :**
  [a] Proximal Part - absorptive part
  [b] Distal Part - secretory part
- Wall - cuboidal epithelium with Brush border of microvilli Outer Coating of a membrane made up of fibrous connective tissue and muscles.
- Pulsation due to muscle, 5-15 pulsation/minute.
- Excretory substance enter in to alimentary canal by pulsation.
- Distal part of malpighi tubules collects excretory substance from Heamocoel.
- Excretory substance mainly in the form of "potassium urate".
- Potassium urate converted into "Uric Acid" and potassium bicarbonate by the cells of cuboidal epithelium.
- They secrete these substances into cavity of malpighian tubules.
- Reabsorption process occurs in proximal part.
- All essential materials absorbed and return into heamocoel.
- Water absorbed by alimentary canal and excretory materials along with undigested substances excreted outside.
- Malpighian tubules are enteronephric and help in Osmoregulation Storage excretion
  [i] Urate cell
  [ii] Nephrocytes
  [iii] Body wall

– Absorbs excretory materials from Haemocoel and store in cuticle.
– Then at the time of moulting excretory substances and cuticle separate out from body.

[iv] Uricose glands - These help in excretion in male cockroach.

Nervous System :

Three types of nervous system.

[1] Central Nervous system :

[i] Brain ring :

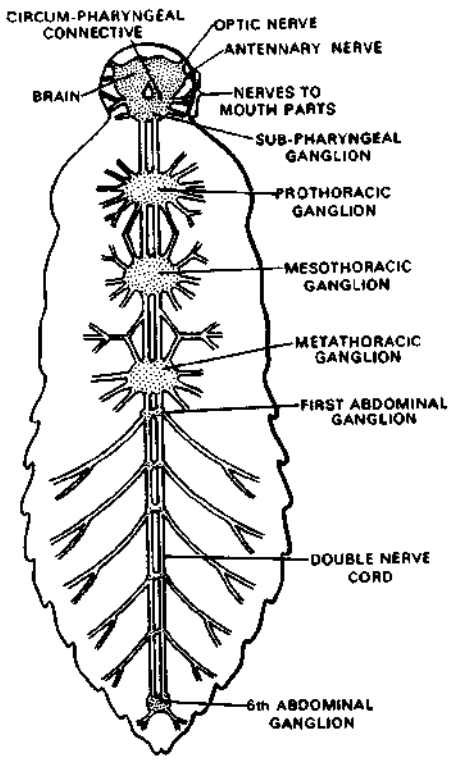
– It is located in the head around the pharynx, just in front of tentorium.
– Its dorsal part is a thick and bilobed supraoesophageal ganglion or "Cerebral ganglion" formed by fusion of three pairs of cephalic ganglia.
– 3 pairs of ganglia are -
  [a] Protocerebrum
  [b] Deutrocerebrum
  [c] Tritocerebrum
– Sub-oesophageal ganglion on ventral side of alimentary canal.
– Sub oesophageal ganglion formed by the fusion of three pairs of ganglia.
– Both ganglia connected to each other by circumoesophageal connective.

[ii] Ventral Nerve Cord :

– Double solid and ladder like.
– Nerve cord have nine segmental ganglia. i.e. There are There large ganglia in thorax and six in abdomen.
– Last ganglion is located in 7th abdominal segment.
– All ganglia formed in embryo stage by the fussion of 2-ganglia. last segmental ganglion formed by fusion of many ganglia.

[2] Peripheral Nervous System :

– 3-pair of nerves comes out from cerebral ganglion.
– 1-pair from protocerebrum - supply - compound eye.
– 1-pair deutocerebrum - in antennae.
– 1-pair tritocrebrum - in labrum.
– Three pairs of nerves connect the suboesophageal ganglion with mandibles, maxillae and labium and other parts of the head and neck.
– Six pairs of nerves from prothoracic ganglion and five pairs from each of the mesothoracic and metathoracic ganglia innervate different parts of their respective segments.
– A single pair of nerves arises from each of the first five abdominal ganglia to innervate muscles, spiracles, heart chambers and other partrs in their respective segments.
– From the last abdominal ganglion three pairs of nerve arise.
– All nerves - mixed nerves, motor nerve, sensory nerve.



(3) "Autonomous System" : It is divisible into three parts :

[i] Stomogastric Nervous System : This includes the following five ganglia and the nerves arising from these to innervate the anterior part of gut as follows.

– This system regulates involuntary activity of foregut.

[a] Frontal ganglion :

– This is a small median ganglion located dorsally upon the pharynx just in front of brain to which it is connected by a pair of short and thick frontal connectives.

[b] Hypocerebral ganglion :

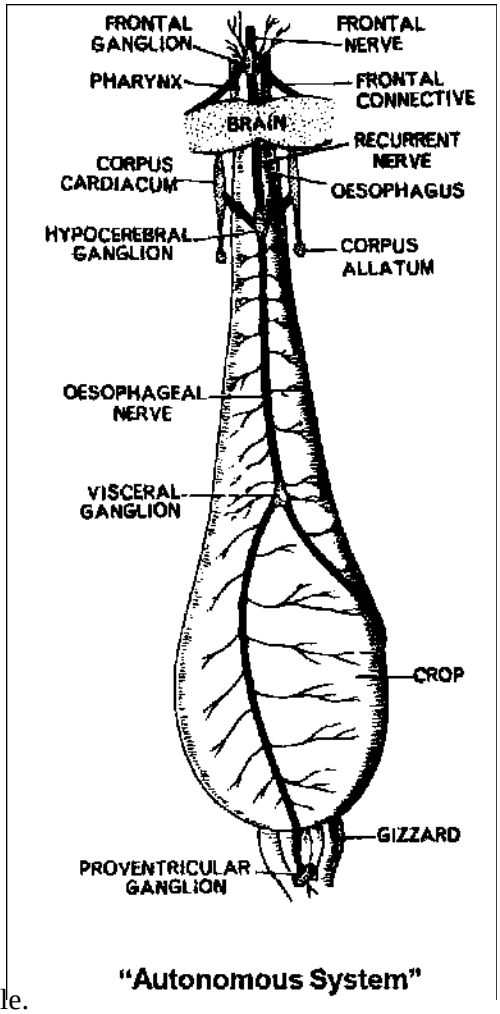
– This is also a small median ganglion located dorsally upon oesophagus behind the brain.

– It is connected in front with the frontal ganglion by means of a thick recurrent nerve.

– It is also connected, by means of two pairs of fine connectives, with two pairs of adjacent endocrine glands.

– Glands named - (i) corpra allata
(ii) Corpora Cardiaca

– All three form "Retrocerebral Complex" (Hypocerebral ganglion + corpora Cardiaca and Corpora Allata)



"Autonomous System"

[c] Visceral ganglion :

– This is located mid-dorsally upon the crop at about its middle.

– A thick oesophageal nerve connectes it with hypocerebral ganglion.

– In front several fine branches of the oesophageal nerve innervate the salivary glands.

[d] Proventricular ganglia (Last ganglia) :

– These are two small ganglia, one upon dorsal and the other upon ventral surface of gizzard.

– Each of these is connected with visceral ganglion by means of a long and thick viscreral nerve.

– These regulate the activity of forgut as of "Peristalsis".

[ii] Spiracular Nervous System :

– These control the activities of spiracles.

– A nerve plexus found around the each spiracle.

– These conected with segmental ganglia of nerve chord.

– These regulate the activity of spiracle.

[iii] Caudal Nervous System :

– Regulate the activity of hindgut, gonads and abdominal appendages.

– This nervous system formed by the last segmental ganglion of nerve chord. (7^{th}).

– This includes certain fine nerves that arise from the last abdominal ganglion and innervate various parts.

Endocrine glands :

[i] Inter cerebral endocrine cells :

– These cell found in cerebral ganglia and secrete brain harmone.

– It regulates the activity of prothoracic gland.

[ii] Corpora Cardiaca :

- It secrete growth hormone in childhood to control the growth of nymph.
- In adult stage these gland regulate heart beat.

[iii] Corpora - Allata :

- These glands secrete Juvenile hormone - "**Neotinin**" in childhood stage.
- Neotinin regulates the growth and differentiation of tissues, preventing untimely moulting and metamorphosis.
- These glands secrete "Gonadotropic" harmone in adult stage - It regulates the activity of reproductive organs.

[iv] Prothoracic Gland :

- Found only in Nymph stage. Secretion of Ecdysone harmone (Moulting harmone) in nymph - this hormone induce moulting.

Sense organs : Receptors cells are present on general body surface.

[1] **Proprioceptors** → For receiving vibration, present on maxillary palp and joints of leg.

[2] **Auditory receptors** → For hearing, present on antennae and anal cerci.

[3] **Thigmoreceptors** → For touch, present on body surface, antennae, maxillary palp and legs.

[4] **Olfactory receptors** → For smell, present on antenna and palp.

[5] **Gustatory** → For taste, present on maxillae, labrum, mandible and hypopharynx.

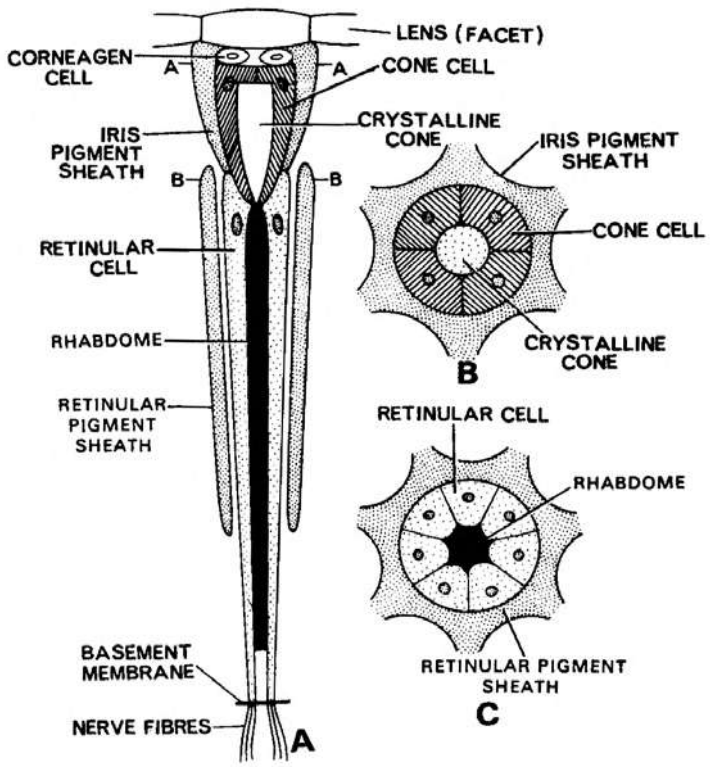
[6] **Thermoreceptor** → For temperature, present on antennae.

[7] **Photoreceptors** → For light and present at the base of antennae and compound eye.

Compound Eyes : Compound eye made up of 2000 units called "Omatidia". Each omatidia having 2 parts.

(1) **Dioptric** - upto cone cell

(2) **Receptive** - Rhabdome and retinal cell together form receptive part.



T.S. of Compound Eyes

- Outer Part of omatidia - hexagonal lens or "Corneal Lens" which is formed of transparant cuticle.
- Just beneath each lens 2 small cells called "Corneagen cells" are present.
- These secrete lens. At the time of moulting, lens also shed from body so cockroach becomes blind for some time.
- Corneagen cell - secretion of a new lens.
- Beneath these cells is a crystalline cone formed by four surrounding conical cells (-vitrella or cone cells). Crystalline cone - Serves as an accessory lens.
- Part of omatidia up to cone cell known as dioptric part or focussing part.
- Beneath the crystalline cone there is a circle of seven cells called "Retinular cells".
- The inner border of each retinular cell bears microvilli.
- The microvilli of the seven rhabdomeres interdigitate to form a long narrow refractile structure called "rhabdome". Image formed on Rhabdom.
- Region of retinular cells is called receptor region. A nerve fibres arise from each retinular cell.
- All nerve fibers of a compound eye together form "Optic Nerve".
- These nerves supply protocerebrum of cerebral ganglion.
- Omatidium surrounded by a "Pigmented sheath" Two Parts Upper part - Irish pigment sheath lower part- Retinular pigment sheath.
- Pigment sheath seperate omatidia from each other.
- These prevent the light rays entering into one ommatidium from crossing over to the adjacent ommatidia.

Mechanism : Two types of vision

[1] Apposition or Mosaic vision :

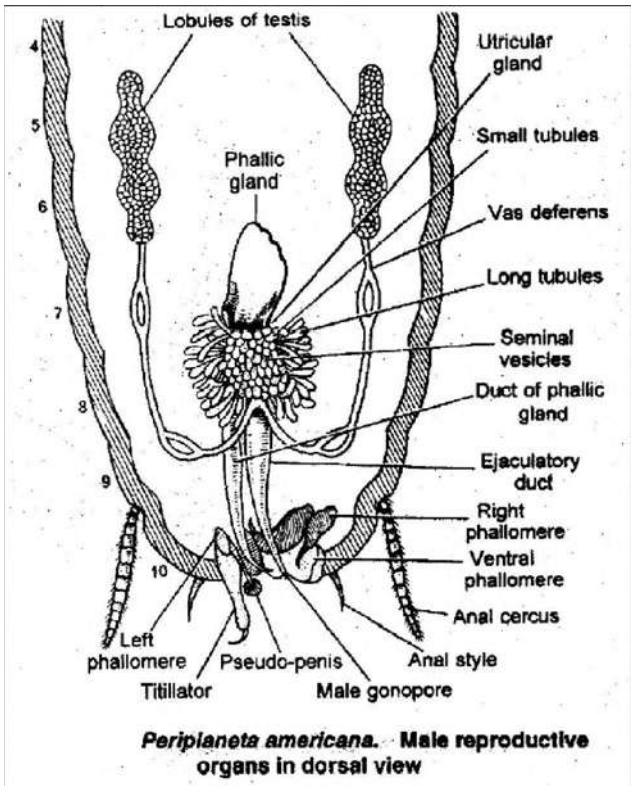
- Apposition vision form in bright light.
- Omatidia fully covered by pigmented membrane.
- The light rays reflected from an object enter in to a number of Omatidia.
- An oblique light ray, that enters into the focussing part of an ommatidium, strikes against its pigment sheath and becomes absorbed.
- A straight light ray that enters into an ommatidium on the other hand reaches into its receptor region and forms the image of corresponding part of the object.
- Thus all the straight light rays entering into an eye from an object form separate images of different parts of the object in the different Ommatidia.
- The totality of these small image is, however, a compund image of the whole object such an image is called apposition image, it is clear and detailed

[2] Superposition image :

- In dim light in nocturnal insect.
- In the night, the pigment sheath of ommatidia contracts and shrinks to thier bases, hence the light rays can easily cross over from one ommatidium to adjacent ommatidia.
- Complete images are formed in all ommatidia.
- This results in the formation of blurred superpostion of the objects.
- In cockroach only apposition image formed (day and night).
- No contraction power in pigmented sheath.

Reproductive System : Cockroach - "Unisexual"

Male reproduction system :



Periplaneta americana. **Male reproductive organs in dorsal view**

- 1-pair of testis in "3-6" abdominal segment. Each testis formed of "3 to 4 lobes". each lobe divided into many lobules.
- Vasa deferentia 1 pair, U shaped - A vesadeferense arise from each testis these open in an ejaculatory duct.
- Ejaculatory duct from 7^{th} – 9^{th} segment open outside by male genital pore. Seminal vesicle form of vesicles located upon ejaculatory duct.
- A gland associated with seminal vesicles called **Mushroom gland** or **Ultricular gland** having two types of tubules.
- Small tubules on inner side-utriculi brevivores. Large tubules outside - utriculi majores Tips of long tubules called "Uricose gland" These absorb excretory material from haemocoel.
- A gland located on mushroom gland called **phallic gland** or **conglobate gland present** on 6^{th} abdominal segment. It opens out side by a long duct "Phallic aperture.
- Chitinous structures associated with phallic apperture and male genital pore called "Phellomeres" or Gonapophysis."

3 phellomeres :

[i] Left Phellomere [ii] Right phellomere [iii] Ventralphellomere

- Phallic aperture present on left phellomere.
- Male genital pore situated on Ventral phellomers.

[1] **Left phellomers :**

[i] Made up of a flate chitinous plate

[ii] Four types of lobes attached with it

- Lower most lobe titilator, with a hooks on tips. "Pseudopenis" - long with bulbow apex.
- Asperate lobe -lobe of spiny surface, phallic duct opens at the base of asperate lobe Innermost lobe - "Acutolobe - with a hook.

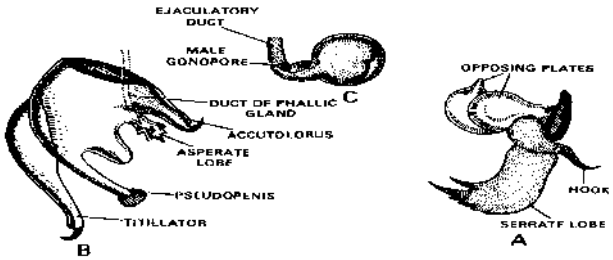
[2] **Right phellomers :** Two lobes

[a] Upper lobe2-"Opposing plate"

[b] Lower lobe Serrate lobe"

- Two large hooks present at apex of serrate lobe.
- A hook present on base of serrate lobe.

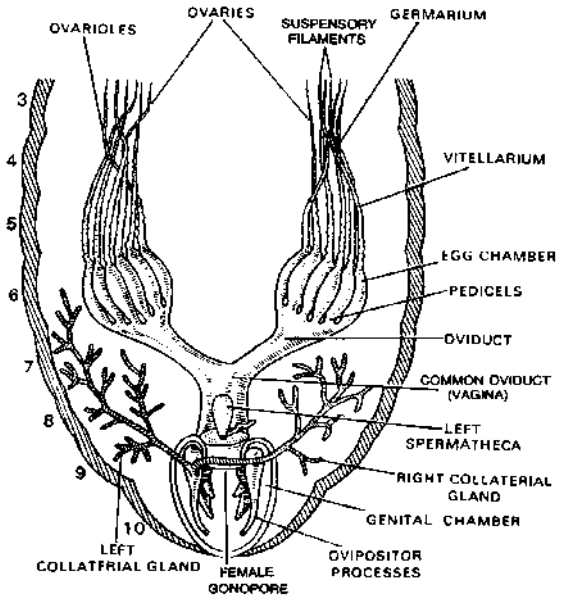
[3] **Ventral - phellomeres :**



(A) Ventral (B) Left (C) Right

- Simplest and formed of a flate chitinous plate Hooks absent.
- Hooks are help to opening of oothecapore of female. Phellomeres : "External genital organ"
- **Spermatogenesis** "Completed in testis". **Seminal Vesicle** - Store the sperms. All sperms glue together to form a ball called "sperm Ball".
- Long tubules secrete a memberane around sperm ball called spermatophore
- Small tubules - secrete a nutritive fluid in spermatophore.
- At the time of copulation spermatophore enters into ejaculatory duct.
- Ejaculaotry duct secrete another coat on spermatophore.
- Spermatophore - "Double layered". When they go out side from male genital pore then phallic gland secrete another layer so spermatophore become three layered.

FEMALE REPORDUCTIVE SYSTEM



Female reporductive organ

- 1-pair of ovary situated in "2 to 6 segment of abdomen". Each ovary made up of 8-long tubules called "Ovarioles".
- Each ovariole differentiated into five parts.
- Upper most part : "Syncytical filament which is made up of multinucleate cytoplasm. These filaments suspend ovarioles to dorsal body wall.
- "Germarium" : It contain oogonia"
- "Vitellarium - "Beaded" due to growing oocytes".
- Egg chamber - each egg chamber have mature ovum. At a time 16 ova are matured.
- "Pedicel" - arrow and contracted and these help in retaining ovum in egg chamber. All pedicel of a ovary joined to form a small oviduct. Both oviduct fuse and form 'Vagina".
- Vagina - vagina opens inside body in a genital chamber.
- Genital chamber - formation of genital chamber by the fusion of 3 abdominal sternum,
- 7th sternum - forms the floor of genital chamber.
- 8th and 9th sterum - become telescoped inwards to form the roof and sides of this pouch, the pouch itself is divisible into a genital chamber in front and oothecal chamber behind.

- A pair of "Spermatheca" associated with gential chamber. Spermatheca unequal in size. Both spermatheca open by a pore in gential chamber.
- A plategorm in genital chamber just beneath spermatheca pore called "Spermatheca Papilla". 1-pair of collaterial glands associated with genital chamber.
- These are branched tubular gland's. Left collaterial gland = More branched. Both glands open in genital chamber by a common pore.
- Three pairs of chitinous porcesses hanging from the roof of genital chamber into its cavity are the external ganitalia of female cockroach.
- These are called ovipositor porcesses because these serve to arrange the ova in a newly forming ootheca, and possibly help in giving proper shape to the oothecae.

COPULATION

- "Breeding season : from march to september. The females secrete a highly odorous and volatile "Sex attracting scent from their scent glands called pheromones or ectohormones.
- Male perceive the smell of this scent with the help of olfactory sensillae located upon their antennae.
- Male cockroach opens the ootheca pore with the help of hooks.
- The male insert whole of its phallomeres into the female's genital pouch. Then it inserts its pseudopenis into the female gonopore for firm anchorage.
- In this position male genital pore situated on spermathecal papilla.
- Discharge spermatophore by male genital pore upon the spermathecal papilla of female.
- After that the secretion of its phallic gland upon the spermatophore occurs. Copulation time $\Rightarrow$ one hour
- The spermatophore remains plastered to the spermathecal papilla of female for about 20 hours. During this period all its sperms escape out and fill in the two spermathecae of the female. Then the female drops out the case of empty spermatophore.
- Sixten ova, one from each ovariole of the two ovaries, are discharged at a time into the genital pouch where these are arranged by the gonapophyses into parallel row.
- Simultaneously, sperms stored in the spermathecae are also discharged into the genital pouch to fertilize the ova.

FERTILIZATION

- "Inernal Fertilization".
- After fertilization the left collaterial gland secretes a soluble "milky protien" while the right one secrete dihydroxyphenol.
- Both secretions mix to form a brownish scleroprotein.
- Scleroprotien forms a common egg. case, called ootheca.
- Formation time-24 hours.
- One end of ootheca like a saw and these close the mouth of ootheca.
- The female deposits it in some dark and dry place.

DEVELOPMENT

- 1-female form 15-40 ootcheca in life time. Development of egg inside ootheca.
- Ootheca are adaptation of terresterial life to prevent the "Water loose".
- Developement time -"4 to 8" weeks. Juvenile stage inside ootheca called "Nymph".

- Nymph appear like adult except for wings and reporductive organs.
- Nymph changed into adult in -1 year. During metamorphosis -7 to 12 times moulting occurs.
- Average -10 times moulting. Time interval between two moulting called "stadium. 6 - 11 stadium.
- Between two moulting nymph is called as "Instar" Adult insect called Imago". "Cleavage" = "superficial mroblastic".
- Gastrulation - "Poly Invagination" or "ingression"
- Egg - "Megalecithal" and "Centrolecithal".

SPECIAL POINTS

1. Parental Care donot found in Cockroach
2. Cannibalism - if food is not available then own species eaten as food.
2. Cockroach word - originated from spainy word "Cucaracha"
3. Cockroach belong to Tropical climate of Africa
4. Cockroach (Periplaneta) - on 25°C run 130 cm/sec.
5. Cockroach Chromosome no. = 34
6. Cilia absent
7. Abdomen without appandages except for anal cerci
8. Mosaic vision found in diurnal insect except for cockroach
9. The first animal to fly were insect
10. Metamorphosis – **"Incomplete or paurometabolus"** . In Insect which have larva stage have complete or holometabolous metamorphosis.

EXERCISE - 1

AMOEBA

Q.1 Amoeba was first discovered by-
(1) Rosel von rosenholf (2) Hirschfield
(3) Doyle (4) Mast and Schneider

Q.2 In Amoeba uroid is
(1) Posterior end
(2) Wrinkled plasmamembrane
(3) Definite polarity (4) All of the above

Q.3 In *Entamoeba histolytica* encystment takes place by action of-
(1) Trypsin (2) Zymase
(3) Pepsin (4) Amylase

Q.4 The streaming movement of endoplasm is called-
(1) Cyclosis (2) Endosmosis
(3) Sol-gel theory (4) None of the above

Q.5 Amoeba belong to-
(1) Sub class Rhizopoda
(2) Class sarcodina
(3) Order lobosa/Amoebia
(4) All of the above

Q.6 How many Pseudopodia present in *Entamoeba histolytica* is-
(1) One (2) Two
(3) Many (4) Five

Q.7 Hyalin cap formed by-
(1) Ectoplasm (2) Endoplasm
(3) Pseudopodia (4) Nucleus

Q.8 Rejuvenation process, immortality and regeneration power found in-
(1) Amoeba (2) Plasmodium
(3) Earthworm (4) All of the above

Q.9 Cyst of Amoeba is-
(1) Trilayered
(2) Made up of chitin
(3) Permeable for gases
(4) All of the above

Q.10 Endosmosis in Amoeba takes place because outer medium is-
(1) Hypertonic (2) Hypotonic
(3) Isotonic (4) Colloid

PLASMODIUM

Q.11 King of fever is called-
(1) Malaria (2) Filaria
(3) Viral (4) Both 1 and 3

Q.12 Maurer's dots related with-
(1) Plasmodium vivax
(2) Plasmodium falsiparum
(3) Plasmodium ovale
(4) Plasmodium malarie

Q.13 Antidose of malaria is-
(1) Paludrine (2) Plasmoquin
(3) Fencidor (4) All

Q.14 The plasmodium can not be detected in blood during-
(1) Incubation period (2) Prepatent period
(3) Erythrocytic cycle
(4) Exoerythrocytic cycle

Q.15 Plasmodium cause thrombosis in human beings-
(1) *Plasmodium vivax*
(2) *Plasmodium falciparum*
(3) *Plasmodium malariae*
(4) *Plasmodium ovale*

Q.16 Shuffner dots are absent in-
(1) *Plasmodium falciparum*
(2) *Plasmodium ovale*
(3) *Plasmodium vivax*
(4) None of the above

Q.17 "Megaly" of spleen during malarial infection is due to-
(1) Plasmodium infection
(2) Increased number of phagocytes
(3) More blood circulation
(4) Disintegration of its cells

Q.18 In man Plasmodium is mainly-
(1) Coelozoic (2) Histozoic
(3) Cytozioc (4) Neutrozoic

Q.19 Quinine can kill Plasmodium in-
(1) Blood (2) Liver
(3) Muscle (4) Heart

Q.20 Fever occurs in which stage-
(1) Rigor (2) Febrile
(3) Defervescent (4) All

Q.21 "Malaria" name is given by-
(1) Macculoch (2) Ronald Ross
(3) Lancisi (4) Laveran

Q.22 Gametocytstes of Plasmodium are found in abundance
(1) Peripheral Blood vssels
(2) Hepatic B.V.
(3) Peptic B.V. (4) Coronary B.V.

Q.23 Adult stage of Plasmodium is found in-
(1) RBC (2) Liver cell
(3) Crop wall (4) Salivary gland

Q.24 One hundred microgametocytes of Plasmodium will produce how many sperms-
(1) 400 (2) 800
(3) 1600 (4) 3200

HYDRA

Q.25 Symbiotic algae in Hydra is-
(1) Extra-cellular (2) Intra-cellular
(3) Inter cellular (4) None of the above

Q.26 The Complete replacement of old cells of Hydra take place in-
(1) 20 days (2) 45 days
(3) 100 days (4) 60 days

Q.27 In Hydra sperms are produced in the month of-
(1) January (2) March
(3) October (4) September

Q.28 Larva of Hydra is-
(1) Hydrula (2) Planula
(3) Bipinnaria (4) Absent

Q.29 Thinest mesoglea is found in-
(1) Tentacles (2) Hypostome
(3) Basal disc (4) All of the above

Q.30 Fastest method of locomotion in Hydra-
(1) Looping (2) Gliding
(3) Walking (4) Somer saulting

Q.31 Dense cytoplasm and large nucleus occurs in which cells of Hydra-
(1) Sensory cells (2) Nerve cells
(3) Interstitial cells (4) Nematoblast

Q.32 In development of Hydra, gastrulation is the result of
(1) Emboly (2) Delamination
(3) Invagination (4) Epiboly

Q.33 Mesoglea composed of-
(1) Chitin
(2) Glycoprotein
(3) Mucopolysaccharides
(4) Albumin

Q.34 Gastrodermis of Hydra is-
(1) Thin
(2) 1/3 part of body wall
(3) 2/3 part of body wall
(4) 3/4 part of body wall

Q.35 Which of the following is more digested in gastro vascular cavity of Hydra-
(1) Proteins (2) Lipids
(3) Carbohydrates (4) All the above

Q.36 Which part of Hydra have maximum number of nematoblasts-
(1) Stalk (2) Hypostome
(3) Tentacles (4) (2) and (3) both

Q.37 Hydra is-
(1) Asymmetrical
(2) Radially symmetrical
(3) Bilaterially symmetrical
(4) Bilateral when young and radial in adults stage

Q.38 Hydra can suddenly contract the body by-
(1) Nutritive muscular cells
(2) Epithelio muscular cells
(3) Glandulo muscular cells
(4) Masoglea

Q.39 Optimum temperature for Hydra is-
(1) 20 - 25° F (2) 20 - 25° C
(3) 10 - 15° C (4) 5 - 10° C

Q.40 Who explained discharge of nematocyst in Hydra-
(1) Jones (2) Tremblay
(3) Linnaeus (4) Leeuwenhoek

Q.41 Which is not found in Hydra-
(1) Ovulation (2) Amphimixis
(3) Cellulation (4) Metabolism

Q.42 How many cells are present in battery of Hydra-
(1) 5 (2) 50-60
(3) 10-12 (4) 100-120

ASCARIS

Q.43 Ascaris is found in-
(1) Muscles (2) Pseudocoel
(3) Coelom (4) Intestine

Q.44 Ascaris is-
(1) Coelozoic Parasite (2) Cytozoic Parasite
(3) Histozoic Parasite (4) 1 and 2 both

Q.45 Which of the following maintains triradiate shape of lumen in pharynx-
(1) Lining of cuticle (2) Radial muscles
(3) Branched gland cell (4) Marginal fibres

Q.46 In Ascaris, number of sensory and motor nerves respectively-
(1) 8, 8 (2) 15, 1
(3) 14, 2 (4) 10, 6

Q.47 On the basis of origin Excretory system of Ascaris-
(1) Intra cellular (2) Inter cellular
(3) Multi cellular (4) Acellular

Q.48 Which is not in migration route of Ascaris-
(1) Hepatic portal vein (2) Hepatic vein
(3) Hepatic artery (4) Pulmonary artery

Q.49 In Ascaris only anterior part of testes is functional in division such gonads are called-
(1) Monorchic (2) Didelphic
(3) Telogonic (4) Hologonic

Q.50 In Ascaris median rachis is found in-
(1) Ovary (2) Oviduct & uterus
(3) Ovary & testes (4) Ovary & oviduct

Q.51 Depressor - ani muscles associated with-
(1) Mouth (2) Uterus
(3) Vagina (4) Anus

Q.52 Infective stage of Ascaris in Man-
(1) Rhabditoid larva (2) Embryonated egg
(3) Unfertilized egg (4) Third stage larva

Q.53 The cuticle in Ascaris is secreted by-
(1) Muscular layer of body wall
(2) Epidermis
(3) Mesoderm (4) None of the above

EARTHWORM

Q.54 Body of nephridia is V-shaped in-
(1) Septal nephridia
(2) Integumentary nephridia
(3) Pharyngeal nephridia
(4) All the above

Q.55 Which of the following is not correctly matcned-
(1) Lumbricus-Europe
(2) Megascolex & Drawida - South India
(3) Pheretima - Shri Lanka, North India
(4) Eutyphaeus - N. America

Q.56 Clitellum of Pheretima is-
(1) Permanent (2) Multilayered
(3) Single layered (4) 1 & 2 both

Q.57 Arrangement of setae in Lumbricus-
(1) Perichaetine (2) Octochaetine
(3) Lumbricine (4) 2 & 3 both

Q.58 Which structure secretes hormone in Earthworm-
(1) Nerve cord (2) Lymph gland
(3) Cerebral ganglia (4) Chloragogen cells

Q.59 The muscles of alimentary canal in Earthworm are-
(1) Striped (2) Unstriped
(3) Both (4) None of these

Q.60 Calciferous glands are present in Earthworm in-
(1) Pharynx & gizzard
(2) Stomach & buccal cavity
(3) Pharynx & stomach
(4) Only in stomach

Q.61 In dry soil, Earthworm dies due to-
(1) Lack of water (2) Lack of food
(3) Asphyxia (4) Toxicity

Q.62 In earthworm skeleton like function is performed by-
(1) Coelomic fluid
(2) Alimentary canal filled with food
(3) Typhlosole (4) Clitellum

Q.63 Appendages in Earthworm are-
(1) Monoramous (2) Biramus
(3) Poly ramus (4) Absent

Q.64 Normal speed of Locomotion in Earthworm is-
(1) 25 meter/sec. (2) 75 cm/min.
(3) 25 cm/min. (4) 25 km/hour

Q.65 One of the following is unpaired in Earthworm-
(1) Male genital pore (2) Female genital pore
(3) Genital papillae (4) Spermathecae

Q.66 Which of the following is incorrectly matched-
(1) Male genital pore - 18th segment
(2) Female genital pore - 14 - segment
(3) Lateral oesophageal hearts - 7 & 9 segments
(4) Seminal vesicles - 11th & 12th segments

Q.67 Which structure is represented typically in almost every body segment-
(1) Septal nephridia (2) Hearts
(3) Genital pores (4) Ganglia

Q.68 Under anaerobic condition pheretima-
(1) Dies
(2) Lives normally
(3) Remains alive for 30 hours
(4) Regeneration

Q.69 If subpharyngeal ganglion is destroyed then pheretima-
(1) Die immediately
(2) Carry on normal life
(3) Stops all types of movements
(4) Uncertain

Q.70 Inner most layer on nerve cord of pheretima is-
(1) Peritonium (2) Perineurium
(3) Epineurium (4) Connective tissue

Q.71 Number of giant fibres on nerve cord of pheretima-
(1) One (2) Two
(3) Three (4) Four

COCKROACH

Q.72 The type of egg in cockroach is called-
(1) Microlecithal (2) Centrolecithal
(3) Isolecithal (4) Telolecithal

Q.73 From egg laying to the development of adult cockroach, the number of moultings are-
(1) 10 - 12 times (2) 9 times
(3) 6 times (4) 3 - 4 times

Q.74 Ootheca is formed in cockroach by-
(1) Phallic gland (2) Conglobate gland
(3) Utricular gland (4) Collaterial gland

Q.75 Common between the trachea of rabbit and cockroach-
(1) Both start in head region
(2) Both are filled with air and fluid
(3) Wall in both is strengthened which does not allow to collapse
(4) None of them

Q.76 What type of vision is found in cockroach-
(1) Mosaic (2) Superposition
(3) Binocular (4) None of them

Q.77 Saliva of cockroach contains enzyme-
(1) Lipase (2) Amylase
(3) Pepsin (4) Trypsin

Q.78 Blood of cockroach does not contain haemoglobin because-
(1) It respires through atmosphere
(2) Respires through book lungs
(3) It does not respire
(4) It has some other means to carry oxygen direct into the tissues

Q.79 Tergum is joined on the sides by-
(1) Pleuron (2) Sternum
(3) Alimentary canal (4) Muscles

Q.80 Wings of cockroah are mainly helpful in-
(1) Egg laying (2) Preying
(3) Finding the male
(4) Protecting against danger

Q.81 Hepatic caecae in cockroach are derived from-
(1) Crop (2) Gizzard
(3) Midgut (4) Hind gut

Q.82 An animal which feeds upon organic matter, dead insects and own cast off cuticle may be called-
(1) Herbivorous (2) Scavanger
(3) Omnivorous (4) Carnivorous

Q.83 Common feature between cockroach and earthworm is-
(1) Hermaphroditism
(2) Moulting of cuticle
(3) Excretion by nephridia
(4) Ventral nerve cord

Q.84 Plantulae are found in cockroach upon-

(1) Tarsus (2) Femur

(3) Trochanter (4) Coxa

Q.85 Most swollen segment in leg in cockroach is-

(1) Tarsus (2) Coxa

(3) Femur (4) Trochanter

Q.86 Unique characteristic of group insecta is-

(1) Jointed appendages

(2) 3-pair of jointed legs

(3) Chitinous exoskeleton

(4) Compound eyes

Q.87 Stomodeal valve in cockroach is found in-

(1) Between gizzard and midgut

(2) Between midgut and hindgut

(3) Gizzard (4) Pharynx

Q.88 The number of teeth in the gizzard of cockroach is-

(1) 6 (2) 8

(3) 7 (4) 12

Q.89 Vestigeal wing is found in-

(1) Male blatta

(2) Female blatta

(3) Male periplaneta

(4) Female periplaneta

Q.90 Which of the parts in cockroach are fundamentaly similar in structure-

(1) Labrum & style

(2) Mandible & antenna

(3) Ist maxilla & labium

(4) Wings & Cerci

Q.91 What would you call cockroaches which can run fast and rarely resort to flight-

(1) Cursorial (2) Diurnal

(3) Nocturnal (4) None of the above

Q.92 Basal part of antenna in periplaneta americana is known as-

(1) Elytra (2) Galea

(3) Scape (4) Stalk

Q.93 How many salivary glands are found in cockroach-

(1) One pair

(2) Two pairs

(3) Three pairs

(4) One pair of bilobed structure

Q.94 The undeveloped simple eyes in cockroach are know as-

(1) Frons (2) Clypeus

(3) Fenestra (4) Genae

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	4	1	1	4	1	1	1	4	2	1	2	4	4	2	1	2	3	1	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	1	2	2	2	2	4	1	4	3	2	3	3	1	3	2	2	2	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	4	1	4	3	1	3	3	3	4	2	2	2	4	4	4	3	2	4
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	1	4	3	2	3	4	3	3	3	4	2	1	4	3	1	2	4	1	4
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94						
Ans.	3	3	4	1	2	2	1	1	2	3	1	3	1	3						

EXERCISE - 2

AMOEBA

Q.1 The nucleus of Amoeba proteus contain-
(1) One nucleoli (2) Two nucleoli
(3) Three nucleoli (4) No nucleoli

Q.2 *Entamoeba histolytica* is-
(1) Monogenetic (2) Digenetic
(3) Free living (4) None of the above

Q.3 Crystals of carbonyl diurea are found in.....
(1) Food vacuole (2) Contractile vacuole
(3) Endoplasm (4) Centrosome

Q.4 Which is absent in Amoeba-
(1) Glycogen (2) Centrosome
(3) Ribosome (4) Amino acids

Q.5 In the process of multiple fission how many progenies are formed by one amoeba-
(1) 200 (2) 500
(3) 1000 (4) 20

Q.6 Which of the following form polyenergrid nucleus in amoeba-
(1) Binaryfission (2) Encystement
(3) Sporulation (4) Rejuvenation

Q.7 At which place contractile vacuole burst to release water outside-
(1) Anterior end (2) Posterior end
(3) Cytopyge (4) Place not fixed

Q.8 Which maintains the shape of nucleus in Amoeba-
(1) Nuclear membrane (2) Honey comb lattice
(3) Nucleoplasm (4) Chromidia

Q.9 In amoeba proteus, the nucleus contains extremely minute, chromatin granules. The number of these granules is between-
(1) 100 to 200 (2) 200 to 400
(3) 500 to 600 (4) 600 to 800

Q.10 The gaint amoeba is called-
(1) *Amoeba proteus* (2) *Radiosa*
(3) Pelomyxa (4) Foraminiflera

Q.11 Pyorrhoea is caused by-
(1) *Entamoeba gingivalis*
(2) *Trichomonas buccalis*
(3) *Leishmania donovani*
(4) *Trypanosoma gamibiense*

PLASMODIUM

Q.12 How many species of Plasmodium occur in world-
(1) 5 (2) 4
(3) 60 (4) 8

Q.13 Vaccine is not available for malaria because-
(1) Plasmodium hides in liver
(2) Plasmodium does not produce antibodies
(3) Host's body does not produce antibodies against Plasmodium
(4) Plasmodium kills lymphocytes

Q.14 Sporozoites of Plasmodium if inoculated in a dog then dog-
(1) Becomes carrier
(2) Develops malaria
(3) Remain unaffected
(4) Becomes a reservoir host

Q.15 Which Plasmodium species have longest incubation period-
(1) *Plasmodium vivax*
(2) *Plasmodium falciparum*
(3) *Plasmodium malariae*
(4) *Plasmodium ovale*

Q.16 Difference in micro and macro gametocytes of Plasmodium is due to-
(1) Size
(2) Position of nucleus
(3) Hemozoin granules
(4) All of the above

Q.17 Paired organelle of Plasmodium help in-
(1) Locomotion (2) Nutrition
(3) Penetration (4) Reproduction

Q.18 Which are termed as phanerozoites-
(1) Cryptozoite (2) Metacryptozoite
(3) Schizont (4) Merozoites

Q.19 Exflagellation in Plasmodium concerned with-
(1) Oogenesis (2) Spermatogenesis
(3) Fertilization (4) Locomotion

Q.20 In man, Plasmodium starts its life cycle in liver instead of blood-
(1) For protection from host W.B.C.
(2) For obtaining more food
(3) For increasing number
(4) All the above

Q.21 Relapse of malaria is due to-
(1) Erythrocytic cycle
(2) Pre erythrocytic cycle
(3) Exo erythrocytic cycle
(4) Post erythrocytic cycle

Q.22 In Plasmodium pseudopodia-
(1) Never form
(2) Form only during ingestion
(3) Form only during some stages of life cycle
(4) Only sporozoites have pseudopodia

Q.23 which stage of paroxysm profuse sweating occurs-
(1) Riger stage (2) Febrile stage
(3) Defervescent stage (4) Prepatent period

HYDRA

Q.24 If an animal which is devoid of glutathione is artificially introduced in coelenteron of Hydra then-
(1) Hydra digest it
(2) It is thrown out of mouth immediate
(3) It is expelled out through aboral pore
(4) None is correct

Q.25 Nematoblast cells of Hydra not sensitive for-
(1) Daphnia (2) Kerona
(3) Tricodina (4) Both 2 and 3

Q.26 Testes are formed in Hydra from-
(1) Inter stitial cells
(2) Epithelio - muscular cells
(3) Nerve cells
(4) All the above

Q.27 Contractile Fibrils of myoepithelial cells in Hydra are arranged-
(1) Obliquely on body
(2) Transverse to longitudinal axis of body
(3) Parallel to the longitudinal axis of body
(4) None of these

Q.28 In Hydra digestion in coelenteron is-
(1) Extra cellular (2) Intra cellular
(3) Inter cellular (4) No digestion

Q.29 Musculo-glandular cells are chiefly found on-
(1) Basal disc (2) In the gastrodermis
(3) On the hypostome (4) On the tentacles

Q.30 Hydra is-
(1) Ammonotelic (2) Ureotelic
(3) Urecotelic (4) None of these

Q.31 Which tissues is totally absent in Hydra-
(1) Epithelial tissue (2) Connective tissue
(3) Muscular tissue (4) Nervous tissue

Q.32 Hydra is-
(1) Insectivorous (2) Frungvivorou
(3) Omni vorous (4) Carnivorous

Q.33 Hydra has nervous system which is represented by-
(1) Polarised nerve cells
(2) Nerves
(3) Ganglionated nerve cells
(4) Non-polarised nerve cells

Q.34 Nematocysts are developed from-
(1) Interstitial cells
(2) Epithelio muscular cells
(3) Ectodermal cells (4) Endodermal cells

Q.35 The mesogloea is-
(1) Partly cellular & partly fibrous
(2) Neither cellular nor fibrous
(3) Only fibrous (4) Cellular

Q.36 Larva of Hydra is called-
(1) Planula (2) Amphiblastula
(3) Blastula (4) None

Q.37 Hydra can be called-
(1) Monoecious (2) Marine
(3) Viviparous
(4) Monoecious or dioecious

ASCARIS

Q.38 Intermediate host of Ascaris is-
(1) Culex (2) Anopheles
(3) House fly (4) Absent

Q.39 In Ascaris, the excretory system is-
(1) Z-shaped (2) J-shaped
(3) N-shaped (4) H-shaped

Q.40 Which of the following has no intermediate host-
(1) Plasmodium (2) Fasciola
(3) Ascaris (4) Taenia

Q.41 Pineal setae of Ascaris arise from-
(1) Anus of male
(2) Cloaca of male Ascaris
(3) Vulva of female Ascaris
(4) All

Q.42 Radial symmetry does not occur in-
(1) Star fish (2) Sea anemone
(3) Ascaris (4) Jelly fish

Q.43 Ascaris has a thick cuticle on its body surface, it is an adaptation for-
(1) Growth (2) Parasitism
(3) Reproduction (4) Locomotion

Q.44 Excretory organs of Ascaris are-
(1) Osmoregulatory (2) Renette cell
(3) Excretory canals (4) All

EARTHWORM

Q.45 In Earthworm neurons are-
(1) Motor (2) Sensory
(3) Adjustar (4) All

Q.46 Canals of nephridia is-
(1) Schizogenous (2) Lysigenous
(3) Intra-cellular (4) Inter cellular

Q.47 Valves are absent in lumen of-
(1) Sub-neural vessel
(2) Ventral vessel & Anterior loop
(3) Dorsal blood vessel
(4) 1 & 2 both

Q.48 Porphyrin pigment of skin in pheretima helps in-
(1) Protection from harmful radiations
(2) Camouflage
(3) Sexual attraction (4) 1 & 2 both

Q.49 In Pheretima phaosome is-
(1) Convex (2) Concave
(3) Biconcave (4) L-shaped

Q.50 Number of loops in body of septal nephridia-
(1) 2 - 6 (2) 3 - 7
(3) 9 - 13 (4) 3 - 4

Q.51 Ventral blood vessel does not supply blood to-
(1) Gonads (2) Septal nephridia
(3) Rectum (4) Stomach

Q.52 Ring vessels in Earthworm occur in muscular coat of-
(1) Stomach (2) Intestine
(3) Pharynx (4) Gizzard

Q.53 In Earthworms, the chromophil cells serve to-
(1) Secrete mucus (2) Regulate skin colour
(3) Stored fat (4) Secrete saliva

Q.54 Locomotion in Earthworm is directly facilitated by-
(1) Mucus secreted by epidermis
(2) Segmentation of body
(3) Rhythmic contractions of prostomium
(4) Setae

Q.55 Vessel in which blood from seminal vesicles of Earthworm is collected-
(1) Lateral oesophageal vessel
(2) Subneural vessel
(3) Ventral vessel
(4) Dorsal vessel

Q.56 Cuticle of annelids is-
(1) Non-chitinous (2) Chitinous
(3) Albuminous (4) All the above

Q.57 Spermatheca of earthworm represents-
(1) Organ for coating over sperms
(2) Male copulatory organ
(3) Female copulatory organ
(4) Structure for storing sperms

Q.58 How many accessory glands are present in earthworms-
(1) One pair (2) Two pairs
(3) Four pairs (4) Two only

Q.59 Pharynx of earthworm is divided into-
(1) Dorsal salivary & ventral conducting chambers
(2) Ventral salivary & dorsal conducting chamber
(3) Dorsal & ventral salivary chamber
(4) None of the above

Q.60 Blood glands of earthworm serve for-
(1) Manufacturing blood corpuscles
(2) Synthesis of haemoglobin
(3) Excretion according to some workers
(4) All of the above

Q.61 In cocoon of earthworm embryo developed within-
(1) 3 to 4 weeks (2) 2 to 3 weeks
(3) Six month (4) One year

Q.62 Smallest longitudinal blood vessel in earthworm-
(1) Dorsal blood vessel
(2) Ventral blood vessel
(3) Supra oesophageal
(4) lateral oesophageal

Q.63 Sperms are stored in which part of spermatheca in earthworm-
(1) Diverticulam (2) Ampulla
(3) Both 1 & 2 (4) None of these

Q.64 Nerve ring of pheretima is-
(1) Vertical (2) Transverse
(3) Oblique (4) Horizontal

Q.65 Earthworm is-
(1) Ammonotelic (2) Uricotelic
(3) Ureotelic (4) Aminotelic

Q.66 In pheretima fertilization is-
(1) External & cross type
(2) Internal & self type
(3) Both (1) and (2) (4) Only internal

COCKROACH

Q.67 Most of the digestion in cockroach occurs in-
(1) Pharynx (2) Mid gut
(3) Gizzard (4) Crop

Q.68 Which type of blood cells are present in cockroach-
(1) Amoebocytes (2) Erythrocytes
(3) Haemocytes (4) Leucocytes

Q.69 Testes in cockroach are-
(1) Bilobed
(2) 4 lobed
(3) Small vesicular bodies
(4) Trilobed with numberous follicles

Q.70 The moulting in a nymph of cockroach is stimulated by a hormone secreted by-
(1) Corpora allata (2) Juvenile gland
(3) Nymph gland (4) Prothoracic gland

Q.71 Each tarsus of leg of cockroach consists of the linear series of-
(1) Three segments (2) Five segments
(3) Six segments
(4) Variable number of segments

Q.72 Gonopore in female cockroach is surrounded by-
(1) One pair of gonapophyses
(2) Two pair of gonapophyses
(3) Three pairs of gonapohyses
(4) None of the above

Q.73 In cockroach the eggs are fertilized-
(1) Into a common oviduct
(2) In the genital chamber of female cockroach
(3) Within the ootheca
(4) In the oviducts

Q.74 Cockroach is-
(1) Nocturnal (2) Diurnal
(3) Cursorial (4) 1 and 3 both

Q.75 Ventral nerve cord has how many ganglia in cockroach-
(1) 3 (2) 6
(3) 9 (4) 13

Q.76 Part of alimentary canal where maximum digestion occurs in cockroach is-
(1) Mesenteron (2) Ileum
(3) Colon (4) Crop

Q.77 No. of longitudinal tracheal trunks in cockroach-
(1) 3 (2) 6
(3) 2 (4) 8

Q.78 Cuticle of bodywall in cockroach is permeable for-
(1) Water (2) CO_2
(3) O_2 (4) All the above

Q.79 Male and female cockroach are differentiated by-
(1) Mouth parts (2) Thorax
(3) Legs (4) Abdomen

Q.80 Which part in the respiratory system of cockroach is non cuticularised-

(1) Spiracles (2) Trachea

(3) Tracheole (4) Atrium

Q.81 Ecdysone is secreted by-

(1) Prothoracic gland

(2) Corpora allata

(3) Corpora cardiaca

(4) Cerebral-neuro-secretory

ANSWER KEY

EXERCISE –2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	3	2	2	3	2	2	3	3	2	3	3	3	3	4	3	2	2	4
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	3	3	1	4	1	3	1	1	1	3	4	4	1	3	4	4	4	4	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	3	2	4	4	3	4	4	4	3	3	1	4	2	1	1	4	2	1	4
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	3	2	3	3	1	4	3	4	4	2	3	3	4	3	4	2	2	4	3
Ques.	81																			
Ans.	1																			

AMOEBA

Q.1 Food reserve in encysted Entamoeba is- **[CPMT 1993]**
(1) Starch (2) Glycogen
(3) Fat (4) None

Q.2 Amoeba secretes digestive enzymes for hydrolysing- **[AFMC 1994]**
(1) Protein (2) Starch
(3) Fat (4) All the above

Q.3 Entamoeba coli causes- **[CBSE 1994]**
(1) Pyorrhoea (2) Diarrhoea
(3) Dysentery (4) None

Q.4 Destruction of nucleus in Amoeba results in- **[RPMT 1995]**
(1) Immediate death
(2) Slowing down of metabolic activity and ultimate death
(3) Quick locomotion (4) No change

Q.5 Amoeba touched with needle will- **[RPMT 1995]**
(1) Die (2) Divided quickly
(3) Develop pseudopodia
(4) Move away

Q.6 Amoeba takes food through- **[RPMT 1995]**
(1) Phagocytosis (2) Pinocytosis
(3) Endocytosis (4) All the above

Q.7 Which is absent in Amoeba- **[RPMT 1995]**
(1) Golgi apparatus (2) Lysosome
(3) Centriole (4) Plasmalemma

Q.8 Amoeba is- **[Orissa JEE 1995]**
(1) Multicellular (2) Cellular
(3) Acellular (4) Subcellular

Q.9 Which one resides in the mouth of human beings- **[MPPMT 1995]**
(1) Entamoeba coli
(2) Entamoeba histolytica
(3) Entamoeba gingivalis
(4) Amoeba proteus

Q.10 In Amoeba, pseudopodia are formed due to- **[RPMT 1995]**
(1) Contact with food
(2) Sol $\rightleftharpoons$ gel change
(3) Movement towards area of higher temperature
(4) All the above

Q.11 Pseudopodia occur in- **[RPMT 1995]**
(1) Sarcodina (2) Sporozoa
(3) Ciliata (4) Mastigophora

Q.12 Nitrogen waste product of Amoeba is- **[CPMT 1993 ; RPMT 1995]**
(1) Ammonia (2) Urea
(3) Uric acid (4) None of the above

Q.13 *Entamoeba histolytica* excretes through- **[MPPMT 1996]**
(1) Food vacuole (2) General surface
(3) Contactile vacuole (4) Malpighian tubules

Q.14 Infection of *Entamoeba histolytica* is prevented by- **[CPMT 1996]**
(1) Avoiding kissing
(2) Avoiding clothes of patient
(3) Uncontaminated food
(4) None of the above

Q.15 Under unfavourable conditions, Amoeba produces a three-layered dissemule. The phenomenon is- **[CPMT 1996]**
(1) Sporulation (2) Encystment
(3) Conjugation (4) Regeneration

Q.16 Amoeba is immortal. It occurs all over the world due to- **[CPMT 1996]**
(1) Binary fission
(2) natural death do not occur
(3) Amoeba is not differentiated into germplasm and somatoplasm
(4) All of these

Q.17 In Amoeba, osmoregulation occurs through- **[BHU 1996]**
(1) Plasmalemma (2) Food vacuole
(3) Lysosome (4) Contractile vacuole

Q.18 Posterior end of Amoeba is characterised by- **[Bih. PMT 1996]**
(1) Plasmid (2) Amphid
(3) Uripygium
(4) Lack of food vacuoles

Q.19 A cyst of *Entamoeba histolytica* produces trophozoites- **[Bih. PMT 1996]**
(1) 1 (2) 2
(3) 4 (4) 18

Q.20 Amoeba sticks to substratum by means of- **[RPMT 1996]**

(1) Rough surface (2) Plasmalemma

(3) Protein (4) None of the above

Q.21 Which one is not a symptom of Entamoeba histolytica infection- **[BHU 1996]**

(1) Relapsing fever (2) Abdomial pain

(3) Blood in stool (4) Irregular bowls

Q.22 Waste material in Amoeba is taken out by - **[RPMT 1998]**

(1) Plasmalemma (2) Cytoplasm

(3) Nephron (4) Vacuole

Q.23 Amoeba is eucaryotic because it possesses- **[APMEE 1999]**

(1) Plasmid (2) Nucleus

(3) Plasmalemma (4) DNA

Q.24 Infective stage of *Entamoeba histolytica* is- **[Pb. PMT 1999]**

(1) Trophozoite (2) Pre-cyst

(3) Uninucleate cyst (4) Tetranucleate cyst

Q.25 Broad description of *Amoeba* given by : **[RPMT 1999]**

(1) Ronald Ross (2) Aristotle

(3) Harshfeild (4) Rosenholf

Q.26 In *Amoeba* binary fission is by :**[RPMT 1999]**

(1) amitosis (2) mitosis

(3) meiosis (4) all of these

Q.27 Funciton of contractile vacuole in *Amoeba* is: **[RPMT 1999]**

(1) osmoregulation (2) nutrition

(3) respiration (4) excretion

Q.28 In *Amoeba* hyaline cap is formed by : **[RPMT 1999]**

(1) around the food vacuole

(2) around the contractile vacuole

(3) around the nucleus

(4) on pseudopodia

Q.29 Formation of pseudopodia due to : **[RPMT 1999]**

(1) chemical changes

(2) viscosity changes

(3) difference in pressure

(4) changing in temperature

Q.30 In Amoeba, contractile vacuole is present- **[CPMT 2000]**

(1) Near trailing end

(2) Near advancing end

(3) At the middle of body

(4) Any where inside body

Q.31 *Entamoeba histolytica* does not form cysts in- **[AMU 2000]**

(1) Liver (2) Ascending colon

(3) Transverse colon (4) Descending colon

Q.32 Which one does not spread disease - **[RPMT 1995 ; Pb. PMT 2000]**

(1) *Entamoeba coli*

(2) *Entamoeba histolytica*

(3) *E. gingivalis*

(4) *Plasmodium ovale*

Q.33 Which one of the following is associated with osmoregulation in *Amoeba* ? **[RPMT 2000]**

(1) Plasma membrane (2) Contractile vaculoe

(3) Mitochondria (4) Endoplasm

Q.34 In *Entamoeba histolytica* cytochromes are found in which one of the following ? **[RPMT 2000]**

(1) Ectoplasm (2) Mitochondria

(3) Endoplasmic reticulum

(4) Endoplasm

Q.35 In case of *Amoeba proteus* which temperature is optimum ? **[RPMT 2000]**

(1) 5^0C to 10^0C (2) 20^0C to 25^0C

(3) 15^0C to 16^0C (4) 30^0C ot 35^0C

Q.36 In *Amoeba* who gave contraction hydraulic theory ? **[RPMT 2000]**

(1) Schultze (2) Claude

(3) Simpson (4) Swan

Q.37 In *Entamoeba histolytica* intestinal ulceration is caused by which one of the following? **[RPMT 2000]**

(1) Metacystic trophozoites

(2) Binucleate stage

(3) Tetranucleate stage

(4) Trophozoites

Q.38 Locomotory structures of Amoeba are- **[BHU 2001]**

(1) Cilia (2) Flagella

(3) Pseudopodia (4) None of these

Q.39 Marine protozoans lack contractile vacuole bacause **[DPMT 2002]**

(1) Their body cannot accomodate it

(2) They are hypoosmotic to their environment

(3) They are isotonic with their environment

(4) Osmoregulation is done by cell membrane

Q.40 In *Amoeba* which controls the cytoplasmic osmality : **[RPMT 2002]**

(1) nucleus (2) ectoplasm

(3) biurets (4) contractile vacoule

Q.41 What happens in anterior part of *Amoeba* at the time of formation of pseudopodia ? **[RPMT 2002]**

(1) plasma gel convert into plasma sol

(2) plasma sol convert into plasma gel

(3) ectoplasm convert into endoplasm

(4) endoplasm convert into ectoplasm

Q.42 In Amoeba, osmoregulation takes place by- **[RPMT 2004]**

(1) Contractile vacuole (2) Ectoplasm

(3) Pseudopodia (4) Hyaloplasm

Q.43 During unfavourable conditions Amoeba reproduces through- **[RPMT 2004]**

(1) Binary fission (2) Sporulation

(3) Multiple fission (4) Conjugation

Q.44 What will happen due to needle piecing in Amoeba- **[RPMT-2005]**

(1) Amoeba will die

(2) Amoeba will produce cyst

(3) Amoeba will runway

(4) Amoeba reproduces

Q.45 If nucleus of Amoeba is destroyed- **[RPMT-2005]**

(1) Sudden death occurs

(2) Decreases in metabolic activities and death

(3) Fast locomotion

(4) No effect

Q.46 In Amoeba cyst formation occurs during- **[RPMT-2005]**

(1) Unfavourable condition

(2) After sexual reproduction

(3) Before sexual reproduction

(4) Favourable condition

Q.47 Which one of the following is a function of pseudopodia of amoeba besides locomotion- **[RPMT-2006]**

(1) Regeneration

(2) Excretion

(3) To obtain various materials

(4) Reproduction

Q.48 Amoeba is- **[RPMT-2006]**

(1) Asymmetrical (2) Biradial

(3) Radial (4) Bilateral

PLASMODIUM

Q.49 The part of life cycle of malarial parasite *Plasmodium vivax*, that is passed female Anopheles is- **[C.B.S.E. 1992]**

(1) Sexual cycle

(2) Pre–erythrocytic schizogony

(3) Exoerythrocytic schizogony

(4) Post–erythrocytic schizogony

Q.50 Schizont stage of Plasmodium occurs in human cells **[C.B.S.E. 1993]**

(1) Erythrocytes (2) Liver cells

(3) Erythrocytes and liver cells

(4) Erythrocytes, liver cells and spleen cells

Q.51 Exflagellation in Plasmodium occurs in- **[C.P.M.T. 1993]**

(1) Merozoites

(2) Megagametocytes

(3) Microgametocytes

(4) Metacryptomerozoites

Q.52 Erythrocytic cycle of Plasmodium occurs in **[C.P.M.T. 1993]**

(1) Liver (2) Spleen

(3) RBC (4) Gut

Q.53 In Plasmodium, gametocytes are formed from **[Bih. P.M.T.1994]**

(1) Schizont (2) Trophozoite

(3) Sporozoite (4) Merozoite

Q.54 The secondary host of Plasmodium is **[M.P.P.M.T. 1994]**

(1) Male Anopheles (2) Female Anopheles

(3) Female Culex (4) Male Culex

Q.55 Common enteritis infection in India occurs by **[M.P.P.M.T. 1994]**

(1) Mosquito bite

(2) Viruses

(3) Ingesting cysts with food and drinks

(4) Eating spice rich food

Q.56 Which one is not a protozoan protist- **[Manipal 1995]**

(1) *Plasmodium vivax*

(2) *Paramecium caudatum*

(3) *Enterobius vermicularis*

(4) *Trypanosoma gambiense*

Q.57 In malaria, which causes chills and fever **[B.H.U. 1995]**

(1) Hematin (2) Haemozoin

(3) Schuffner's granules

(4) Hematocrit

Q.58 Development and functioning of gametocytes of Plasmodium in the body of Mosquito are depend upon- **[R.P.M.T. 1996]**

(1) Temperature (2) Food

(3) Position (4) All the above

Q.59 Who was awarded Noble Prize in 1902 for discovery of oocyst Plasmodium **[R.P.M.T. 1996]**

(1) Golgi (2) Ronald Ross

(3) Laveran (4) Shortt

Q.60 Which one is spindle–shaped mobile with microtubules **[R.P.M.T. 1996]**

(1) Sporont (2) Ookinete

(3) Cryptozoite (4) Sporozoite

Q.61 Which stage of Plasmodium is infective for Mosquito **[R.P.M.T. 1996]**

(1) Trophozoite (2) Gametocyte

(3) Ookinete (4) Sporozoite

Q.62 Trophozoites of Pladmodium occur in **[Bih. P.M.T. 1996]**

(1) Liver cells

(2) Spleen

(3) Lymph channels

(4) Red blood corpuscles

Q.63 Multiple fission in Plasmodium is- **[D.P.M.T. 1996]**

(1) Gamogony (2) Schizogony

(3) Sporulation (4) None of the above

Q.64 Development of gametocytes from merozoite of Plasmodium occurs in- **[D.P.M.T. 1996]**

(1) Red blood corpuscles

(2) Liver cells

(3) Stomach of female Anopheles

(4) All of the above

Q.65 Malarial species found in South America and West Africa is **[B.H.U. 1996]**

(1) *Plasmodium falciparum*

(2) *P. vivax*

(3) *P. malariae* (4) *P. ovale*

Q.66 Recurrence of high temperature in malaria at intervals is due to completion of- **[B.H.U. 1996, A.I.I.M.S. 1996]**

(1) Erythrocytic schizogony

(2) Sporogony

(3) Gamogony

(4) Exoerythrocytic schizogony

Q.67 Symptoms of malaria in spleen and skin are due to **[B.H.U. 1996]**

(1) Schuffner's granules

(2) Hemozoin

(3) Hamaton (4) Blood sugar

Q.68 Sporogony in malarial parasite occurs in- **[B.H.U. 1996, A.P.M.E.E. 1996]**

(1) Human liver

(2) Human red blood cells

(3) Stomach of female Anopheles

(4) Stomach wall of female Anopheles

Q.69 In Plasmodium, diploid stage is **[A.P.M.E.E. 1996]**

(1) Oocyst (2) Gamont

(3) Schizont (4) Sporozoite

Q.70 Exo–erythrocytic cycle is absent in- **[B.H.U.1997]**

(1) *Plasmodium malariae*

(2) *P.ovale*

(3) *P. viivax*

(4) *P. falciparum*

Q.71 High temperature in malaria occurs after completion of- **[C.P.M.T. 1997]**

(1) Erythrocytic cycle

(2) Exo–erythrocytic cycle

(3) Pre–erythrocytic cycle

(4) Gametogony

Q.72 Plasmodium is inoculated in humans by **[M.P.P.M.T. 1997]**

(1) Female Culex (2) Male Culex

(3) Female Anopheles

(4) Male and female Anopheles

Q.73 Secondary host for *Plasmodium vivax* is **[Orissa1997]**

(1) Anopheles female (2) Anopheles male

(3) Culex male (4) Culex female

Q.74 Sporozoites of Plasmodium are formed in **[A.F.M.C. 1997]**

(1) Gametocytes (2) Oocysts

(3) Sporoblasts (4) Trophozoites

Q.75 After how many days could a patient commonly feel malaria from the time of biting of mosquito- **[C.P.M.T. 1998]**

(1) 2–8 days (2) 8 – 10 days

(3) 10–20 days (4) 20–30 days

Q.76 A person suffering from malaria runs fever when **[C.P.M.T. 1998]**

(1) Exoerythrocytic cycle is completed

(2) Signet ring stage is formed

(3) RBCs rupture and a haemozoin granules are released

(4) All of the above

Q.77 Symptoms of paroxysm in malaria are due to **[R.P.M.T. 1998]**

(1) Sporozoite (2) Gametocyte

(3) Pre–erythrocytic cycle

(4) Erythrocytic cycle

Q.78 Relapsing malaria is due to- **[R.P.M.T. 1998]**

(1) *Plasmodium falciparum* and *P. vivax*

(2) *Plasmodium ovale* and *P. vivax*

(3) *Plasmodium falciparum and P. ovale*

(4) *P. falciparum only*

Q.79 Symptom of paroxysm in malaria (infection) are dipicted in stage- **[RPMT 1998]**

(1) Sporozoite (2) Gametocyte

(3) Pre erythrocytic cycle

(4) Erythrocytic cycle

Q.80 Which of the following groups cause relapse malaria- **[RPMT 1998]**

(1) Plasmodium falciparum and Plasmodium vivax

(2) Plasmodium ovale and Plasmodium vivax

(3) Plasmodium falciparum and Plasmodium ovale

(4) Only Plasmodium falciparum

Q.81 Motile elongate zygote of Plasmodium occurs in **[C.P.M.T. 1999]**

(1) Human RBCs (2) Human liver

(3) Salivary glands of mosquito

(4) Gut of mosquito

Q.82 Haemozoin formed in malaria is produced by- **[M.P.P.M.T. 1999]**

(1) Globin part of haemoglobin

(2) Haeme of haemoglobin

(3) Cryptozoites (4) Dead leucocytes

Q.83 Incubation period of Plasmodium vivax is- **[D.P.M.T. 1999]**

(1) 14 days (2) 20 days

(3) 30 days (4) 45 days

Q.84 Which pigment is caus of malaria ? **[RPMT 1999]**

(1) hemocyanine (2) haemoglobin

(3) haemozoine (4) none of these

Q.85 Malignant malaria is cause by :**[RPMT 1999]**

(1) *Plasmodium falciparum*

(2) *Plasmodium ovale*

(3) *Plasmodium vivax*

(4) *Plasmodium malariae*

Q.86 Malarial parasite harmful for liver cells in which cycle ? **[RPMT 1999]**

(1) Erythrocytic cycle

(2) After erythocytic cycle

(3) Before erythrocytic cycle

(4) None of these

Q.87 Malarial parasite is observed by : **[RPMT 1999]**

(1) Sir Ronald Ross (2) Laveran

(3) Patric Mantion (4) Grassi

Q.88 Poisonous substance released on rupturing of schizont in RBCs of malarial patient is- **[B.H.U. 2000]**

(1) Haematin (2) Haemozoin

(3) Haem (4) Haemoglobin

Q.89 Common malaria parasite of India is- **[A.M.U. 2000]**

(1) Placmodium falciparum

(2) P. vivax

(3) P. ovale (4) P. malariae

Q.90 Which one of the following is pernicious quotidian, malignant and tropical malarial parasite? **[RPMT 2000]**

(1) *Plasmodium vivax*

(2) *Plasmodium falciparum*

(3) *Plasmodium mallarie*

(4) *Plasmodium ovale*

Q.91 In *Plasmodium* which one of the following is not distinct ? **[RPMT 2000]**

(1) Mitrochondria (2) Golgi body

(3) Cilia (4) Nucleus

Q.92 Which stage of *Plamodium* contains rhoptries? **[RPMT 2000]**

(1) Sporozoite (2) Merozoite

(3) Signetring stage (4) Ookinete

Q.93 What is the chromosome number of *Plasmodium?* **[RPMT 2000]**

(1) 9 (2) 14

(3) 10 (4) 4

Q.94 In which city Ronald Ross worked for malarial parasite? **[RPMT 2000]**

(1) Delhi (2) Calcutta

(3) Hyderabad (4) Madras

Q.95 Which is wrong combination- **[A.I.I.M.S 2001]**

(1) Haemocyanin-Prawn

(2) Haemoglobin in mammals- RBC

(3) Haemoglobin in plasma-Pheretima

(4) Haemozoin - Plasmodium cytoplasm.

Q.96 Sprinkling oil over ponds would control malaria because- **[A.F.M.C. 2001]**

(1) Fishes die

(2) Water gets oil layer

(3) Larvae are asphyxiated

(4) Mosquitoes are repelled

Q.97 Life cycle of Plasmodium species causing benign tertiary malaria consists of- **[A.M.U. 2001]**

(1) Erythrocytic cycle

(2) Post–erythrocytic cycle

(3) Pre–erythrocytic cycle

(4) All of the above

Q.98 Highest incubation period occurs in Plasmodiumb - **[C.P.M.T.2002]**

(1) *P. malariae* (2) *P. vivax*

(3) *P. ovale* (4) *P. falciparum*

Q.99 Black water fever is caused by- **[C.P.M.T. 2002]**

(1) *Plasmodium malariae*

(2) *P. ovule*

(3) *P. falciparum* (4) *P vivax*

Q.100 Where does exoerythrocytic cycle take place in life cycle of *Plasmodium*? **[RPMT 2002]**

(1) RBC of human (2) Human liver

(3) Stomach of *Anopheles* mosquito

(4) Salivary gland of *Anopheles* mosquito

Q.101 Incubation period of Plasmodium vivax is - **[RPMT 2003]**

(1) 4 days (2) 6 days

(3) 14 days (4) 30 days

Q.102 The infective stage of Plasmodium in humans is- **[RPMT 2004]**

(1) Sporozoite (2) Trophozoite

(3) Gametocyte (4) Merozoite

Q.103 In Plasmodium ookinete is formed by- **[RPMT 2004]**

(1) Trophozoite (2) Zygote

(3) Sporozoite (4) Merozoite

Q.104 In Plasmodium signet ring stage is formed during- **[RPMT 2004]**

(1) Exo-erythrocytic scizogony

(2) Erythrocytic schizogony

(3) Sporogony

(4) Gamogony

Q.105 Who recieved Nobel Prize in 1902 for the discovery of oocyst- **[RPMT-2005]**

(1) Ronald Ross (2) Van Mohl

(3) Petric Mehsin (4) Grassi

Q.106 Which stage of plasmodium produce malaria in human- **[RPMT-2005]**

(1) Sporozoite (2) Trophozoite

(3) Metazoite (4) Cyst

Q.107 Malaria fever is controlled by which of the following drug- **[RPMT-2006]**

(1) Penicillin (2) Quinine

(3) DDT (4) Streptomycin

Q.108 Infective stage of malarial parasite is- **[RPMT-2006]**

(1) Trophozoite (2) Merozoite

(3) Sporozoite (4) Gametozoite

HYDRA

Q.109 Nematocysts take part in – **[MPPMT 1993]**

(1) Locomotion

(2) Offence and defence

(3) Food capture

(4) All of the above

Q.110 A radially symmetrical diploblastic animal is – **[AFMC 1993]**

(1) Roundworm (2) Earthworm

(3) Hydra (4) Liver fluke

Q.111 Budding is a normal mode of a sexual reproduction in- **[CBSE 1993]**

(1) Starfish and Hydra

(2) Hydra and sponges

(3) Tapeworm and Hydra

(4) Sponge and starfish

Q.112 Which one of the following animals possesses nerve cells but no nerves – **[CBSE 1993]**

(1) Hydra (2) Tapewarm

(3) Earthworm (4) Frog's tadpole

Q.113 Common between trichocysts of paramecium and nematocysts of Hydra is– **[CPMT 1994]**

(1) Attachement and defence

(2) Defence only

(3) Sensitivity

(4) Food capturing

Q.114 Nematocysts are activated by- **[Bih. PMT 1994]**

(1) Water (2) Touch

(3) Brain (4) None of these

Q.115 Testes/gonads are formed in Hydra from- **[RPMT 1995, Bihar PMT 1995]**

(1) Interstitial cells

(2) Epithelio–muscular cells

(3) Nerve cells

(4) All of the above

Q.116 Food of Hydra is – **[RPMT 1995]**

(1) Aquatic plants

(2) Aquatic animals

(3) Algae and aquatic animals

(4) Some crustaceans

Q.117 Which pair of cells is present in epidermis of Hydra but not in its endoderm– **[Bih. PMT 1995]**

(1) Stinging cells and interstitial cells

(2) Gland cells and germ cells

(3) Stinging cells and germ cells

(4) Stinging cells and gland cells

Q.118 Hydra is- **[Orissa JEE 1995, RPMT 1995]**

(1) Monoblastic (2) Diploblastic

(3) Triploblastic (4) Tetrablastic

Q.119 Nerve cells are found in – **[RPMT 1995]**

(1) Hydra (2) Sycon

(3) Paramecium (4) Amoeba

Q.120 Cnidaria is characterised by – **[RPMT 1996]**

(1) Pneumatoblasts

(2) Coelenteron

(3) Tissue level of organisation

(4) All of the above

Q.121 Mesogloea of Hydra is made of-**[RPMT 1996]**

(1) Mucopolysaccharides

(2) Protein

(3) Protein and fat

(4) Reticulate tissue

Q.122 Characteristic feature of coelenterata is- **[CPMT 1996]**

(1) All are marine

(2) Presence of tentacles around mouth

(3) Polyp

(4) Gastrovascular cavity

Q.123 Hydra is famous for a type of reproduction – **[CPMT 1996]**

(1) Budding
(2) Gametogenesis
(3) Position of sex organs
(4) Both 2 and 3

Q.124 Hydra cut into two pieces will result in – **[CPMT 1996]**

(1) Growth without mouth and basal disc
(2) Growth of mouth and disc according to their position in the parent
(3) Growth of mouth and disc at any end
(4) No regeneration is possible

Q.125 In Hydra, new nematocysts develop from– **[BHU 1996]**

(1) Cnidocils (2) Glandular cells
(3) Germ cells (4) Interstitial cells

Q.126 If Hydra is broken into pieces- **[RPMT 1995,1996]**

(1) Hydra will die
(2) Every fragment will grow into complete Hydra
(3) Some fragments will form complete Hydra
(4) Hydra will undergo sexual reproduction

Q.127 The largest nematocysts of Hydra are- **[BHU 1997]**

(1) Volvents (2) Penetrants
(3) Atrichous isorhizas
(4) Holotrichous isorhizas

Q.128 Hydra is – **[BHU 1998]**

(1) Fresh water, radial and diploblastic
(2) Fresh water, biradial and triploblastic
(3) Marine, radial and triploblastic
(4) Marine, radial and diploblastic

Q.129 In Hydra, digestion is- **[BHU 1999. CPMT 1999]**

(1) Extracellular
(2) Intracellular
(3) First extracellular and then intracellular
(4) First intracellular and then extracellular

Q.130 A number of buds have developed on Hydra- **[APMEE 1996, Pb. PMT 1999]**

(1) Oldest bud is towards oral region
(2) Oldest bud is towards aboral region
(3) Both 1 and 2 (4) There is no order

Q.131 Poisonous fluid present in nematocysts of Hydra is- **[CPMT 1993, 2001]**

(1) Hypnotoxin (2) Haematin
(3) Haemozoin (4) Agglutinogen

Q.132 Larval stage of *Hydra* is : **[RPMT 1999]**

(1) planula (2) rhabditiform
(3) trochophore (4) none of these

Q.133 In *Hydra*, which substance of nematocyst worked as hipnotizing substance ? **[RPMT 1999]**

(1) Glutatheone (2) Heparin
(3) Histamin (4) Hypnotoxine

Q.134 *Hydra* is : **[RPMT 1999]**

(1) triplobastic, radial symmetrical and acoelomate
(2) triploblastic, radial symmetrical and coelomate
(3) diplobalstic, radial symmetrical and acoelomate
(4) diploblastic, radial symmetrical and coelomate

Q.135 *Hydra* is : **[RPMT 1999]**

(1) herbivorous (2) more developed
(3) carnivorous (4) omnivorous

Q.136 How many ovum are developed in ovary of *Hydra* ? **[RPMT 1999]**

(1) Two (2) Many
(3) One (4) Three

Q.137 Cell–tissue organisation occurs in– **[CBSE 2000]**

(1) Amoeba (2) Hydra
(3) Tapewarm (4) Ascaris

Q.138 Characteristic cells of Hydra are– **[AMU 2000]**

(1) Trichocysts (2) Nematocysts
(3) Cnidoblasts (4) Sporocysts

Q.139 Coelenterates are mostly – **[AMU 2000]**

(1) Asymmetrical
(2) Radially symmetrical
(3) Bilaterally symmetrical
(4) Irregular

Q.140 Hydra is – **[AMU 2000]**

(1) Coral (2) Worm
(3) Polyp (4) Medusa

Q.141 In ectoderm of Hydra, bulk of cells are – **[Pb. PMT 2000]**

(1) Musculo–epithelial (2) Interstitial
(3) Nematoblasts (4) Germ cells

Q.142 Hydra is coelenterate because it possesses- **[Pb. PMT 2000]**

(1) Mesogloea (2) Nematocysts
(3) Body cavity (4) Tentacles

Q.143 Germ cells of Hydra are derived from– **[BHU 2000]**

(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) Mesogloea

Q.144 What is the diameter of stenoteles ? **[RPMT 2000]**

(1) 16 microns (2) 25 microns
(3) 10 microns (4) 5 microns

Q.145 *Hydra* belongs to which of the following? **[RPMT 2000]**

(1) Biradially symmetrical
(2) Radially symmetrical and coelomate
(3) Coelomate and bilaterally symmetrical
(4) Radially symmetrical and acoelomate

Q.146 Recombinant nodules are found during whichof the following ? **[RPMT 2000]**

(1) Prophase (2) Anaphase
(3) Telophase (4) Metaphase

Q.147 Which type of reproduction is found in *Hydra*? **[RPMT 2000]**

(1) Sexual (2) Asexual
(3) Sexual and asexual (4) None of these

Q.148 Which is correct about nematocyst in Hydra– **[A.F.M.C 2001]**

(1) It is re–used
(2) Ejection is conditioned reflex
(3) Ejection occurs in response to contact and pierces the prey
(4) Prevents coming in contact with other Hydra

Q.149 In Hydra, egestion of undigested food and excretion of nitrogenous wastes occur through- **[CBSE 2001]**

(1) Mouth and tentacles
(2) Mouth and body wall
(3) Mouth
(4) Body wall and body cavity

Q.150 Hydra will regenerate from a fragment, if it contains- **[AFMC 2001]**

(1) Tentacles
(2) Epidermis and gastrodermis
(3) Tentacles, epidermis and gastrodermis
(4) Epidermis, hypodermis and gastrodermis

Q.151 Characteristic free swimming larva of coelenterates is- **[CPMT 2000, BHU 2001]**

(1) Onchosphere (2) Rhabditiform
(3) Planula (4) Cysticercus

Q.152 One of the characteristic of *Hydra* is : **[RPMT 2002]**

(1) Predation (2) Metamerism
(3) Hibernation (4) Mimicry

Q.153 If *Hydra* is cut transversly in three equal parts then : **[RPMT 2002]**

(1) all there parts will die
(2) regeneration will occur in all the three parts
(3) regeneration will occur only in anterior
(4) regeneration occurs only in middle part

Q.154 Trichocyst and nematocysts are meant for- **[RPMT 2003]**

(1) Defense (2) Nutrition
(3) Respiration (4) Excretion

Q.155 Digestion and distribution of nutrients both functions are performed by- **[RPMT 2003]**

(1) Blastocoel
(2) Coelom
(3) Spongocoel
(4) Gastrovascular cavity

Q.156 In Hydra reproduction occurs in favourable conditions- **[RPMT 2004]**

(1) By budding (2) By gametes
(3) By gemmules (4) Binary fission

Q.157 Nematoblasts are formed by- **[RPMT 2004]**

(1) Interstitial cells (2) Gland cells
(3) Mesoepithelial cells (4) Nerve cells

Q.158 Hydra is- **[RPMT-2005]**

(1) Omnivorus (2) Carnivorus
(3) Herbivorus (4) Sporophytic

Q.159 Which animal lacks neurons but has nerve cells- **[RPMT-2005]**

(1) Hydra (2) Ascaris
(3) Earthworm (4) Amoeba

Q.160 In Hydra, gastrodermis formed by- **[RPMT-2005]**

(1) Epithaliomuscular cell
(2) Nutritional muscular cell
(3) Muscular sensory cell
(4) Nematoblast

Q.161 What is the function of Nematocyst of Hydra- **[RPMT-2005]**

(1) To catch prey (2) To paralise prey
(3) To intake food (4) To locomotion

Q.162 Hydra belongs to class- **[RPMT-2006]**

(1) Cnidaria (2) Hydrozoa
(3) Schiphozoa (4) Actinozoa

Q.163 Asexual reproduction in hydra- **[RPMT-2006]**

(1) Budding (2) Sporulation
(3) Binary fission (4) Fragmentation

ASCARIS

Q.164 The first and last moults of Ascaris occur in- **[CPMT 1993]**

(1) Heart (2) Kidney
(3) Liver (4) Intestine

Q.165 Which one used in treatment of ascariasis- **[CPMT 1994]**

(1) Chenopodium oil (2) Paludrin
(3) Terramycin (4) None of these

Q.166 Embryonated egg of Ascaris is – **[BHU 1994]**

(1) An egg with gastrula
(2) An egg with blastula
(3) An egg with juvenile
(4) An egg within an egg

Q.167 A thick layer of cuticle on the surface of Ascaris indicates – **[CPMT 1994]**

(1) Reproduction (2) Growth
(3) Parasitism (4) Evolution

Q.168 Pseudocoel occurs in- **[CPMT 1994]**

(1) Hydra (2) Ascaris
(3) Cockroach (4) Earthworm

Q.169 Which one spreads through food contamination- **[APMEE 1995]**

(1) Taenia (2) Schistosoma
(3) Ascaris (4) Fasciola

Q.170 Excretory pores present in Ascaris are– **[RPMT 1995]**

(1) One (2) Two
(3) One pair (4) Two pairs

Q.171 Sensory structures in Ascaris are- **[RPMT 1995]**

(1) Phasmids (2) Amphids
(3) Papillae (4) All of the above

Q.172 The infective stage of Ascaris is- **[CPMT 1994, 96]**

(1) Fertilized egg (2) Embryonated egg
(3) Rhabditoid (4) Larva

Q.173 Ascaris has three lips – **[APMEE 1996]**

(1) One median dorsal and two ventrolateral
(2) All dorsal
(3) Two lateral and one ventral
(4) Two dorso–lateral and one median ventral

Q.174 Life span of Ascaris is – **[RPMT 1996]**

(1) 6–9 months (2) 9–12 months
(3) 4–10 years (4) 10–12 years

Q.175 Which is not true of Ascaris infection- **[RPMT 1996]**

(1) More common in children
(2) Does not produce tonsilitis
(3) Number can be 500-5000
(4) Infection is cured even without medication

Q.176 Which larval stage of Ascaris is infective– **[RPMT 1996]**

(1) First (2) Third
(3) Second (4) Third and fourth

Q.177 Find out the correct sequence in body wall of Ascaris- **[RPMT 1998]**

(1) Cuticle, epidermis, longitudinal muscles and circular muscles
(2) Cuticle, epidermis and longitudinal muscles
(3) Epidermis, cuticle, longitudinal muscles and circular muscles
(4) Epidermis, longitudinal muscles, cuticle and circular muscles

Q.178 Number of juvenile stages found during development of Ascaris is – **[RPMT 1998]**

(1) 1 (2) 2
(3) 3 (4) 4

Q.179 Sexual dimorphism occurs in– **[CPMT 1998]**

(1) Ascaris (2) Amoeba
(3) Pheretima (4) All of the above

Q.180 Metazoan parasite which is transmitted through contaminated food is – **[DPMT 1999]**

(1) Filarial Worm (2) Guinea Worm
(3) Entamoeba (4) Ascaris

Q.181 Sensory structures/cheomoreceptors located in the anterior part of Ascaris are- **[APMT 1999]**

(1) Amphids (2) Copulatory bursa
(3) Pineal setae (4) Pineal spicules

Q.182 Respiration of *Ascaris* is : **[CPMT 1999]**
(1) aerobic respiration
(2) anaerobic respiration
(3) both '1' and '2'
(4) none of these

Q.183 Infective stage of *Ascaris* is : **[CPMT 1999]**
(1) embryonated eggs (2) sporozoite
(3) cysticercus larva (4) rhabditiform larva

Q.184 *Ascaris* is completed its life cycle : **[CPMT 1999]**
(1) only in Human (2) Human and Sheep
(3) Human and Mosquito
(4) Human and Cow

Q.185 Female reproductive organ of *Ascaris* are : **[CPMT 1999]**
(1) protandrous (2) polydelphic
(3) didelphic (4) monodelphic

Q.186 Penial setae are present in male *Ascaris*: **[CPMT 1999]**
(1) in cloaca (2) in rectum
(3) anus (4) mouth

Q.187 Size of female Ascaris lumbricoides is- **[RPMT 2000]**
(1) 50–80 mm (2) 100–150 mm
(3) 150–250 mm (4) 200–350 mm

Q.188 Ascaris lumbricoides is – **[AMU 2000]**
(1) Hermaphrodite (2) Sexually dimorphic
(3) Polymorphic
(4) Sexually undifferentiated

Q.189 Intermediate host of Ascaris lumbricoides – **[AMU 2000]**
(1) Mosquito (2) Pig
(3) Snail (4) None of the above

Q.190 Body cavity of Ascaris is– **[CPMT 2000]**
(1) Acoelom (2) Pseudocoelom
(3) Schizocoelom (4) Enterocoelom

Q.191 Infective stage of Ascaris is – **[Karnataka 2000]**
(1) Adult worm (2) Second juvenile
(3) Fourth juvenile (4) Egg

Q.192 Excretory system of *Ascaris* is made up of : **[CPMT 2000]**
(1) single cell (2) many cells
(3) four cells (4) two cells

Q.193 What is the length of male *Ascaris lumbricoides*? **[CPMT 2000]**
(1) 50-60 mm (2) 100-200 mm
(3) 150-310 mm (4) 160-315 mm

Q.194 Muscle cells of *Ascaris* are arranged in: **[CPMT 2000]**
(1) coelomyarian (2) platymyarian
(3) polymyarian (4) holomyarian

Q.195 What is the length of female *Ascaris lumbricoides* ? **[CPMT 2000]**
(1) 200-350 mm (2) 150-320 mm
(3) 100-150 mm (4) 50-80 mm

Q.196 Larvae of Ascaris hatch out in –**[CPMT 2001]**
(1) Soil (2) Intestine
(3) Liver (4) Lungs

Q.197 The animal in which sexes can be differentiated from external morphology is- **[Manipal 2001]**
(1) Taenia (2) Krait
(3) Ascaris (4) Sea Anemone

Q.198 Which of the two characters are typical of *Ascaris* ? **[CPMT 2002]**
(1) Sexual dimorphism and rhabditiform larva
(2) Hermaphroditism and pseudocoelomic
(3) Parasitism and metamerism
(4) Multilocular heart

Q.199 The body cavity of *Ascaris* is :**[CPMT 2002]**
(1) lined by mesoderm
(2) not lined by mesoderm
(3) formed by ectoderm
(4) filled with parenchyma

Q.200 Pseudocoel is present in- **[RPMT 2004]**
(1) Periplaneta (2) Ascaris
(3) Pheretima (4) Hydra

Q.201 Ascaris is found in- **[RPMT 2004]**
(1) Body cavity (2) Lymph nodes
(3) Tissue (4) Alimentary canal

Q.202 Ascaris is- **[RPMT 2004]**
(1) A parasite (2) A autotroph
(3) Facultative autotrophs
(4) Facultative heterotroph

Q.203 The male ascaris is differentiated from female ascaris in which character- **[RPMT 2005]**
(1) It is long
(2) Penial setae with curved tail
(3) Penial setae in long tail
(4) Curved tail without penial setae

Q.204 In ascaris, cuticle is derived from- **[RPMT 2005]**

(1) Epidermis
(2) Muscles of endodermis
(3) Syncitium (4) Mesoglea

Q.205 Ascaris in man is found in- **[RPMT 2006]**

(1) Stomach (2) Intestine
(3) Urinarybladder (4) Rectum

EARTHWORM

Q.206 What is common between earthworm, leech and centipede- **(CBSE 1993)**

(1) Absence of legs
(2) Presence of ventral nerve cord
(3) Presence of malpighian tubules
(4) They are hermaphrodite

Q.207 Photoreceptor in pheretima are-**(CPMT 1993)**

(1) On ventral side of skin
(2) On dorsal side of skin
(3) On both
(4) In clitellum

Q.208 Trait common amongst Earthworm, Leech and Centipede is- **(PCS 1993)**

(1) Absence of legs
(2) hermaphrodite nature
(3) Ventral nerve cord
(4) Malpighian tubules

Q.209 In Earthworm, testes occur in segments- **(CPMT 1994)**

(1) 12 and 13 (2) 10 and 11
(3) 14 and 15 (4) 17 and 18

Q.210 In Earthworm, arrangement of blood vessels is- **(BHU 1994)**

(1) Different in last fifteen segments
(2) Different in first thirteen segments
(3) Same throughout
(4) Different in middle thirteen segments

Q.211 In a copulatory pair of earthworms, there occur- **(BHU 1994)**

(1) Reciprocal fertilization and internal fertilization
(2) Cross fertilization and external fertilization
(3) External fertilization and internal fertilization
(4) Cross fertilization and reciprocal fertilization

Q.212 Excretory organs of Earthworm are- **(RPMT 1995)**

(1) Coelom (2) Flame cells
(3) Nephridia (4) Gizzard

Q.213 In Earthworm, setae are absent from- **(RPMT 1995)**

(1) Clitellum
(2) First segment
(3) Clitellum and last segment
(4) Clitellum, first and last segment

Q.214 Excretory organ of Earthworm are- **(Manipal 1995)**

(1) Nephridia (2) Solenocytes
(3) Green glands (4) Kidneys

Q.215 Just as there are nephridia in earthworm so are- **(CBSE 1996)**

(1) Myotomes in fish (2) Statocyst in prawn
(3) Parotid gland in toad
(4) Flame cells in liver fluke

Q.216 Spermathecal pores in Pheretima are present in segments- **(CPMT 1996)**

(1) 1/2, 2/3, 3/4, 4/5
(2) 6/7, 7/8, 8/9, 9/10
(3) 5/6, 6/7, 7/8, 8/9
(4) 14/15, 15/16, 16/17, 17/18

Q.217 Life span of Earthworm are is-**(RPMT 1996)**

(1) 1-3 years (2) 2-8 years
(3) 3.5-10.5 years (4) 6-8 years

Q.218 Copulation period of Earthworm is- **(RPMT 1996)**

(1) One hour (2) Two hours
(3) Four hours (4) About one week

Q.219 Dorsal vessel of Earthworm is- **(APMEE 1996)**

(1) Distributing (2) Collecting
(3) Collecting in first thirteen segments and distributing in the rest
(4) Distribution in first thirteen segments and collecting in the rest

Q.220 Spermathecal pores of pheretima are present in- **(CPMT 1996)**

(1) 5/6, 6/7, 7/8 and 8/9
(2) 6/7, 7/8, 8/9 and 9/10
(3) 1/2, 2/3, 3/4 and 4/5
(4) 14/15, 15/16, 16/17 and 17/18

Q.221 Typholosole found in Pheretima occurs in- **(CPMT 1996)**

(1) Oesophagus (2) Stomach

(3) Gizzard (4) Intestine

Q.222 Chromophil cells present in pharynx of Earthworm take part in secretion of- **(RPMT 1996)**

(1) Mucus (2) Lipases

(3) Carbohydrases (4) All the above

Q.223 Who wrote the memoir on pheretima and described its anatomy- **(BHU 1997)**

(1) M.L. Bhatia (2) B.I. Sunderraj

(3) K.N. Bahl (4) Beni Prasad

Q.224 Chloragogen cells in pheretima are specialised for- **(CPMT 1998)**

(1) Nutrition (2) Excretion

(3) Reproductive (4) Respiration

Q.225 Spermatheceae of Earthworm take part in- **(RPMT 1998)**

(1) Collection of sperms of other worm

(2) Collection of sperms of the same worm

(3) Sperm maturation

(4) Fertilization

Q.226 Nephrostome occurs in- **(RPMT 1998)**

(1) Septal nephridia

(2) Integumentary nephridia

(3) Pharyngeal and septal nephridia

(4) Pharyngeal and integumentary nephridia

Q.227 Haemoglobin is dissolved in blood plasma of- **(CPMT 1998)**

(1) Rabbit (2) Cockroach

(3) Earthworm (4) Frog

Q.228 Role of typhlosole of earthworm is to- **(BHU 1997; CPMT 1998)**

(1) Emulsify

(2) Control blood flow

(3) Increase absorption area of digested food

(4) Produce digestive enzymes

Q.229 Function of spermatheca in Earthworm is - **[RPMT - 1998]**

(1) Sperm maturation

(2) Collection of sperms of same animal

(3) Collection of sperms of other animal

(4) Fertilization

Q.230 Nephrostome is a component of - **[RPMT - 1998]**

(1) septal nephridia

(2) integumentary nephridia

(3) pharyngeal and septal nephridia

(4) pharyngeal and integumentary nephridia

Q.231 Which one exhibits concentric tube-within tube plan- **(Manipal 1999)**

(1) Arthropoda

(2) Oligochaeta/Earthworm

(3) Mollusca

(4) Echinodermata

Q.232 Closed circulatory system occurs in- **(Manipal 1999)**

(1) Earthworm (2) Cockroach

(3) Grasshopper (4) Housefly

Q.233 Which one is not deuterostome-

(1) Chordata (2) Cephalochrodata

(3) Annelida (4) Echinodermata

Q.234 In earthworm mouth is situated on- **(APMEE 1999)**

(1) Protomium (2) Peristomium

(3) Stomium (4) Protostomium

Q.235 Annelida is advanced over nematoda in having- **(DPMT 1999)**

(1) Closed circulation

(2) Metameric segmentation

(3) True coelom (4) All the above

Q.236 Haemoglobin in Earthworm is present in : **[RPMT 1999]**

(1) RBC (2) protoplasm

(3) coelomic fluid (4) plasma

Q.237 Fertilization in Earthworm is : **[RPMT 1999]**

(1) cross fertilization

(2) combined fertilizaion

(3) self-fertilization (4) all of these

Q.238 Segments of Earthworm are called : **[RPMT - 1999]**

(1) metamere (2) sarcomere

(3) prostomium (4) podomeres

Q.239 Which parasite is present in seminal vessicle of Earthworm ? **[RPMT - 1999]**

(1) *Monocystis* (2) *Nosema*

(3) *Sasrcocystis* (4) *Nictotherus*

Q.240 In Earthworm dorsal blood vessel is collecting channel- **(AMU 2000)**

(1) Behind 13th segment

(2) Anterior 13 segment

(3) Throughout

(4) In typhlosolar region

Q.241 In Pheretima, septa are absent-**(CPMT 2000)**

(1) 5/6, 10/11 (2) 5/6, 7/8

(3) 6/7, 7/8 (4) First four segments

Q.242 Blood vessel in Pheretima having valves is- **(AIIMS 2000)**

(1) Dorsal (2) Ventral

(3) Lateral (4) Integumentary

Q.243 Male genital apertures of earthworm are located in the segments- **(CBSE 2000)**

(1) 14 (2) 18

(3) 13 (4) 19

Q.244 Chloragogen cells of Earthworm are similar to an organ of vertebrates- **(Har. PMT 2000)**

(1) Liver (2) Lung

(3) Kidney (4) Spleen

Q.245 In *Pheretima* blood glands are found in which of the following segments ? **[RPMT - 2000]**

(1) 1, 2, 3 (2) 7, 8, 9

(3) 4, 5, 6 (4) 10, 11, 12

Q.246 How many lateral hearts are in *Pheretima* ? **[RPMT - 2000]**

(1) 12 (2) 16

(3) 8 (4) 4

Q.247 In pheretima lymph gland produces : **[RPMT - 2000]**

(1) lymphocyte cells (2) phagocyte cells

(3) oxynitic cells (4) amoebocyte cells

Q.248 In *Pheretima* mouth develpos form which of the following ? **[RPMT - 2000]**

(1) Ectoderm (2) Mesoderm

(3) Blastopore (4) Endoderm

Q.249 In *Pheretima* which nephridia is present ? **[RPMT - 2000]**

(1) Protonephridia

(2) Coelom duct

(3) Micro-metanephridia

(4) Solenocytes

Q.250 The animal which respires without respiratory organs is- **(CPMT 2000)**

(1) Frog (2) Fish

(3) Earthworm (4) Cockroach

Q.251 Septum is lacking in Pheretima in segments- **(CPMT 2001)**

(1) 7/8, 6/7 (2) 3/4, 9/10

(3) 4/5, 8/9 (4) 6/7, 8/9

Q.252 Neurons of Pheretima are- **(CPMT 2001)**

(1) Only motor (2) Only adjustor

(3) Only Sensory (4) All

Q.253 Blood vessel in earthworm are- **(AFMC 2002)**

(1) Different in last 15 segments

(2) Different in first 13 segments

(3) Same through out

(4) Different in middle segments

Q.254 Which one is not true about earthworm- **(CPMT 2002)**

(1) It can live in deficiency of O_2 for 3-10 hours

(2) It has life span of 3½ to 10 years

(3) Pineal setae are dissolved in KOH

(4) It is soilivorous

Q.255 Enteronephric nephridia of earthworm also performs function of- **(CBSE 2002)**

(1) Respiration (2) Excretion

(3) Osmoregulation (4) Thermoregulation

Q.256 In *Pheretima*, locomotion occurs with the help of : **[RPMT - 2002]**

(1) circular muscles

(2) longitudinal muscles and setae

(3) circular, longitudinal muscles and setae

(4) parapodia

Q.257 The functiion of clitellum in *Pheretima* is : **[RPMT - 2002]**

(1) formation of cocoon

(2) secretion of hormone

(3) nutrition of sperm (4) respiration

Q.258 Metameric segmentation is the main feature of- **[RPMT - 2004]**

(1) Annelida (2) Echinodermata

(3) Arthropoda (4) Coelenterata

Q.259 Earthworm takes food by which method- **[RPMT-2005]**

(1) Ciliary feeding (2) Detritus feeding

(3) Liquid feeding (4) None of these

Q.260 Nerves in earthworm are- **[RPMT-2005]**
(1) Motor (2) Sensory
(3) Adjuctor (4) All

Q.261 The brown colour of Earthworm is due to- **[RPMT-2005]**
(1) Melanin (2) Haemoglobin
(3) Porphyrin (4) 1 & 3 both

Q.262 In earthworm gizzard is found in which segment- **[RPMT-2006]**
(1) 7 (2) 8
(3) 9 (4) 10

Q.263 Cocoon is formed in earthworns in- **[RPMT-2006]**
(1) Chitinous setae (2) Cutitcle
(3) Clitellum (4) Epidermal muscles

COCKROACH

Q.264 The principal function of blood vascular system in cockroach is - **(CPMT-1993)**
(1) Distribution of absorb nutrients
(2) Distribution of oxygen
(3) Transportation of enzymes
(4) Transportation of heat

Q.265 Function of stomodael valve in the gut of cockroach is to prevent the entry of food from- **(CPMT-1993)**
(1) Gizzard into midgut (2) Preoral cavity
(3) Hindgut to midgut (4) Midgut into gizzard

Q.266 One common feature of tracheae of cockroach and rabbit is that both- **(CBSE-1993)**
(1) Have ciliated inner lining
(2) Are paired and branched
(3) Have cartilagenous ring
(4) Have non collapsible wall

Q.267 The total no of ganglia present on the nerve cord of cockroach is - **(AFMC-1993)**
(1) 6 (2) 9
(3) 10 (4) 12

Q.268 A - Periplaneta americana is nocturanal omnivorous, house hold pest- **(CBSE-1993)**
R - It is because it act as scavenger
(1) A is true but R is false
(2) A is false but R is true
(3) A and R is true and R is the right explanation of A
(4) A and R is true but R is not correct explanation of A

Q.269 Basic difference between periplaneta americana and Blatta orintalis is in - **(CPMT-1994)**
(1) Body size (2) wings length
(3) length of antenna (4) life history

Q.270 Alary muscles in cockroach occur in- **(CPMT-1994)**
(1) Heart wall and help in blood circulation
(2) Dogsal septum and connect the septum with heart and tergite
(3) wall of gizzard and help in its contraction
(4) intestinal wall and help in digestion

Q.271 Insects excrete nitrogen as- **(CMEET-1994)**
(1) Uric acid (2) Guanine
(3) Urea (4) Ammonia

Q.272 Two common Indian cockroaches are - **(CPMT-1994)**
(1) Periplaneta american and Blatta indica
(2) Periplaneta orientalis and Blatta americana
(3) Periplaneta americana and Blatta orientalls
(4) Periplaneta indica and Blatta orientalis

Q.273 Number 16 in cockroach is concerned with - **(CPMT-1995)**
(1) Body segments (2) malpighian tubule
(3) tracheae (4) ootheca

Q.274 Which part of cockroach has both exoskeleton and endoskeleton - **(RPMT-1995)**
(1) Head (2) Thorax
(3) Both of these (4) None of these

Q.275 Male and female cockroaches can be distingushed externally through - **(RPMT-1995)**
(1) Anal styles in male
(2) Anal cerci in female
(3) Anal style and antennae in female
(4) both (2) and (3)

Q.276 The component units of compound eye of cockroach are called -**(KME Manipal-1995)**
(1) Eyelets (2) Fenestra
(3) Ommatidia (4) Ocelli

Q.277 Metamorphosis in the life history of periplaneta is- **(RPMT-1995)**
(1) Absent (2) Incomplate
(3) Complete (4) Pupa

Q.278 Young cockroach is called - **(RPMT-1995)**
(1) Maggot (2) Ephyra
(3) Nymph (4) Pupa

Q.279 The first animals to fly were - **(RPMT-1995)**
(1) Mammals (2) Lizards
(3) Birds (4) Insect

Q.280 Periplaneta americana differs from blatta orientalis in having - **(CPMT-1996)**
(1) no wings
(2) only first pair of wings
(3) well developed wings
(4) only second pair of wings

Q.281 Diagnostic feature of insects in **(PCS-1996)**
(1) Three pairs of legs (2) Compound eye
(3) Chitinous body (4) Two pairs of wings

Q.282 The pincer like structures present on the stipes of maxilla of cockroach are -**(EAMCET-1996)**
(1) Cardo (2) lacinia
(3) galea (4) paraglossa

Q.283 The longest segment in the leg of cockroach is- **(CMEET-1996)**
(1) Coxa (2) femur
(3) tibia (4) trochenter

Q.284 The respiratory system of cockroach consist of- **(CMEET-1996)**
(1) Bronchus (2) Trachea
(3) Bronchiole (4) Capillary

Q.285 Reduced (vestigial) wings are found in - **(CPMT-1997)**
(1) Periplaneta (2) mosquitoes
(3) female blatta (4) male blatta

Q.286 In arthropoda, the body cavity is called- **(AFMC-1997)**
(1) Interon (2) Pseudocoel
(3) Haemocoel (4) Coelom

Q.287 13 chambered tubular heart is present in- **(AFMC-1997)**
(1) Cockroach (2) Earthworm
(3) Frog (4) Rabbit

Q.288 Open blood vascular system without haemoglobin or any other respiratory pigment is found in- **(CBSE-1998)**
(1) cockroach (2) earthworm
(3) Hydra (4) Nereis

Q.289 Malpighian tubules remove excretory products from- **(CPMT-1998)**
(1) alimentary canal only
(2) haemolymph only
(3) both (4) none

Q.290 Superposition image forms in cockroach during- **(CPMT-1998)**
(1) dim light (2) dark light
(3) bright light (4) none of these

Q.291 Collaterial gland is found in - **(CPMT-1998)**
(1) male cockroach (2) female cockroach
(3) none (4) both

Q.292 How many segments are present in cockroach's head - **(RPMT-1998)**
(1) 6 (2) 5
(3) 9 (4) 10

Q.293 Haemocoel is found in - **(RPMT-1998)**
(1) Hydra and Aurelia
(2) Taenia and Ascaris
(3) Cockroach and pila
(4) Herdmania and Balano glosses

Q.294 If corpora allata are removed from Ist instar of a nymph then - **(RPMT-1998)**
(1) It will remain nymph forever
(2) It will enter into secondary stage of juvenile
(3) It will become adult immediately
(4) None

Q.295 An insect which undergoes complete metamorphosis is called - **(RPMT-1998)**
(1) Ametabola (2) Hemimetabola
(3) Holometabola (4) None of these

Q.296 Pericardial space in cockroach is regularly altered by muscles - **(CPMT-1998)**
(1) Ciliary (2) Alary
(3) Circular (4) Longitudinal

Q.297 Antennae of Cockroach function as **(RPMT-1998)**
(1) tactile and sensory receptor
(2) gustatory receptor
(3) auditory receptor (4) olfactory receptor

Q.298 Male Cockroach can be identified by - **(RPMT-1998)**
(1) anal style (2) anal cerci
(3) antennae (4) wings

Q.299 Function of ecdysone hormone in insect is - **(RPMT-1998)**
(1) the growth and development of larva
(2) the maturation into adult and laying eggs
(3) to carry moulting in larval stage to form pupa
(4) the secretion of cuticle in adult

Q.300 Which of the spiracles in Cockroach are larger keep open always - **(RPMT-1998)**
(1) First and second pair
(2) First and third pair
(3) First and tenth pair
(4) Second and third pair

Q.301 Oxygen carrying respiratory pigment of cockroach and other insect is- **(CBSE-1999)**
(1) Haemoglobin (2) Haemocynin
(3) Haemoerythrin (4) none

Q.302 Body of an insect is divisible into - **(CBSE-1999)**
(1) Head, thorax and abdomen
(2) Head, trunk and abdomen
(3) Cephalo thorax, head and abdomen
(4) Trunk, thorax and abdomen

Q.303 What is similarity between fly, mosquitoes and cockroach - **(BHU-1999)**
(1) 13 chambered heart
(2) 3 pairs of legs
(3) open excretory system
(4) house fly

Q.304 Respiration pigment of blood Cockrocach is : **(RPMT-1999)**
(1) haemozoine (2) haemocyanin
(3) haemoglobin (4) absent

Q.305 Changing of a small Cockroach into adults is know as : **(RPMT-1999)**
(1) moulting (2) metamorphosis
(3) ecdysis (4) transformation

Q.306 Cockrocach is an animal of which class ? **(RPMT-1999)**
(1) Hexapoda (2) Apoda
(3) Meriopoda (4) Cephalopoda

Q.307 Which type of image is found in eye of Cockroach ? **(RPMT-1999)**
(1) Mosaic (2) Superposition
(3) Overlappring (4) None of these

Q.308 Mandibles are present in the mouth parts of - **(BHU-2000)**
(1) locust (2) cockroach
(3) bedbug (4) housefly

Q.309 The palpiger of cockroach bears - **(EAMEET-2000)**
(1) lingula (2) submentum
(3) labrum (4) labial palp

Q.310 Hormone prouduced by corpora allata in insects is - **(HPMT-2000)**
(1) growth hormone (2) juvenile hormone
(3) inhibiting hormone (4) moulting hormone

Q.311 Ecdysone is produced by - **(PCS-2000)**
(1) prothoracic gland (2) corpora cardiaca
(3) corpore allata (4) abdominal gland

Q.312 The number of eggs in ootheca of Cockroach is : **(RPMT-2000)**
(1) 8 (2) 16
(3) 32 (4) 64

Q.313 Which one of the following mouth parts are found in Cockroach ? **(RPMT-2000)**
(1) Cutting and chewing
(2) Piercing
(3) Sucking
(4) Drilling

Q.314 In *Periplaneta* the cuticular lipid is secreted by: **(RPMT-2000)**
(1) hypodermal cells (2) oenocyte cell
(3) dermal gland cells (4) basal cell

Q.315 How many Malpighian tubules in Cockroach are present ? **(RPMT-2000)**
(1) 80-90 (2) 100-150
(3) 50-60 (4) 200-250

Q.316 Mouth parts of cockroach is **(CPMT-2001)**
(1) Piercing and sucking type
(2) Biting and sucking type
(3) Biting and chewing type
(4) sponging type

Q.317 Basic unit of compound eyes of Cockroach is: **(RPMT-2001)**
(1) ocselli (2) ommatidia
(3) ratinule (4) crystalline cone

Q.318 In Cockroach vision is due to :**(RPMT-2002)**
(1) one compound eye
(2) only two compound eyes
(3) two simple eyes
(4) two compound and two simple eyes

Q.319 Haemocoel is present in- **(RPMT-2004)**
(1) Pheretima (2) Periplaneta
(3) Sponge (4) Ascaris

Q.320 Chitinous exoskeleton found in-**(RPMT-2004)**
(1) Periplaneta (2) Ascaris
(3) Pheretima (4) Hydra

Q.321 Which type of hearts are found in Cockroach- **[RPMT-2005]**

(1) Neurogenic (2) Myogenic
(3) Neuromyogenic (4) None

Q.322 The enormous amount in saliva of cockroach- **[RPMT-2005]**

(1) Amylase (2) Protease
(3) Lipase (4) None

Q.323 Anterior wings of cockroach is called as- **[RPMT-2006]**

(1) Alitra (2) Pedpalps
(3) Antenna (4) Chelicera

Q.324 In cockroach number of segaments in muscle abdomen are- **[RPMT-2006]**

(1) 10 (2) 12
(3) 14 (4) 16

Q.325 Which one of the following organisms is scientifically correctly named, correctly printed according to the International Rules of Nomenclature and correctly described ? **[AIPMT Mains 2012]**

(1) *Musca domestica* - The common house lizard, a reptile
(2) *Plasmodium falciparum* - A protozoan pathogen causing the most serious type of malaria.
(3) *Felis tigris* - The Indian tiger, well protected in Gir forests.
(4) *E. coli* - Full name *Entamoeba coli*, a commonly occurring bacterium in human intestine

ANSWER KEY

EXERCISE – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	1	4	2	4	4	3	3	3	2	1	1	2	3	2	4	4	4	3	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	2	4	4	2	1	4	2	1	1	1	2	2	2	1	4	3	3	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	1	3	3	2	1	3	1	1	3	3	3	4	2	3	3	2	1	2	4
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	4	2	1	4	1	2	4	1	4	1	3	1	2	2	3	4	2	4	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	2	1	3	1	3	3	2	2	2	3	2	2	3	4	3	4	1	3	4
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	1	2	2	1	2	2	3	4	3	2	1	1	2	1	4	3	2	1	4
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	4	1	2	4	2	2	1	3	2	1	4	4	3	3	3	2	3	2	3
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	1	2	1	1	4	1	3	3	2	2	3	1	3	1	4	1	1	2	1	2
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	2	2	1	4	1	3	3	2	3	1	4	2	1	2	4	3	2	4	1	4
Ques.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
Ans.	1	3	4	1	3	1	4	2	4	2	2	1	3	3	1	2	3	1	2	2
Ques.	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
Ans.	4	1	2	1	2	2	2	3	2	2	4	3	4	1	4	3	3	1	4	1
Ques.	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Ans.	4	1	3	2	1	1	3	3	2	2	2	1	3	2	4	4	1	1	1	1
Ques.	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
Ans.	4	1	2	1	3	4	1	1	3	3	2	4	2	3	3	2	1	1	2	4
Ques.	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
Ans.	3	2	3	1	4	4	2	1	2	1	1	3	4	3	1	3	2	3	4	3
Ques.	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
Ans.	1	2	3	2	3	3	1	1	2	4	2	1	3	3	3	2	1	1	3	2
Ques.	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
Ans.	4	1	2	4	2	1	1	2	4	2	1	2	1	2	2	3	2	2	2	1
Ques.	321	322	323	324																
Ans.	1	1	1	1																

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** Zoochlorella alge prsence in Hydra.
R : Hydra is not benefited but algae obtains CO_2.

Q.2 **A :** Tester are more on the oral half and ovary is one on the oboral half of Hydra.
R : More number of sperms Increase the chances of Fertilization.

Q.3 **A :** Stero - gastrula presence in Hydra.
R : Gastrula in Hydra is formed by Delamination

Q.4 **A :** Nematablast cells are presence in Hydra.
R : Maximum Nematablast are found in Basal disc.

Q.5 **A :** Presence of polyp and medusa is a salient feature of class Hydrozoa
R : Hydra has more dveloped poly and less developed medusa.

Q.6 **A :** Symboitic algae is transmitted from generation to generation in Hydra.
R : Transmitted the algae by both bud and ovum.

Q.7 **A :** Nematoblast is used once only in Hydra.
R : They are special modification of the interstitial cells.

Q.8 **A :** Hydra do not exhibit any response to the water Temperature.
R : It is negative to cathode and positive to anode when mild current is passed.

Q.9 **A :** Cross fertilization is presence in Hydra.
R : Protandrous candition is presence in Hydra.

Q.10 **A :** Hydra is unable to digest starch.
R : Amylash enzyme is absence in Hydra.

Q.11 **A :** The head of cockroach is hypognathus.
R : Proximal part of lower lip of cockroach is called pastmentum.

Q.12 **A :** The heart of cockroach is neurogenic.
R : He heart beats in cockroach are 49 perminute.

Q.13 **A :** Albectoreceptors are found on the antennae.
R : Phonoreceptors are found on the joints of legs.

Q.14 **A :** Corpora allata glands secrete maulting harmone.
R : Carpora cardiaca secrets juvenile harmone.

Q.15 **A :** Earthworm is brown or clay coloured.
R : Because of presence of pigment parphyrin.

Q.16 **A :** Chlorogogen cells are considered, analogous to liver of vertebrates.
R : Because it is concerned with storage of reserve food, deamination of protiens, formation of urea etc.

Q.17 **A :** Earthworm is saprozoic.
R : Because it feed on small insect.

Q.18 **A :** Earthworm is hermophrodite.
R : Because in earthworm both sexes are separate.

Q.19 **A :** Earthworms are enemy of farmer.
R : Because they destroy the crop in field.

Q.20 **A :** In body of earthworm porphyrin pigment is found.
R : Because it protect earthworm from chemicals.

Q.21 **A :** In earthworm development is direct.
R : Because in development larval stage is not found.

Q.22 **A :** In anus of earthworm, depressor ani muscle are found.
R : Which help in elimination of excretion from rectum.

Q.23 **A** : Plasmodium is blood- parasites.

R : Plasmodium is Digenetic parasites

Q.24 **A** : Malaria is spread by female Anopheles.

R : Female Anopheles is secondary host of plasmodium.

Q.25 **A** : Ascaris is a Resevoir host of plasmodium.

R : Plasmodium is unecellular parasits.

Q.26 **A** : Ziemann's dots found in plasmodium vivax.

R : Maurer's dots found is plasmodium malaria.

Q.27 **A** : Incubation period of plasmodium Ovale is 12-14 days.

R : Incubation period of plasmodium Malaria is 12-14 days.

Q.28 **A** : Lethal malaria spread by plasmodium vivax.

R : Quartan malaria spread by plasmodium Ovale.

Q.29 **A :** The Round worm are ecucoelomate.

R : They have a fluid- filled coelom.

Q.30 **A :** Reproductive system male ascaris is Telogonic.

R : They have only one Testes.

Q.31 **A :** The ascaris is pseudocoelomate.

R : Body cavity is not lined by mesoderm.

Q.32 **A :** During migration the ascaris stays 10 days in lungs

R : Larva of ascaris moults only once in lungs.

Q.33 **A :** Epidermis of ascaris is syncytium.

R : Epidermis of ascaris is multinucleated.

Q.34 **A :** Body cavity of ascaris have three cell bodies.

R : All cell bodies are present on pharynx.

Q.35 **A :** The ascaris have amoeboide tail less sperm

R : They have two uterus

Q.36 **A :** The ascaris have thick cuticle on body.

R : It is the mainparasitic adaptatios.

Q.37 **A :** Ascaris have poorly developed digestive system.

R : They gets pre digested food.

Q.38 **A :** Ascaris used glycogen in anaerobic respiration

R : Ascaris have cytochrome in body wall.

ANSWER KEY

EXERCISE-4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	1	3	3	2	2	4	1	1	2	2	3	3	1	1	3	3	4	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
Ans.	1	1	2	1	3	4	3	4	4	2	1	3	1	4	2	1	1	2		

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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ANIMAL KINGDOM-I

INTRODUCTION

- Taxomony (Gr.) - study of **nomenclature, classification** and their **principles.** This word was given by **''Candolle''** (**Taxis** – arrangements. Nomos - Law).
- Division of animals species on the basis of similiarity and dissimilirity is known as classification.
- **Systematics** is the scientfic study of the diversity of organisms.
- The term systematic was coined by **Carolus Linnaeus** in 1735.
- **Founder of modern taxonomy** is **Carolus Linnaeus,** a Swedish botanist.
- The foundation of modern classification was laid in the book Linnaeus, 'Systema Nature' (10th edition) in 1758.
- Linnaeus introduced **binomial nomenclature.**

HISTORICAL BACKGROUND OF TAXONOMY

- **Aristotle : -** "father of zoology ". (Book : **Historia Animalium)**
  Father of ancient animal – Classification. He classified animals into two groups on the basis of their natural similarities and differences into –

(i) Anaima :- Those animals which don't have Red blood or in which RBC are absent e.g. Sponges, Cnidaria, Mollusca, Arthropoda. Echinodermata like Invertebrates.

(ii) Enaima :- These animals have red blood. This group includes all vertebrates and it has been further divided into two sub groups.

(a) Vivipara :- It incldues animals which give birth to young-ones e.g. Man, Whale and other mammals.

(b) Ovipara :- It includes animals which lay eggs. e.g. Amphibians, Pisces, Aves, Reptiles etc.

- **Pliny :-** He classified animal into groups : -
  (a) Flying **(b) Non-flying**
- **John-Ray :-** He gave & defined the term **'' species''** as the smallest unit of classfication. He gave **''concept of species ''**. According to him, the organisms which develop from the similar type of parents, belong to the same-species.
- **Mayr : -** According to him similar species are those which are capable of interbreeding in natural conditions. Modern definition of species is coined by **''Mayr''.**
- Binomial system of Nomenclature was devised by **Gesparrd-Bauhin.** But the detailed information about Binomial system was given by **Linnaeus**. In 1758 in the 10^{th} edition of his book **''Systema Naturae''** he gave the classification of known 4236 animals and presented the Binomial system of nomenclature of animal. He is also known as **''Father of Modern-Taxonomy''**
- In binomial system the name of each animal has two parts. First part has its **genus** name and second part has its **species** name. First letter of genus name must be written in **Capital letter** species name is written in **small letters** eg. **Canis familiaris.** In certain species, sub-species are also found. For naming the sub species three words are used. First name is for genus, second for species and third for sub-species. The method of nomenclature of Sub-species is termed as the **Trinomial nomenclature** and it was given by **''Huxley** and **Strickland''**. eg. ***Homo sapiens sapiens.***
- **G.L. Cuvier : -** Coined the term **Phylum.**
- **Julian-Huxley** (1940) : - Proposed **New systematic.**
- **Engler and Prantl : -** Proposed **Phylogenetic classification.**

- **Key** for identification of animal was developed by **John Ray.**
- **Invertebrate** and **Vertebrate** term was given by **Lamarck.**
- **Robert Whittaker** (1969) **: -** Proposed **Five-Kingdom system classification** to show phylogenetic relationship.
  (1) Monera (2) Protista (3) Fungi (4) Plantae (5) Animalia
- **Linnaeus** classified animal kingdom into 6-classes.
  (1) Mammalia (2) Aves (3) Amphibia (4) Insecta (5) Pisces (6) Vermes
- **Storer and Usinger** classified whole animal kingdom into 31 phyla. Out of which 10 are major and 21 are minor phyla. Main phyla are :

Phylum	**Protozoa** (Single-celled)	Euglena, Amoeba, Paramecium, Trypanosomes, malarial parasite.
Phylum	**Porifera** (porous)	Sponges.
Phylum	**Coelenterata** (sac-like, two layers of cells separated by non-cellular mesogloea; stinging cells (nematoblasts)	Hydra, colonial hydroids, jellyfish, sea anemones, corals
Phylum	**Platyhelminthes** (flatworm)	Planarians, Parasitic flukes, tapeworm
Phylum	**Nematoda** (round worms)	Ascaris, hookworms, Wuchereria (filaria)
Phylum	**Annelida** (ringed worms, segmented)	
	Polychaeta	Neris (ragworm), fanworms, lugworm.
	Oligochaeta	Earthworm
	Hirudinea	Leeches
Phylum	**Mollusca** (soft-bodied typically with shell)	
	Gastropoda	Whelks, Limpets, snails, slugs.
	Lamellibranchiata (bivalves)	Mussels, clams, oysters.
	Cephalopoda	Squids and octopuses
Phylum	**Arthropoda** (jointed limbs, hard exoskeleton)	
	Crustacea	Water fleas, Sacculina, Barnacles, Shrimps, Woodlice, Prawns, Crayfish, Lobsters, Crabs
	Myriapoda	Centipedes and millipedes
	Arachnida	Eurypterids (fossils), horseshoe crab (Limulus), scorpions, mites, ticks,
	Insecta	Spiders, Cockroach, lucust, aphids, lice, mosquitoes, flies, fleas, bees, bug (e.g. rhodnius), butterfish and moths
Phylum	**Echinodermata** (Spiny-skinned, pentaradiate)	starfish, brittle stars, sea urchins, sea cucumbers, sea lilies.
Phylum	**Chordata** (possess notochord at some stage in life history)	

	Protochordata (invertebrate chordates) Vertebrata (notochord replaced by vertebral column) Cyclostomata (jawless fishes) Pisces (true fishes) Amphibia Reptilia Aves (birds)	sea squirts, acorn worms, amphioxus Lampreys and hagfishes Elasmobranchs (Modern cartilaginous fish) e.g. dogfish, rays, sharks, teleosts (modern bony fishes) e.g. cod. Newts, salamanders, frogs, toads Dinosaurs, lizards, crocodiles, turtle snakes Pigeons, gulls, kiwi, ostrich etc.
	Mammalia	
	Monotremes (egg-lying) Marsupials (pouch mammals with rudimentary non-allantoic placenta) Eutherians (have true placenta)	duck-billed platypus, spiny anteater opossums, tasmanian wolf (thylacinus), koala bear, kangaroos the many group include the rodents great cats, and primates (e.g. baboons, chimpanzee, man)

SEQUENCE OF CLASSIFICATION

- Smallest unit of classification is **''Species''. Genus** includes various types of species. **Family** is made up of various genera. Many families join together to form an **Order,** many order join together to form a **class** and many classes form a **Phylum.** All the phyla unite to form the largest unit i.e. **Kingdom.**
  Various grouping levels or ranks in classification known as Obligate categories.
  e.g., kingdom — Phylum — Class — Order — Family — Genus — Species
- Based on this, all animals are included in the animals kingdom – groups and written in the following Hierarchical manner. For example obligate category of man can be written as

TAXA		**Category**
Kingdom	⟶	Animalia
Phylum	⟶	Chordata
Class	⟶	Mammalia
Order	⟶	Primates
Family	⟶	Hominidae
Genus	⟶	***Homo***
Species	⟶	***Sapiens***

BASIS OF CLASSIFICATION

Some Term related to Animal Body :

1. **Anamniotes :** Vertebrates without embryonic membranes e.g., fishes, amphibians.
2. **Amniotes :** Vertebrates with embryonic membranes (chorion, amnion, allantois, yolk sac) e.g., reptiles, birds, mammals.

3. **Acraniata or Protochordata :** Chordates without cranium (brain box). It includes urochordata and cephalochordata.
4. **Chordates :** Animals with notochord dorsal tubular nerve cord, paired pharyngeal gill slits. All urochordates, cephalochordates and vertebrates are called chordates.
5. **Craniata or Vertebrate :** Chordates with cranium. It includes cyclostomes, pisces, amphibians, reptiles, birds and mammals.
6. **Nonchordates :** Animals without notochrod (a rod like elastic structure which supports the body). Phylum Porifera to phylum Hemichordata are called nonchordates.
7. **Invertebrates :** Animals without vertebral coloumn (backbone) All the nonchordates, urochordates and cephalochordates are collectively called invertebrates.
8. **Levels/Grades of organization :** Four levels of organization are found in muticellular animals.
   (i) **Acellular or Molecular or Protoplasmic level :** It is present in protozoans .
   (ii) **Cellualr level :** The body consists of many cells which may be similar or show minor division of labour. Distinct tissues are not formed e.g., sponges.
   (iii) **Tissue level :** The body is multicellular. The cells form poorly defined tissues. The cells occur in two distinct layers or tissues of specialized cells e.g., coelenterates.
   (iv) **Organ-system level :** The body is multicellular. The cells are organised into tissues, tissues into organs, organs into organ systems. Except sponges and coelenterates, all the animals of the kindom animalia have organ-system level of organization.

METAZOA

- The multicellular eukaryotic organisms with holozoic mode of nutrition are called as **metazoans.** Based on complexity of organization, metazoans are further sub-divided into two sub-kingdoms, the **Parazoa** and **Eumetazoa.**
- **Parazoa :** Parazoa includes the sponges in which the cells are loosely aggregated and do not form tissues or organs.
- **Eumetazoa :** Eumetazoa includes the rest of the animals, the cells are organized into structural and functional units called as tissues, organs and organ systems.

HABITAT

- The place on the earth, where an animal finds optimum conditions for food and shelter is called its **habitat**. Habitat can be defined as the physical and geometrical space where an organism lives.
- The habitat may be water, soil or earth's surface. On the basis of their habitat, animals can be of following types :

1. Terrestrial habitat :

- Animals which live on land or dry earth's surface, are said to have terrestrial habitats.
- Terrestrial animals are adapted for following types of habitat modes :
  a. Aerial or flying : These animals possess wings and therefore can fly. *e.g.,* Birds, bats.
  b. Arboreal : These animals mainly live on trees. *e.g.,* Bat, Monkey.
  c. Fussorial : These animals live in burrows or underground. *e.g.,* Rabbits, rat, earthworm etc.
  d. Scansorial : These animals can climb on walls, rocks etc. *e.g.,* Wall lizard, flying squirrel.
  e. Cursorial : These animals are adapted to run very fast. *e.g.,* Tiger, horse, dog etc.

2. Aquatic animals :

- These animals live in water. They may be **fresh water or marine water.**
- The aquatic animals may further be of following types :
  a. Zooplanktons : The animals which flow passively, with water current, on the surface of water, are called zooplanktons. *e.g.,* many aquatic protozoans, larvae, crustaceans etc.
  b. Nektons : These animals can float actively in water body even against water current. *e.g.,* many fishes such as sharks, many skates and rays.

c. Benthos : These animals live at the bottom of the water body. *e.g.,* Deep sea fishes, many echinodermates, sponges and corals.

d. Pelagic : These animals usually live at the surface or water body. These include both zooplanktons and Nektons.

HABITS

✯ Nature of living is called habit. Animals lead various types of life and on this basis, they are of following types:

a. Solitary animals : Animals which have singly (not in groups). *e.g.,* Taenia, Earthworm etc.

b. Colonial animals : Animals which live in groups and form colony. *e.g., Volvox,* honeybee, termites, wasp etc.

c. Gregarious animals : Animals which live in groups, but do not interact with each other. *e.g.,* locust.

d. Free living animals : Animals, which do not depends on other organisms for food and shelter and live independently. *e.g.*, cat, dog etc.

e. Parasitic animals : Animals which depends on other living organisms for food are called parasitic organisms. *e.g., Entamoeba, Taenia, Fasciola, Ascaris, Louse* etc.

f. Saprophagous animals : Animals which obtain their food from dead and decaying organisms and organic matter are called saprophagous animals. *e.g.,* house fly etc.

g. Sanguivorous animals : Animals which feed on the blood of other organisms. *e.g.,* Mosquitoes, Leech etc.

h. Sessile (sedentary) animals : Animals which do not move here and there are remain immotile, are called sessile organisms. *e.g., Herdmania*.

i. Motile animals : Animals, which have locomotory organs and can move here and there, are called motile organisms. *e.g.,* man horse etc.

j. Diurnal animals : Animals, which are active during day time for obtaining their food, are called **diurnal organisms**. *e.g.,* man, horse, dog etc.

k. Nocturnal animals : Animals, which are active at night for obtaining food are called **nocturnal animals**. *e.g.,* Cockroach etc.

l. Crepuscular animals : Animals which are active at dusk (evening) for obtaining their food are called crepuscular animals. *e.g.,* rabbit.

m. Vasperal animals : Animals which are active early morning. *e.g.,* Birds.

n. Caprophagous animals : Animals which can eat their own faecal matter to re-digest it. *e.g.,* Rabbit.

SYMMETRY

Animal Body symmetry is the similarity of parts in different regions and directions of the body. When the body is not divisible into equal havles by any plane it is called asymmetrical or asymmetric as found in Amoeba and some sponges. An animal is said to be symmetrical if its body is divisible into equal havles by one or more planes. Four types of symmetry found in animals are –

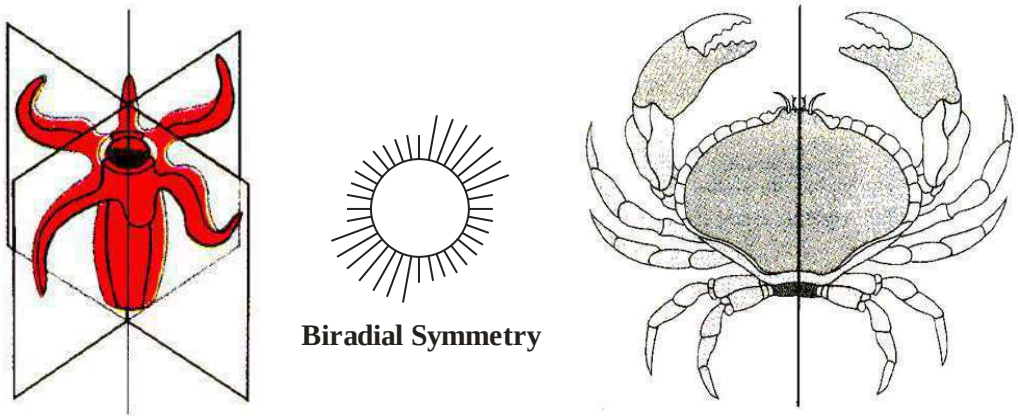
(a) Spherical symmetry : In this type of symmetry, any plane passing through the centre divides the body into equivalent of mirrored havles. It is found in animals whose body resembles a sphere e.g., Protozoans such as *Volvox*, *Heliozoa*, *Radiolaria*.

(b) Radial symmetry : In this type of symmetry, a number of similar parts radiate out from a central axis. The body of the individual can be divided into equal halves by any plane passing through the centre from top to bottom. This type of symmetry is found in some sponges (*Sycon*), coelenterates (e.g., *Hydra, jelly fish*), echinoderms (e.g., star fish).

(c) Biradial symmetry : In this type of symmetry, only two planes passing through the longitudinal axis. The body can be divided into two similar havles by one or two vertical planes only. This type of symmetry is found in sea walnuts (phylum ctenophora) and sea anemones (Anthozoa). The animals which show radial

and biradial symmetry have oral and aboral sides. The oral side is that which has mouth, whereas the aboral side is one which is opposite to oral side.

(d) Bilateral symmetry : In this type of symmetry the body can be divided into two equal havels by a median longitudinal or sagittal plan only. The appearance of bilateral symmetry in animal evolution was a major advancement, because bilateral animals are much better fitted for directional (forward) movement than in radial symmetrical animals. This type of symmetry is found in many invertebrates and all vertebrates.

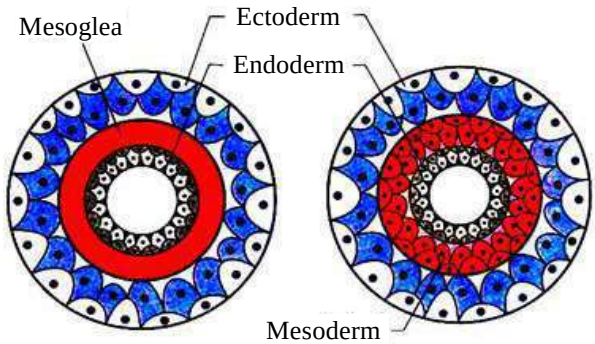


Radial symmetyry **Biradial Symmetry** **Bilateral symmetry**

Table 4.1 Difference between bilatral and radial symmetry

S. NO.	Bilateral Symmetry		Radial Symmetry
(i)	Body can be divided into two similar havles (the left and right) in one plane only.	(i)	Body can be divided into two equal parts by a number of radial divisions (lines passing through the centres).
(ii)	Examples. Invertebrates like roundworms, segmented worms, arthropods, molluscs and all vertebrates	(ii)	Examples. Sponges, coelenterates, adult echinoderms like starfish etc.

GERM LAYERS



Diploblastic **Triploblastic**

- Germ layers give rise to all the tissues/organs of the fully formed individuals. On the basis of germ layers, animals can be

(i) Diploblastic : In **Diploblastic animals** the body cells are arranged in two layers, an outer **Ectoderm** and an internal **Endoderm** with an intervening **Mesoglea.**

(ii) Triploblastic : If the body wall in animals is made up of three germ layer i.e. **ectoderm, mesoderm** and **endoderm**, they are called as **triploblastic animals.**

Table 4.2 Difference between bilatral and radial symmetry

S. NO.	Diploblastic animals		Triploblastic animals
(i)	These animals develop from two cellular layers only.	(i)	These animals develop from three cellular layers called three primary germ layers.
(ii)	The outer one is ectoderm and the inner one is endoderm. These layers are separated by a gelatinous non-cellular layer called mesoglea.	(ii)	There are three primary germ layers–outer ectoderm, middle mesoderm and inner endoderm. The layer mesoderm is significant in many aspects.
(iii)	Present in the lower metazoans (tissue level organisation) like coelenterates (Cnidaria)	(iii)	Present in the higher metazoans (organ-level organisation) like platyhelminthes, annelids, arthropods, echinoderms, molluscs and vertebrates

BODY PLAN

- Animals have three types of body plan :

(i) Cell aggregate : Cell aggregate type of body plan is present in sponges.

(ii) Blind sac : Blind sac type of body plan is present in **Platyhelminthes** and **Coelenterates,** where the alimentary canal has only one opening.

(iii) Tube within tube : Tube within tube type of body plan is present in **Nemathelminthes, Annelida, Arthropoda, Mollusca, Echinoderms Hemichordates** and **Chordates**. The digestive system is a continuous tube with an opening at each end. Tube-within-a-tube body plan has been **achieved in two different ways** in two evolutionary lines. In one called the **Protostomes,** the first opening to develop in the embryonic digestive tube is the mouth; the anus develops later. **This is seen in the annelid, mollusc and arthropod line.**
In the other, the **Deuterostomes,** the anus develops first and the mouth is formed later. This occurs in the Echinoderms Hemichordates and Chordates (including the vertebrates). We are thus evolutionarily closer to the **echinoderms (starfish)** than to insects or molluscs.

BODY CAVITY OR COELOM

- On the basis of coelom, animals can be

(i) Acoelomate : The animals in which the coelom is absent are called as **Acoelomates**, for example flatworms. In them the space between ectoderm and endoderm is filled with parenchyma e.g., Platyhelminthes.

(ii) Pseudocoelomate : The body cavity is not completely lined with mesoderm. Instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm. Such a body cavity is called as pseudocoelom **e.g roundworm.**

(iii) Eucoelomate : The true coelom is a body cavity which arises as a cavity in embryonic mesoderm. In this case, the mesoderm of the embryo provides a cellular lining, called as coelomic epithelium or peritoneum, to the cavity. The coelom is filled with coelomic fluid secreted by the peritoneum. The coelom is found in **Arthropods, Molluscs, Annelids, Echinoderms, Hemichordates** and **Chordates.** True coelom is of two types :

(a) Schizocoelom : It develops by the splitting up of mesoderm. It is found in annelids, arthropods and molluscs. **Body cavity of arthropods is called heamocoel.**

(b) Enterocoelom : The mesoderm arises from the wall of the embryonic gut or enteron as hollow outgrowths or enterocoelomic pouches. It occurs in Echinoderms, Hemichordates and Chordates.

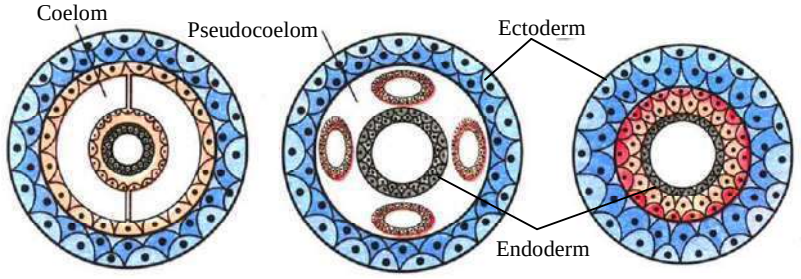


Table 4.3 Comparison amongst coelom, pseudocoelom and haemocoel

S. NO.	Coelom		Pseudocoelom		Haemocoel
(i)	The body cavity is lined with **mesoderm** on both the sides.	(i)	The body cavity is lined with **ectoderm** outside and endoderm inside.	(i)	A large blastocoel lined by ectoderm from outside and mesoderm on the inside.
(ii)	Contains a fluid called coelomic fluid.	(ii)	Contains large vacuolated cells having protein-rich fluid.	(ii)	Contains blood with colourless plasma called haemolymph.
(iii)	(a) Acts as a shock absorber (b) Provides space for enlargement of internal organs.	(iii)	Osmoregulatory in function	(iii)	Helps distend the body during moulting so that cuticle can slit open.

Table 4.4 Comparison between acoelomate and coelomate animals

S.NO.	Acoelomate animals		Coelomate animals
(i)	No body cavity, i.e., without coelom	(i)	True body cavity, i.e., coelom
(ii)	Mesoderm fills the entire area.	(ii)	Coelom is lined by mesoderm on both the sides.
(iii)	Lower metazoans like platyhelminthes	(iii)	Higher metazoans like annelids, vertebrates.

SEGMENTATION

- In some animals, the body is externally and internally divided into segments or metameres with serial repetition of atleast some organs. For example, in earthworm, the body shows metameric segmentation and the phenomenon is known as metamerism.

Table 4.5 Comparison amongst kinds of body segmentation

S. NO.	Unsegmented		Pseudosegmented or non-metamerically segmented		Metamerically segmented
(i)	Body is not divided into any segments e.g. platyhelminthes, roundworms.	(i)	body is divided into number of pseudosegments.	(i)	Body is divided into number of segments.
		(ii)	The segments are independent of each other.	(ii)	The segments are interdependent and together work as an organism.
		(iii)	Each segment is able to perform all the vital functions of the body.	(iii)	Each segment is specialised to perform certain important functions along with common functions.
		(iv)	Body grows by addition of new segments from the anterior end e.g. tapeworm	(iv)	Body has a specific growth pattern e.g. annlids, arthropods and all higher animals.

NOTOCHORD

- Notochord is mesodermally derived rod-like structure formed on the mid-dorsal surface during embryonic development in some animals. Animals with notochord are called chordates and those animals which do not form this structure are called non-chordates, e.g., Porifera to Echinoderms or Hemichordates.

Table 4.6 Differences between notochord and nerve cord

S.NO.	Notochord		Nerve cord
(i)	First skeleton laid during embryonic stages	(i)	Anterior part develops into brain and the remaining part into the spinal cord.
(ii)	Present on the dorsal side (below) of the nerve cord.	(ii)	Present above the notochord.

BLOOD VASCULAR SYSTEM

- Blood vascular system is basically of two types : Open and Closed.

(i) Open type : In **open type,** the blood is pumped by the heart into the blood vessels that open into blood spaces (sinuses). There is no capillary system (i.e., most arthropods, some molluscs **except** cephalopods and tunicates). These sinuses are actually the body cavitites, and are called **haemocoel.** The pressure of the blood is low; it moves slowly between the tissues, and finally, returns to the heart via the opened veins. In fact, distribution of blood in the tissues is very poorly controlled. The pigments, which carry oxygen, remain dissolved in blood plasma. Body tissues and visceral organs exhange respiratory gases, nutrients and waste products, directly with blood.

(ii) Closed type : Many invertebrates and all the vertebrates, including humans, have a **closed circulatory system.** In closed type, the blood flows around the body through the specific blood vessels. In this system, the same blood regularly circulates in the body under high pressure, and returns back to the heart without leaving the system of tubes. The heart pumps the blood into the aorta, which branches in the body into the arteries, and in the tissues into the arterioles, to form the capillary network. The venules of the capillary network carry the blood back to heart via veins and vena cava. This helps in supplying the nutrients and oxygen to the tissues, and removing waste materials and carbon dioxide from tissues.

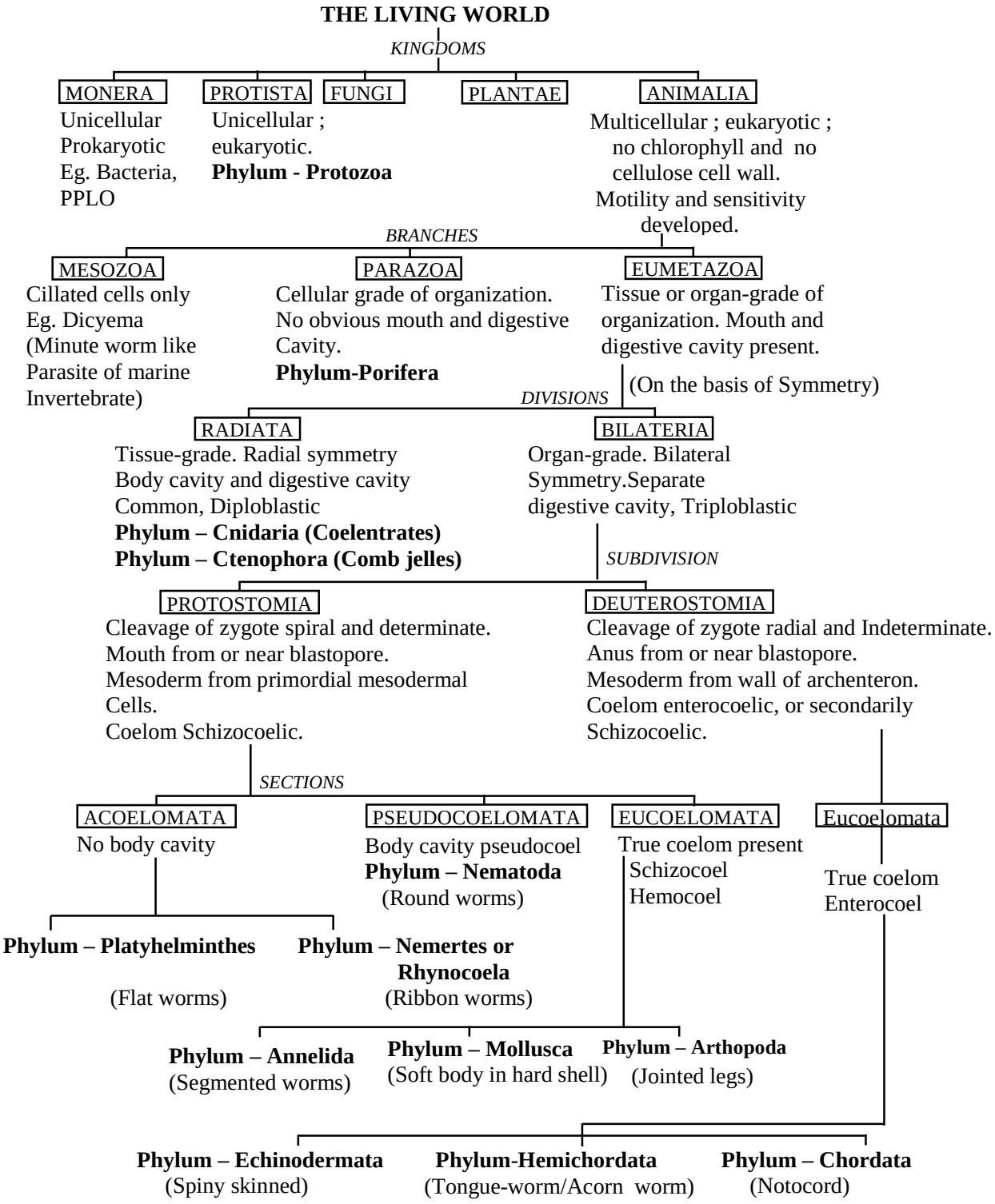
Comparison of Open and Closed Circulatory Systems

Open System	Closed System
These are usually low pressure systems.	These are usually high pressure systems.
Blood is conveyed directly to the organs without formation of capillaries.	Blood is conveyed directly to the organs through capillaries.
Distribution of blood to different organs is not well regulated.	Distribution of blood to different organs is well regulated.
Blood returns to the heart slowly.	Blood returns to the heart rapidly.
Found in most arthropods, non cephalopod mollusks and tunicates.	Found in cephalopods (octopus, squids) and vertebrates.

Table 4.7 Difference between exoskeleton and endoskeleton

S.NO.	Exoskeleton		Endoskeleton
(i)	Formed by the deposition of hard protective material on the body surface.	(i)	Formed by the formation of hard protective material within the body
(ii)	(a) **Chitinous** as cuticle (impervious to water) in arthropods (b) Calcareous as in the shells of molluscs. (c) **Ossicles** as in echinoderms (d) In the form of scales in fish, beak and feather in birds, and hair and nails in reptiles and mammals.	(ii)	(a) **Notochord** in lower vertebrates (b) **Bones** in vertebrates all over the body (c) **Cartilage** in cartilage fish, extremities of bones and parts of vertebrates like none and ear.

(iii)	**Functions** (a) To survive in dry or wet environment. (b) To protect the soft body. (c) To give ability to fight as organs of defense.	(iii)	**Functions** (a) To support the whole body. (b) To give shape, flexibility and rapid movement. (c) To protect vital organs like heart and lungs. (d) To helps vertebrates to attain a large size.



Note : *Whittekar removed protozoa from animal kingdom & kept in kingdom protista.*

PHYLUM - PROTOZOA

1. It is **3rd largest phylum.** One celled performed all the biological activities like multicellular animals. So they are termed as **''Acellular''** organism, proposd by **Dobell.**
2. Protozoans were first studied by **Leeuwenhoeck.**
3. And the name Protozoa was coined by **Goldfuss.**
4. Study of protozons is known as **Protozoology.**
5. They are world wide, Cosmopolitan and mostly **Microscopic, Aquatic, Terrestrial, free living** (Amoeba) or parasitic (Plasmodium).
6. Solitary or colonial (Proterospongia).
7. Many causes serious diseases or pathogenic.
8. Protozoans are small microscopic, **Eukaryotic Unicellular,** Colourless, Spherical, Oval, Bell shaped, Spindle shaped slipper like having irregular Symmetry.
9. Level of body organisation of Protozoans is Protoplasmic level.
10. Consists of uninucleate or multinucleate protoplasm mostly **necked** or some have body bounded by delicate membrane or a firm **pellicle/Test/Lorica/shell.**
11. In few groups of protozoa **$CaCO_3$ & Silica shell** as exoskeleton is found. e.g. **Radiolarian group** & **Foraminiferan group.**
12. Number of nuclei vary from one to many. Few show nuclear **dimorphism.** e.g. Paramecium.
13. Body performs all necessary biological activity so in them **subcellular – Physiological division of Labour** is found.
14. Locomotion by means of

    (1) Finger-like Pseudopodia e.g. ***Amoeba*** (2) Whip like Flagella e.g. ***Euglena***

    (3) Hairy cillia e.g. ***Paramecium*** (4) By contraction

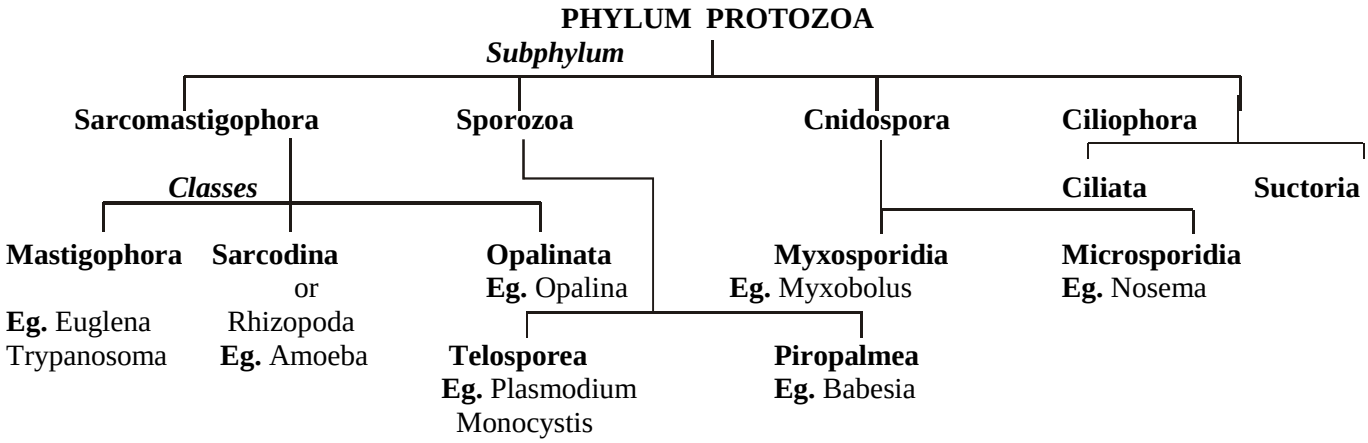
    (5) No locomotory organelles
15. Nutrition of Protozons are mainly **holozoic** (Amoeba), **Mixotrophic.** (Euglena), Parasitic, **Saprozoic** (Plasmodium) and Digestion is **intracellular** take place in **food vacuole.**
16. **Respiration** and **Excretion** takes place by exchange of gases through body surface. Some excretion may occur through **contractile vacuole.**
17. Nitrogenous waste is **Ammonia.**
18. Some fresh water protozoans get rid of excess water through contractile vacuole and phenomenon known as **Osmoregulation. Amoeba** has one and **Paramecium** has two vacuoles.
19. **Reproduction** takes place by

Asexual	Sexual
(1) Binary fission ***(Amoeba)***	(1) Syngamy ***(Plasmodium)***
(2) Transverse fission ***(Paramecium)***	(2) Conjugation ***(Paramecium)***
(3) Longitudinal fission ***(Trypansoma, Euglena)***	
(4) Multiple fission ***(Plasmodium)***	
(5) Budding	

20. Some also form cyst which help in unfavorable condition for reproduction of organism. They do not have natural – death because in unicellular animals there is no division of somatoplasm & germplasm so these are considered as **immortal.**

CLASSIFICATION OF PROTOZOA AT GLANCE

Based on Locomotary organs



SUB – PHYLUM SARCOMASTIGOPHORA

- Locomotary organs are **pseudopodia or flagella or both**,
- Nucelus one or many and similar type.

These are divided into 3 classes -

✯ **Class – 1 : Mastigophora or Flagellata**

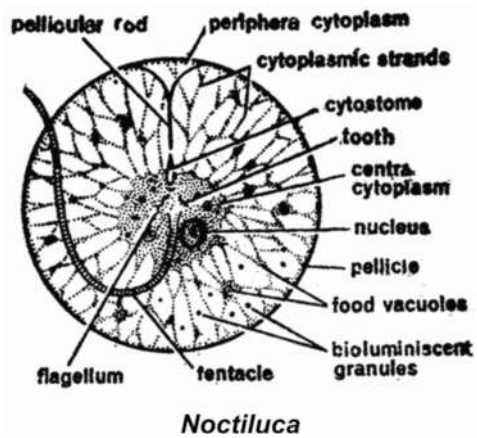
(a) Locomotary organs are one or many **flagella**.
(b) Many members have **chlorophyll** e.g. ***Euglena***.
(c) Their body has **pellicle** so they have a definite shape.
(d) **Nucleus one**.
(e) Binary fission is longitudinal. Sexual Reproduction is absent.
(f) **Contractile - Vacuole is present for Osmoregulation**.
(g) Nutrition is **mixotropic.**

Examples :

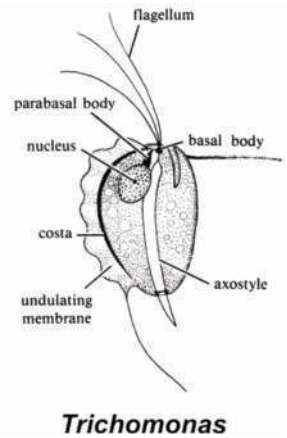
1. ***Euglena***.
2. ***Proterospongia* :** This is a colonial protozoan. **It is a connecting link between protozoa and porifera.**
3. ***Mastigamoeba* : It is a connecting link between mastigophora and Sarcodina.**
4. ***Leishmania donovani* -** This parasite is responsible for **kala-azar disease in man**.

- This disease spreads through ***sand - fly (phlebotomus)***.
- This parasite is dimorphic and digenetic. Disease caused by it is also known as **"Dum-dum fever"** or visceral Leishmaniasis or Tropical splenomegaly. (L. Tropica causes – **Delhi Boils** or **oriental sores** disease.)

5. ***Trypanosoma gambiens* :** This parasite causes **"African sleeping sickness"** in man-This disease spreads through **Tse-Tse fly *(Glossina palpalis/tachinoides)*** . T. gambiens is polymorphic-Leptomonad form, crithidial form, Trypanosomal forms.
6. ***Trypanosoma cruzi* -It causes Chagas disease**.
7. ***Giardia intestinalis* :** It is termed as **Grand-old man of Intestine"**. It causes diarrhoea in humans.
8. ***Trichomonas vaginalis* :** It is a parasite in the vagina. It causes **"Vaginitis = Leucorrhoea".**
9. ***Trichonympha* :** This is a symbiont in the intestine of termite and wood cockroach. It helps in the digestion of cellulose.
10. ***Noctiluca* -** It shows **bioluminiscense due to Luciferin protein. It is also called the Fire of Sea"**.



Noctiluca



Trichomonas

✯ **Class – 2 : Sarcodina or Rhizopoda**

(a) Locomotary organs are pseudopodias. Different types of pseudopodias are
  (i) ***Lobopodia*** **-** in Amoeba
  (ii) ***Filopodia*** **-** in Euglypha, Chlamydophorus
  (iii) ***Reticulopodia*** **-** in Globigerina
  (iv) ***Axopodia*** **-** in Actinophyrus, Actinosphaerium.

(b) Body is naked so shape is changeable, few have different types of shells.

(c) Pseudopodia help in feeding and locomotion.

(d) Nutrition is Holozoic or Saprozoic or others.

(e) Cytoplasm is divided into Ectoplasm and Endoplasm.

(f) Nucleus is one or many but monomorphic.

(g) Animals may be free-living or parasitic.

(h) Contractile vacuole found in only fresh water species like **amoeba**. But in **parasites** and **marine-animals** the **contractile-vacuoles are absent**. e.g. **Entamoeba histolytica**

(i) Asexual reproduction normally takes place by Binary-fission, which is transverse, Sexual reproduction is absent.

Example :

1. ***Amoeba*** **–** Simplest animal
2. ***Pelomyxa - chaos*** – **This is the largest amoeba**. Size = 6 mm. **It is multinucleated**.
3. ***Entamoeba histolytica*** **-** It is a parasite in the **colon of man**. **It causes amoebic dysentery** in man. In it contractile vacuoles are absent. It is dimorphic-
  (i) Magnum-Pathogenic
  (ii) Minuta-Nonpathogenic.
4. ***Entamoeba gingivalis*** **- It is found in between the teeth of man**. It increases **Pyrea** disease but does not cause it. **Pyrea** is caused by **"Trichomonas-tinax"**.
5. ***Arcella*** **-** It has an exoskeleton of tectin.
6. ***Elphidium (Polystomella)*** **-** It has a multichambered shell of $CaCO_3$, silica and magnesium sulphate.
7. ***Allogromia*** **-** It has internal skeleton.
8. ***Actinophrys*** **-** It is termed as the "Sun aninmalcule".
9. ***Entamoeba coli*** - It is found in the intestine of man. **It shows commensalism**.
10. ***Aulocantha*** **-** It have maximum chromedia.
11. ***Radiolarian*** **–** Exoskelaton present.

✯ **Class - 3 : Opalinata or Protociliata**

(a) Locomotory organs are flagella which are found on the whole surface of body.
(b) Body has pellicle over it.
(c) Nuclei many but isomormphic.
(d) Binary fission common, sexual reproduction takes place by **syngamy**.
(e) **Contractile-vacuole is absent**.
(f) All flat and parasite in the intestine of amphibia.
(g) Cytostome absent.

Example : ***"Opalina"*** - It is found as a parasite in the intestine of frog.

SUB-PHYLUM SPOROZOA

Characteristics :

1. All the members of this **group are endoparasite**. These are found in cells (called ***cytozoic***) tissues (called **histozoic**) or in vacuoles (called **coelozoic**).
2. **Locomotory organs are absent**.
3. A thick pellicle is present on the body.
4. **Cytostome, cytopyge and contractile vacuoles are absent**.
5. Binary-fission absent, In place of that asexual reproduction takes place with the help of multiple fission.
6. Sexual reproduction takes place by **syngamy**. Spore formation takes place in most of the members.
7. Life-cycle is complex. Polar filaments are absent in spores.
8. Sub-phylum sporozoa is divided into four classes on the basis of presence or absence of spores in life cycle.

✯ **Class (1) Telosporea :**

Sporozoites elongated and mostly find in spores

Examples :

(1) ***Plasmodium*** **-** Four species spread malaria fever in human. **Female anopheles is the carrier of plasmodium. P. falciparam** causes – **"Malignant Malaria"** or "Black water fever" or "Cerebral Malaria".

(2) ***Monocystis*** **-** It is found in **seminal vesicle of earthworm**, and causes sterility in earthworm. It is monogenetic in nature.

(3) ***Eimeria*** **-** It is found in epithelial cells of liver of rabbit.

✯ **Class - 2 : Piroplasmea**

- Microscopic parasites of the RBC of animals in which spores are not formed, the sporozoites are naked.

Example : ***Babesia*** **-** It causes the **"Texas cattle fever"** in animals. This disease also called "**Red water fever**" or **"Haemoglobin-uric fever".**

✯ **Class - 3 : Toxoplasmea & Sarcocystis.**

Example - ***Toxoplasma & Sarcocystis***

✯ **Class - 4 : Haplosorea**

Example - ***Coelosporidium***.

SUB-PHYLUM CNIDOSPORA

- Parasites of other animals like **sporozoa**.
- Absence of locomotary organs and **contractile vacuoles**.
- Spore-formation takes place in life-cycle the spores have polar - filaments.
- Cnidospora has been classified into 2 classes on the basis of development of spores

✯ **Class-1 : Mixosporea**

Spores develop from many nuclei. Spore shell made of 2 or 3 valves. Example - Ceratomyxa, Myxidium.

✯ **Class-2 : Microsporea**

- Spores develop from 1 nucleus. Spore shell made of only 1 valve.
  Example : ***Nosema*** **-** It is an endoparasite of the tissues of **silk-worm**. It causes harm to **"Sericulture".** This disease is called **"Pebrine disease".**

SUB-PHYLUM CILIOPHORA

- These are complex protozoa.
- In at least one stage of life cycle cilia are present for locomotion & feeding.
- Nuclei are dimorphic or two types the larger one is **Macronucleus** (vegetative nucleus) and the smaller is **Micronucleus** (generative nucleus).
- Body surface has a rigid-pellicle.
- Asexual reproduction by **Binary fission** and sexual reproduction by **Conjugation**. Ciliophora is divided into two classes ciliata and suctoria.

✯ **Class-1 : Ciliata**

(a) Life-cycle is complex. A rigid-pellicle is found around body.
(b) Locomotary organs are **cilia** and present on the whole body surface
(c) Nutrition is **Holozoic**.
(d) Nuclei are dimorphic. i.e. Macro nuclei or vegetative and micro nuclei or generative
(e) Asexual reproduction takes place by transverse binnary fission and sexual reproduction takes place by **Conjugation**, Autogamy, Hemimixis, Endomixis and Cytogamy
(f) Two contractile - vacuoles are found; present at the anterior and posterior ends of the body. These help in **osmo-regulation**.
(g) For the ingestion and egestion of food permanent pores are present. For ingestion ***cytostome*** is present and for egestion **cytopyge** or ***cytoproct*** are also cell-anus is present.
(h) Below the pellicle, "**Trichocysts**" are found which are **defence organelles**.

Example :

(1) **Paramecium -** It is termed as the "Slipper-animalcule". In the cytoplasm of paramecium some toxic particles are found called **"Kappa particles" and "Sigma particles"**. Both these particles shown cytoplasmic inheritence.
Kappa-particles produce "Paramecin which destroys the sensitive species. Paramecium which have Kappa-particles are called ***killer*** *and which don't have them are called* ***Non-Killer****. Lambda, Mu, Pi particles are also present in cytoplasm. They are transferred to next generation by cytoplasmic inheritance.*
(2) **Vorticella -** It is called "**Bell animalcule. It is a pedicellate protozoan.**
(3) **Didinium -** It is called **"Water-Bear"**.
(4) **Spirostomum -** It is the **largest living ciliate**. It is 4 mm long.
(5) **Balantidium coli** - This parasite cause ulcer in the colon of man and causes diarrhoea.
(6) **Nyctotherus -** It is a parasite in the rectum of frog. It is also found in the rectum of cockroach.
(7) **Neummulites - In the form of fossils largest member of protozoa**.
(8) Stentor.

✯ **Class-2 : Suctoria**

(a) The members of this class are sessile and stalked.
(b) Locomotary organs in adults are the "Sucking-tentacles."
(c) Pellicle is found.
(d) Cytostome and cytopyge are absent.
(e) Asexual reproduction by external budding.
(f) Binary fission is absent.
(g) Nuclei are dimorphic i.e. a macronucleus and micronucleus are present, but the macronucleus is branched.
(h) Only 1 contractile vacuole is present.

Example - Arcineta, Ephelota

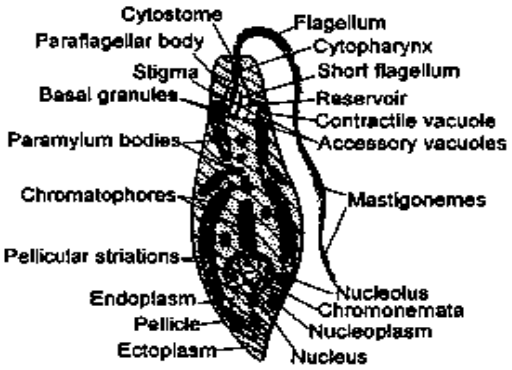
Special points :

1. **Largest protozoa - Pelomyxa Palustris** - 1.4 cm long.
2. **Longest live protozoa -** Euglena gracilis - 20 years.
3. Paramecium bursaria possesses green algae.
4. Fastest running protozoan is **"Monas Steigmata".**
5. Some protozoans have a loose exoskeleton called **"Lorica-hourse"** on them e.g. Difflugia, Tintinn opsis.
6. The fastest reproducing protozoan is **"Glaucoma".** It produces 6-generation within 24 hrs.
7. The largest euglena is "E. oxyuris".
8. When Euglena is kept in dark, then its chlorophyll disappears.
9. "**Heliozoans**" are mainly fresh-water rhizopods and termed **"Sun - animalcules.".**
10. Oblique binary fission in ceratium.
11. **Ceratium** and **Notoiluca** are **bioluminiscent** due to presence of **luciferin protein**.

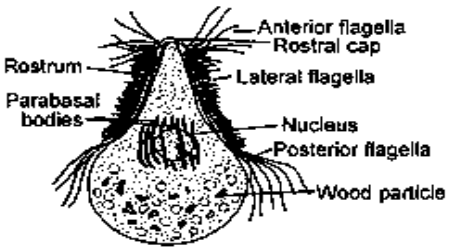
Comparative study of characters of three classes of protozoa

S. No.	Character	Sub-phylum-Sarcomastigophora			Sub-phylum Sporozoa	Sub-phylum-Ciliophora	
		a. Mastigophora	b. Rhizopoda	c. Oplinata		a. Ciliata	b. Suctoria
1	Locomotary organs	Flagella	Pseudopodia	Flagella	Absent	Cilia	Sucking-tentacles
2	Pellicle	*Present*	Absent	Present	Present	Present	Present or Absent
3	Nucleus	One	One or Many, monomorphic	Many, monomorphic	One or Many, monomorphic	Two or Many, dimorphic	Two dimorphic Macronucleus-branched
4	Asexual Reproduction (Binary fission)	Longitudinal	Transverse	Longitudinal	Absent	Transverse	Simple by budding
5	Sexual Reproduction	Absent	Absent	Present	Present	Present	Present
6	Contractile vacuole	Present	Present or Absent	Absent	Absent	Present	Present
7	Nutrition	Mixotrophic or Parasitic	Holozoic or Saprozoic	Parasitic	Parasitic	Holozoic or saprozoic	Holozoic
8	Trichocysts	Absent	Absent	Absent	Absent	Present	Absent
9	Cytopyge & Cytostome	Absent	Absent	Absent	Absent	Present	Absent

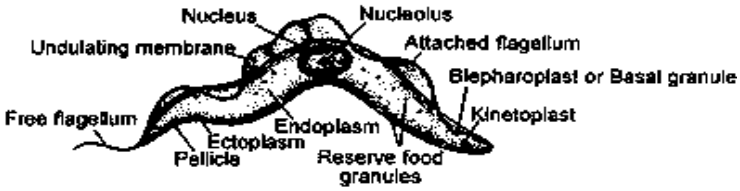
WITNESS FEW COMMON PROTOZOANS



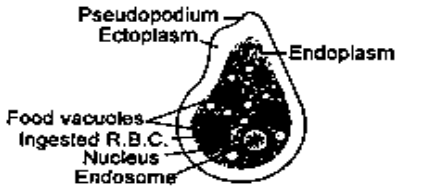
Euglena viridis



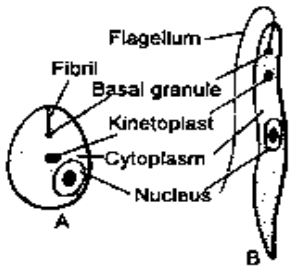
Trichonympha



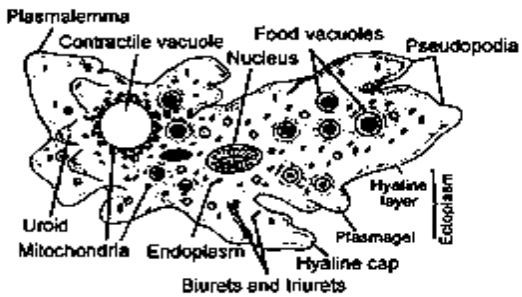
Trypanosoma gambiense



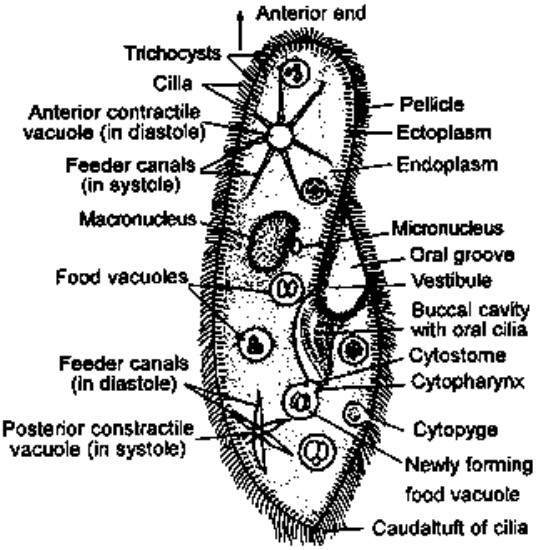
Trophozoite of Entamoeba histolytica



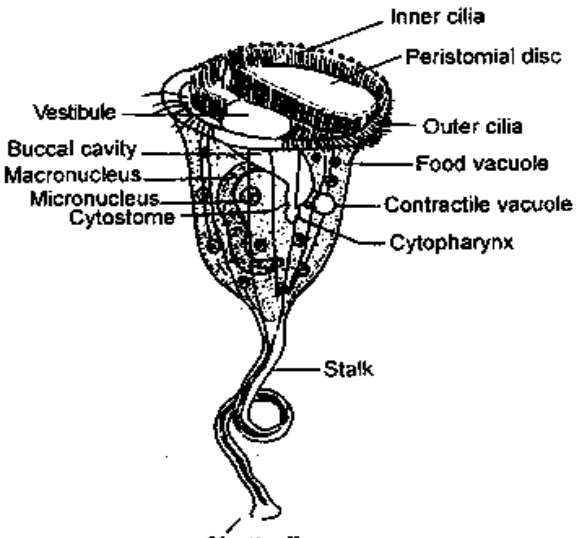
Leishamania donovani :
(A) Leishmania form,
(B) Leptomonad form



Structure of Amoeba proteus



Paramecium caudatum



Vorticella

PHYLUM - PORIFERA

(Common Name - Sponge)

1. **Ellias** proved that sponges are animals.
2. **Robert Grant** gave the name Porifera.
3. Study of sponges is known as **Parazoology.**
4. Phylogenetically evolved from choano flagellates **(Proterospongia)**
5. Mostly marine but few are found in **fresh water** also. They are **sessile, solitary** or **colonial.** Entire body with pores i.e. numerous mouthlets **Ostia** and one opening for exit **Osculum.**
6. Sponge have various body form and shapes i.e. **Vase shape, cylindrical** with radial symmetry ***(Leucosolenia),*** **irregular** shape (asymmetrical).
7. Sponges have **Cellular level** of organisation with two germ layer i.e. **Diploblastic** and do not posses head and appendages.
8. Body wall consists of

(i) Outer <u>Dermal</u> layer or <u>Pinacoderm</u>

(a) Pinococytes (Flat cell)

(b) Porocytes (oval)

In case of Sycon **pinacoderm** is divided into **exopinacoderm** and **endopinacoderm.** Endopinacoderm lines the incurrent canal.

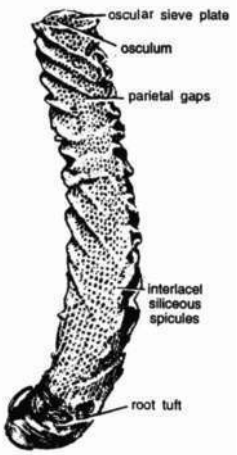
(ii) Inner <u>Choanocytic</u> layer or <u>Choanoderm</u> / Gastral layer Collar cell or Choanocytes (Flagellated)

- Characteristic of Porifera
- Choanocytes discovered by - **H.J. Clark**

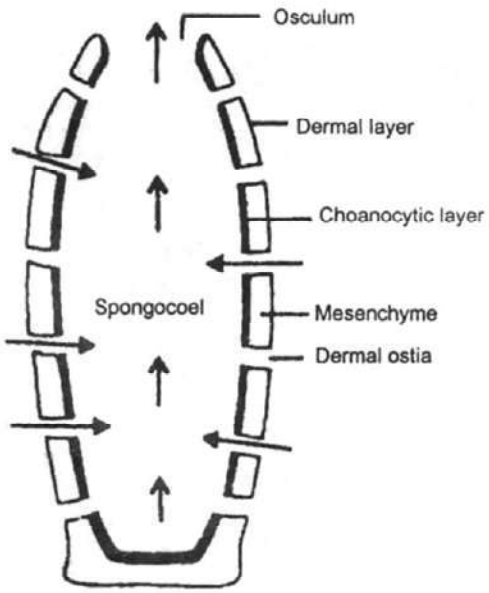
(iii) Between these two layers gelatinous material Mesenchyme (Mesohyl) is present which is non-cellular. It Consist of Amoebocytes = gives rise to different types of cells of both pinacoderm and Choanoderm

Amoebocytes

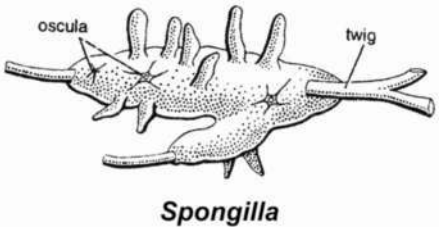
Scleroblast	–	For skeleton
Spongioblast	–	For skeleton
Thesocytes	–	For food storage (Glycogen)
Phagocytes	–	To engulf by phagocytosis
Trophocytes	–	For Distribution of food
Archaeocytes	–	Formation ova & spermatozoa (Totipotent cells)
Collenocytes	–	Connective tissue cell
Chromocytes	–	Pigmented
Myocytes	–	Highly contractile (at osculum)
Gland cells	–	Secrete shiny substance
Germ cells (Sex cells)	–	Form sperm & ova during breeding season.



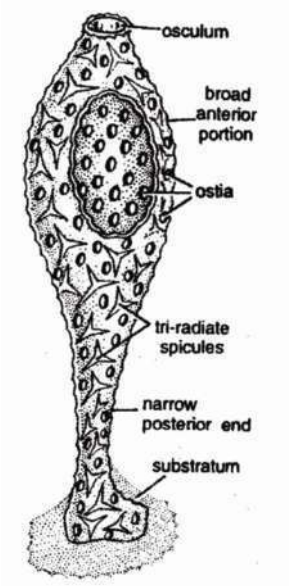
Euplectella



BODY WALL OF PORIFERA



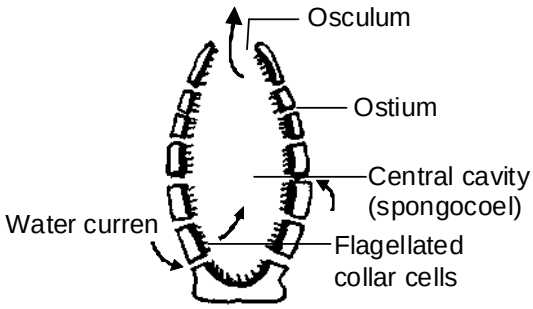
Spongilla



Clathrium (= Olynthus)

9. Body wall enclose a large cavity the **spongocoel** or **paragastric cavity.**
   Choanocytes with flagella is lined in Spongocoel and radial canal.
10. Ceaseless beating of flagella cause current of water which enter through ostia perforating porocytes and various canals and enters in spongocoel and finally leave through large aperature **osculum.**
11. **Canal system :** Canal system of porifera helps in **nutrition**, **respiration**, **excretion** and **reproduction.** Canal are developed due to folding of inner wall. There are four types of canal systems.

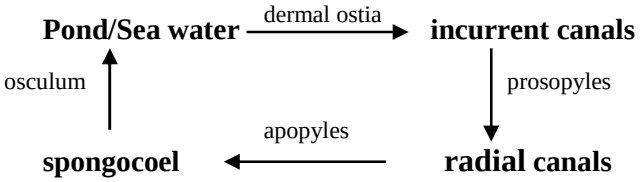
(i) **Asconoid** (Simplest canal)



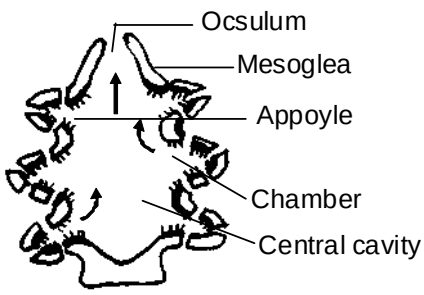
Asconoid

Ex. - Lencosolenia, Olynthus

(ii) **Syconoid**

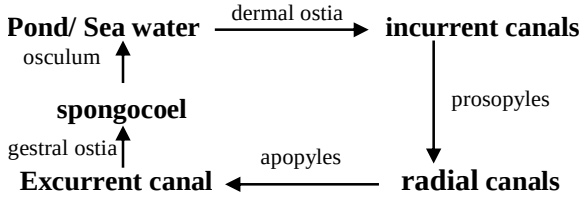


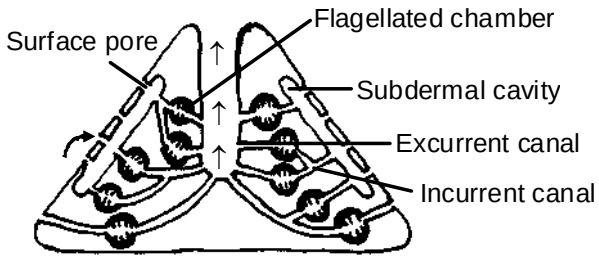
Ex. - Scypha



Syconoid

(iii) **Leuconoid** (complex and most efficient canal system)





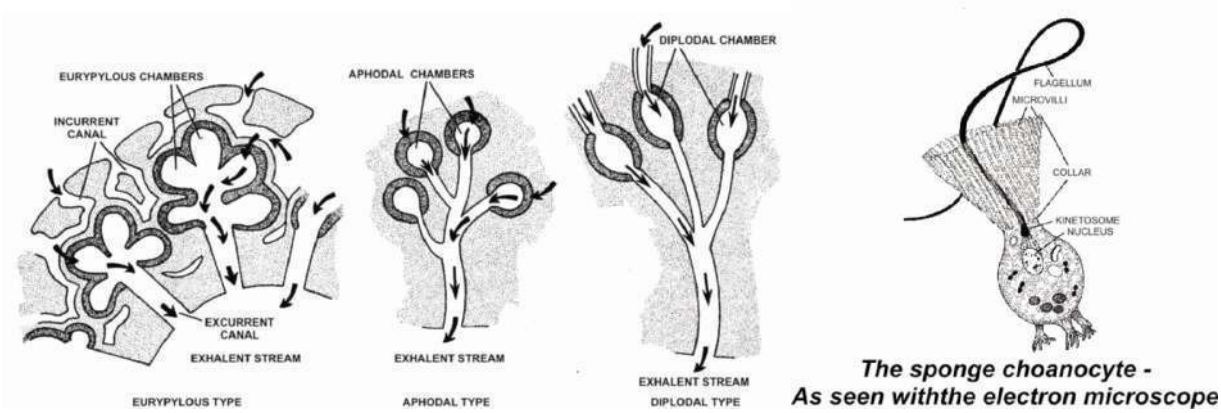
Leuconoid

Ex. - Euspongia, Spongilla

(iv) **Rhagon**

Ex. Larva of Demospongia

It is further of 3 types Eurypylous, Aphodal, Dipodal types.



The sponge choanocyte - As seen withthe electron microscope

12. Skeleton is internal, consist of tiny calcarious **Spicules (calcoblast)** or silicaceous spicules **(silicoblast)** or fine spongin fibre **(spongioblast)**, or of both located in mesenchyme.

    There are four types of spicules in sponges

    (1) Monaxon (Usually at osculum) (2) Triaxon

    (3) Tetraxon (4) Polyaxon [Hexa - radiated]

    Scleroblast secrets spicules and **Spongioblast** secrets spongin fibre.

13. **Digestive cavity** and mouth is absent. Nutrition is holozoic. Digestion is **intracellular** and occurs in food vacuoles of choanocytes.

    Food particle is taken by collar cell and pass them to amoebocyte.

    Food is stored in **thesocytes.**

    Distribution of food from ingestive cell to other is brought about by the movable amoeboid cell. -Trophocytes

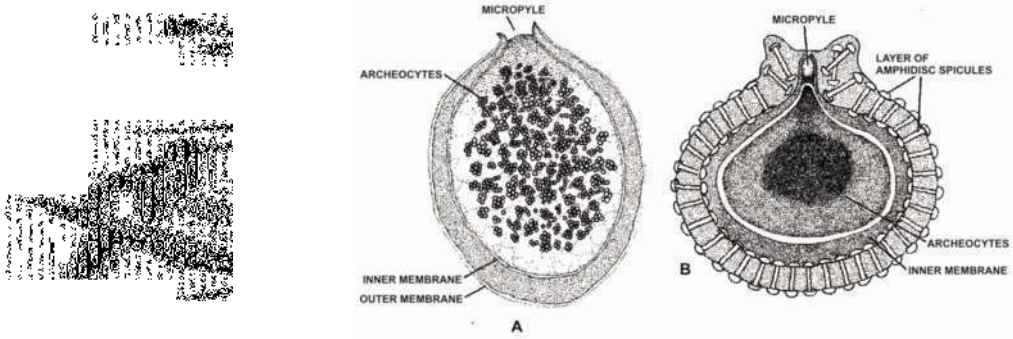
14. **Respiration** and **Excretion** takes place by diffusion of gases through body surface. Excretory matter is Ammonia.
15. Sponges do not have **nervous system.**
16. **Reproduction** takes place by means of

    (i) Asexual -

    By Fragementation : Regeneration in sponges was demonstrated by Wilson. It is brought about by archaeocytes.

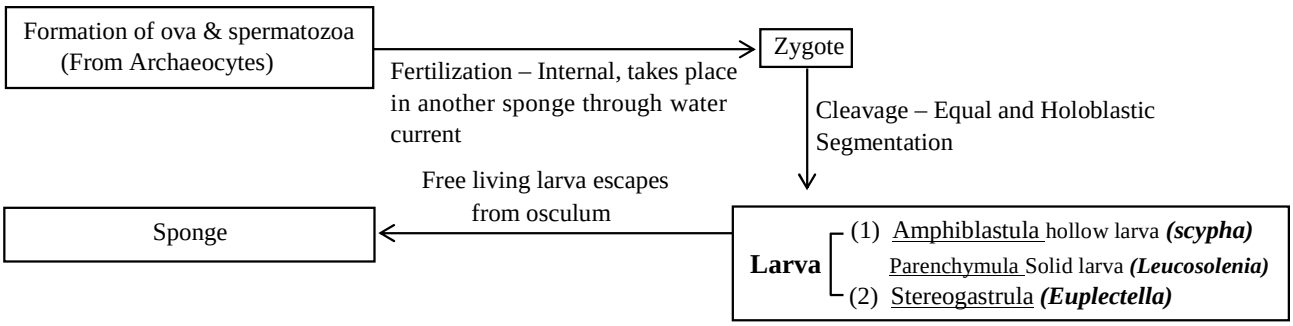
    By Budding : Special cell mass **Gemmules** containing **Archaeocytes.**

    Also called as **Endogenous budding** and the process is known as **Gemmulation**.



Sponge larvae A. The parenchymula larva of leucosolenia B. The amphiblastula larva of sycon

(ii) Sexual - Sponges are Hermaphrodite, fertilization internal and cross fertilization, Protogynous condition is found .



CLASSIFICATION OF PORIFERA

(On the basis **Skeleton** divide into three classes)

Classes	Calcarea	Hexactinellida	Demospongia
Skeleton	- Calcareous spicules	6 rayed siliceous spicular (Glass sponge)	1 or 4 rayed silicious spicules or sponging fibre or both
Choanocytes	- Relatively large.	Collar cells small	Small collar cells
Inhabit	- Exclusively marine in shallow water	Exchesively marine and inhabit in deepwater	Marine or fresh water in deep or shallow water.
Canal system	- Ascon or sycon type C.S.	Leucon type	Leucon/Rhagon
e.g.	***Leucosolenia (smallest)***	***Euplectella*** - (Venus flower basket, Bridal gift in Japan)	***Spongia (Euspongia)*** - (Bath sponge)
	Scypha (Sycon -Urn sponge	***Hyalonema*** - (Glass rope sponge)	***Spongilla*** - (Fresh water sponge)
	Leucilla	***Pheronema*** -(Bowl sponge)	***Ephydatia*** - (Sulphur sponge) Freshwater
	Clathrina		***Cliona*** - (Boring sponge) harm ful to Oyster
	Grantia		***Hippospongia*** - (Horse-sponge or Horny sponge)
			Chalina - Marmaid's gloves
			Poterion - Neptune's Cup
			Oscarella - Skeleton absent
			Chondrosina – Skeleton absent
			Halichondria – Bread sponge
			Haliclona – Finger sponge

⇒ Proterospongia = connective link between Protozoa-Porifera
⇒ Largest sponge – ***Spheciospongia***
⇒ Hypothetical simple sponge & between larva & sponge – ***Olynthus***
⇒ Shrimps – (also called as **Spongicola** fish) A crustacean, shows commensalisms with ***Euplectella***

PLYLUM-COELENTERATA

1. Leuckart coined name **Coelenterate.**
2. **Hatschek** named **Cnidaria** on the basis of stinging cells. **Peyssona**l & **Trembley** established **animal nature** of Coelenterata.
3. Cnidology-Study of cnidaria
4. Mostly **marine, few fresh-water** (Hydra.) Carnivorous, some are fixed or free floating.
5. Coelenterates have two types of **forms** (Dimorphic)

(1) Polyp	(2) Medusa
- Cylindrical in shape - Mostly sessile, but some are motile - May be solitary or Colonial - Types of structures : Gastrozooids (Hydranth) - For Nutrition Dactylozooids - For Protection Gonozooids - For Reproduction	- Umbrella like - Free swimming - Always solitary - Types of structures : Phyllozooids - For Protection Nectophore - For swimming Gonophore - For Reproduction Pneumatophores - For Swimming

Either or both zooids may occur in a species.
If both forms are found in a group it is called **Cormidia.**
If both are found in a species, two form alternate in life cycle. (**Alternation of generation** or **Metagenesis**)

6. Group of different types of zooids in polyp or medusa shows polymorphism.
7. Coelenterates are usually having **radial symmetry,** Some Anthozoans have **Biradial symmetry.**
8. Coelenterates have two **Germ layers (1) Ectoderm (2) Endoderm** i.e. They are **Diploblastic**
9. Coelenterates have **Tissue level of organisation.**
10. No head and appendages. The oral end (mouth) often bears slender, flexible process hollow tentacles.
11. **Body wall** consists of -
    (a) Epidermis (Outer layer) **-** Formed of 7 different types of cells.
    Stinging cells or **<u>Nematoblast</u>** or Cnidoblast (for offence & defence) characteristic of coelenterata.
    Inject **Hypnotoxin.**

Cnidoblasts : A – Undischarged ; B – Discharged discovered and regeneratin in *Hydra*.

Interstitial cells (Totipotent and act as reserve to replace worn out cells/germ cells/Nematocyst); Epithelio - muscular cells ; Glandulo – muscular cells ; Sensory cells ; Germ cells

(b) Gastrodermis (Inner layer) - Formed of 5-different types of cells such as
Endothelia - muscular cells or Nutritive cells (with food vacuole) ; Interstitial cells ; Sensory cells; Nerve cells ; Germ cells

12. Between these two layers, gelatinous **Mesogloea** is present which contain free cells. **Mesogloea** is secreted by both the above layers.

- **Structure of nemetocyte :** The cytoplasm of a cnidoblast contains a conspicuous nucleus lying to one side, and a oval or pyriform sac filled with a poisonous fluid, **hypnotoxin**. The sac is known as the **nematocyst.** The outer end of nematocyst is invaginated into a long, hollow, and tubular thread tube, coiled like a watch-spring inside the sac itself. The tip of thread tube is open and its base is swollen to form the **butt or shaft.** The inturned thread is covered over at the base by a lid-like structure, the operculum. At the base of the thread tube pointing inward are three large spines, called **barbs or stylets,** and three spiral row of minute spines, called **barbules or spines.** The outer end of the cell projects freely beyond the epidermal surface, as a tiny, pointed process, the cnidocil; a restraining thread, called ***lasso,*** **is attached to the base of nematoblast. It prevents the nematocyst from being thrown out of it.**

- **Occurence of nematocysts :** The nematocysts occur scattered mostly singly, throughout the epidermis of the body but remain absent on the basal disc. They are abundant in the epidermis of the oral region and the tentacles where they cluster as wart-like **''nematocyst batteries''.**

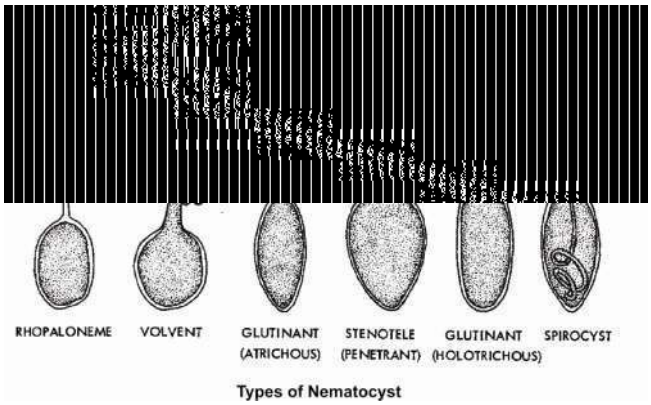
- **Mechanism of discharge :** The sudden eversion of the thread tube is caused by an increased osmotic pressure inside the capsule, probably due to rapid intake of water. As a result, the lid is forced open, the thread tube turns inside out and the entire nematocyst explodes to outside. Under normal conditions, the discharge is brought about by mechanical stimulation of the cnidocil, such as contact with prey. The thread tube once

discharged cannot be withdrawn. Such nematoblasts migrate to the gastrovascular cavity and are digested, to be replaced by fresh nematoblasts, developed from the interstitial cells.

- **Types of nematocysts :**

(a) ***Penetrant*** or **stenotele** is the largest and most complex nematocyst. It's structure has been discussed earlier. When discharged it pierces the skin or chitinous exoskeleton of the prey and injects the poisonous fluid, *hypnotoxin,* that either paralyzed the victim or kills him.

(b) ***Volvent*** or ***desmoneme*** is a small and pear-shaped nematocyst. It contains a short, thick, spineless, smooth and elastic thread tube forming a single loop and closed at the far end. When discharged, it tightly coils around the prey. They are smallest nematocysts.



Types of Nematocyst

(c) ***Stereoline glutinant*** or ***atrichous isorhizas.*** The thread tube is long with a narrow butt and forms three or four transverse coils. It bears a spiral row of small spines and may coil upon discharge.

The glutinants secrete a sticky substance possibly used in locomotion by fastening the tentacles of Hydra to solid objects as, well as in food-caputre.

13. Body of coelenterates may be supported by horny or calcareous exoskeleton.
14. Cavity of the **Coelenteron** is having single aperture. Mouth serve both purpose i.e. **incomplete digestion tract (Blind sac).**

    Digestion is first time **Extra-cellular** as well as **Intracellular** i.e. takes place in Coelenteron as well as food vacuole. Coelenteron is also responsible for distribution of food besides partly digesting it. This dual role named coelenteron as **Gastrovascular** cavity.
15. **Respiration** and **Excretion** takes place by diffusion of gases through **body surface.**

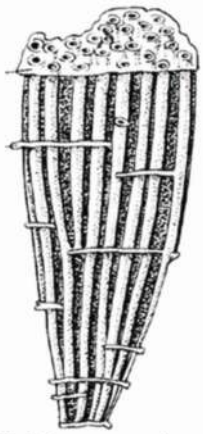
    Excretory matter is Ammonia.
16. **Nervous system** present both in polyp & medusa and form a loose net work of nerve fibres on either side of mesogloea (Diffused type). Neurons are non-polar. Sensory cell are also present. Medusa have sense organ **Rhopalia** or **statocyst/**Tentaculocyst.
17. Sexes may be separate or united. Coelenterates can reproduce **Asexually** by Budding (Polyp) and by **Sexually**-(Medusa).
18. Gonads have no duct. Fertilization may be **External** or **internal**. Cleavage is **Holoblastic.**
19. Development includes larva.
20. Larva of ***Obelia*** – **Planula** (free living) and **scyphistoma** larva fixed polyp like.

    Larva of *Aurelia* – **Ephyra** , Scyphistoma

METAGENESIS AND POLYMORPHISM

Colenentrata members shows polymorphism most common is polyp & medusa forms.

In the life-cycle there is an alternation of the asexual polyp phase and the sexual medusa phase and it is termed as **Metagenesis**.



Tubipora musica
(Skeletan of entire colony)

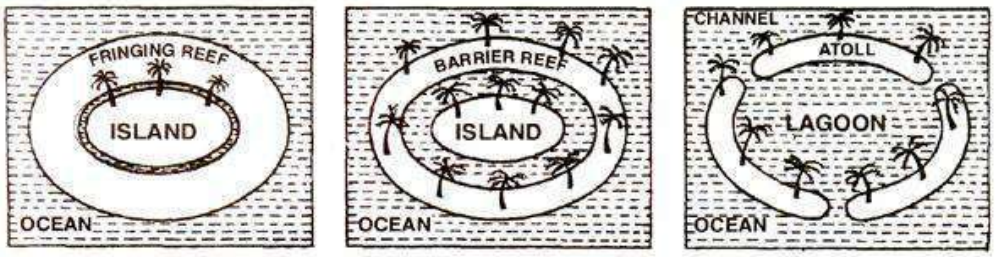
Coelenterata is classified into three classes		
Hydrozoa	**Scyphozoa**	**Anthozoa (Actinozoa)**
– Fresh water as well as marine – Polyp & medusa often show polymorphism & metagenesis. – Polyps with manubrium – Medusa have a velum (Craspedote) – Mesogloea is Acellular – Gastrovascular cavity undivided. – Gonads are Ectodermal and shed gametes directly in to the surrounding water. – Cnidoblast is present only in epidermis e.g. **Hydra -** Fresh water polyp **Obelia -** the sea fur, (Polyp, Blastostyles, Medusa shows metagenesis) **Physalia -** the Portuguese man-of-war. (Neurotoxic, gas gland present) **Bougainvillea** **Porpita** **Vellela -** Little sail **Tubularia** **Millipora (Sting coral)**	– Exclusively marine – Medusa form is more common – Polyp form reduced or absent and have small manubrium – Velum absent. [Acraspedote] – Mesogloea is thick, gelatinous and contains cells. – Gastrovascular cavity undivided. – Gonads are Endodermal and shed the gametes into the digestive tract when escape through the mouth. – Cnidoblast is present in epidermis & Gastrodermis e.g. **Aurelia -** the Jelly fish, Moon jally, Larva - Ephyra **Rhizostoma -** Many mouth (Polystomum) **Pilema** **Cyanea -** Sun Jelly **Atolla** **Periphylla**	– Exclusively marine – Only polyp form – No manubrium – Velum absent. – Mesogloea contains cells & fibres – Gastro vascular cavity have compartment i.e. mesenteries – Gonads -Endoermal and shed gametes into the digestive tract escape via mouth – Cnidoblast is present in epidermis & Gastrodermis e.g. This class has two types of animal (1) **Anemones** - Skeleton absent **Adamsia** - sea anemone **Metridium** - Sea anemone (2) **Coral** - $CaCO_3$ Skeleton **Astraea** - the star coral **Pennatual** - the sea pen **Gorgonia** - the sea fan **Pteroides** - Sea feather **Renilla** - Sea pansy **Tubipora** - Organ - pipe coral **Alcyonium** - Dead man's finger (Soft coral) **Corallium** - Red coral (Moonga) **Heliopora** - Blue coral **Oculina** - Eye coral **Meandrina** - Brain coral **Madrepora** - Stag-Horn coral **Fungia** - Mushroom coral

- **Coral Reefs :** A coral reef is a ridge or mound in a shallow, tropical sea, has its upper surface near the surface of water, supports a variety of animals and plants. It is formed of calcium carbonate produced by some of its

inhabitant, chiefly medreporarian corals. Coral reefs form stable marine ecosystems. The coral reefs are of three kinds :

(i) Fringing Reefs : The coral reefs lying close to the shores of some volcanic island or part of some continent are called the **fringing reefs.** Hawaiian is lands are an ideal example of permanent fringing reefs.

(ii) Barrier Reefs : They are like the fringing reefs but are located some distance from the shore. The stretch of water of **lagoon** separates the barrier reefs from land. **Australia's Great Barrier Reef** is an example of such a reef which is about 900 nautical miles long and 90 miles from sea shore.



Different types of coral reefs

(iii) Atoll reefs : An atoll reef is also called **coral island** or **lagoon island** which is a circular or horse shoe shaped reef that encircles a lagoon but not an island. It may be complete or broken by a number of channels of which only a few are navigable. The Lakshadweep and Maldive islands in the Indian Ocean are composed of Atoll reef.

PHYLUM – CTENOPHORA

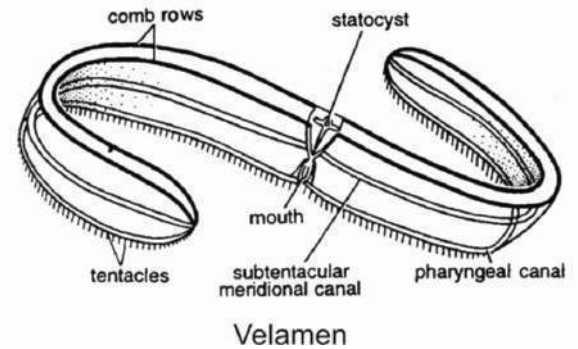
1. **Ctenophora** name was given by **Eschescboltz.** Commonly called **''Sea-gooseberries''** or **''Comb-jellies''** or **''Sea-walnuts''.**
2. Nematoblasts are absent, so they are also called **''acnidaria''**
3. Exclusively **marine** and **pelagic** (float on sea surface) and show **Bioluminescence.**
4. Body form may be **spherical, cylindrical** or **Pear-shaped.**
5. Body is soft **transparent** jelly like having **Biradial symmetry** with **tissue grade** body organization.
6. **Triploblastic** Mesoglea contains amoeboid **mesodermal cells called Colloblast,** Amoeboid cells and smooth muscle cell.
7. Locomotion takes place by the presence of **8 ciliary comb plates** on the body surface.
8. Special sensory structure statocyst at the opposite end (absoral end) of the mouth is present.
9. Tentacles may be present or absent. **When present, the number of tentacles are 2.** They are solid and possess adhesive cells called as **colloblasts** (lasso cells).
10. Digestion is both extracellular and intracellular. These are carnivorous animals.
11. The **animals move by cilia,** which join together to form **comb plates,** there are eight median comb plates forming locomotory organs.
12. Resp. system, skeletal, circulatory & excretory system are absent. Nervous system is diffuse type.
13. All animals are **Bisexual.** Complex type of **sexual reproduction** is found. Metagenesis is absent. Gonads = endodermal, Fertilization is external.
14. Regeneration is normally found.
15. Development is of **indirect type.** Life cycle involves a free living **Cydippid** larval stage.
16. Cleavage is **Holoblastic** determinate and **unequal.**

17. Asexual reproduction is absent.
18. **Regeneration** & **paedogenesis** is normally found.

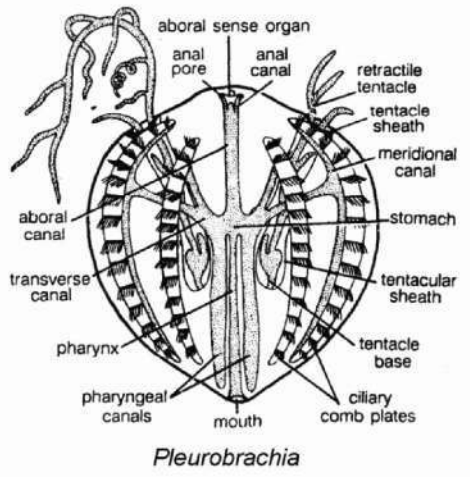
Ctenophora is divided into **two classes** on the basis of presence or absence of tentacles

TENTACULATA (Tentacles present)
e.g. Pleurobrachia
Velamen
Cestum – ''Venus's girdle''
Ctenoplana – Commensal with **Alcyonium.**
Hormiphora
Euchlora rubra – with cnidoblast (Exception)

NUDA (Tentacles absent)
Beroe - Swimming eye of cat.



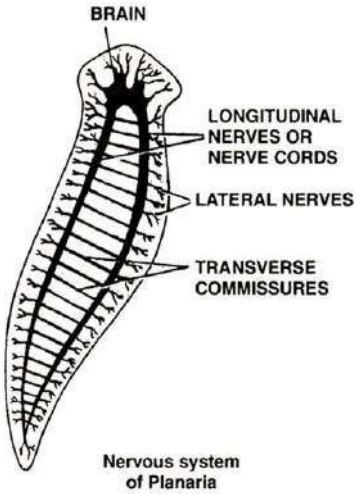
Velamen



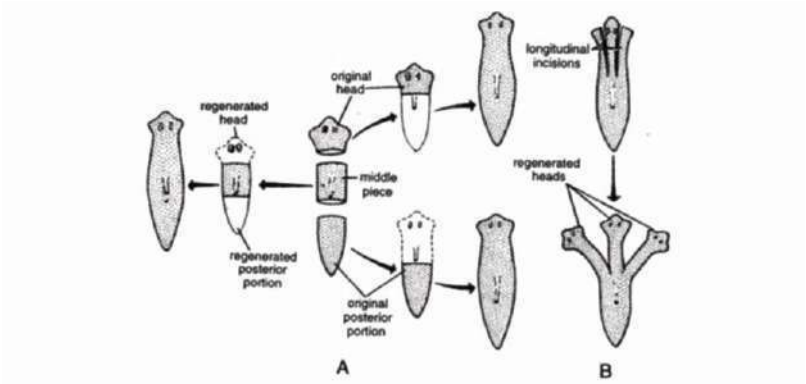
Pleurobrachia

PHYLUM – PLATYHELMINTHES

1. **Gagenbaur** suggested the name **Platyhelminthes.** Includes flat worms, **free living** (terrestrial, fresh water or marine) or **parasitic.**
2. Study of worms causing parasitic infestation in human is **Helminthology.** Most members of this phylum are the parasites of vertebrate. Some are found in aquatic habitat.
3. Body organisation is of organ and organ system level of organisation.
4. Body is **Triploblastic.**
5. Body is **Bilaterally** symmetrical. Ist bilateral animals.
6. Anterior and posterior parts are clear. (Ist phylum to have **cephalization**).
7. Locomotary organs are absent in these animals but **adhesive organs** are present like **suckers, hook** etc.
8. Epidermis is **syncytial** and is some times ciliated. On the body wall of parasitic animals a thick cuticle is present which protects from the digestive-enzymes of the host. It is secreted by Epidermis.
9. Muscles in the body-wall are **mesodermal.** Below the epidermis **longitudinal, circular** and **oblique** muscles are present.
10. **Nervous system** is **Primitive** and **ladder like** having brain ring and 1-3 paired longitudinal nerves connected at intervals by transverse commissures. Sense organs occur in free living form.



Nervous system of Planaria



Regeneration in planarians
(A) Three individuals regenerate from an individual cut into three parts
(B) Formation of a heteromorph with three heads

11. These are **acoelomate.** In between various organs a solid, loose mesodermal tissue called **Mesenchyma** or **Parenchyma** is present, which helps in transportation of food material.
12. In Turbellaria and Trematoda classes an **incomplete** (Blind sac body plan and without anus) digestive system is present. In animals of class Cestoda, digestive system is completely absent.
13. **Skeleton** and **circulatory** systems are absent. Turgidity of the fluid in the parenchymal meshes maintains the form of the body (Hydroskeleton).
14. Animal **respire** through **body surface. Anaerobic** respiration in internal parasite like Taenia.
15. **Excretory** organs are **protonephridia** or flame-cells. **Flame - cells** are also termed as the **Solenocytes.** They also help in **osmoregulation.**

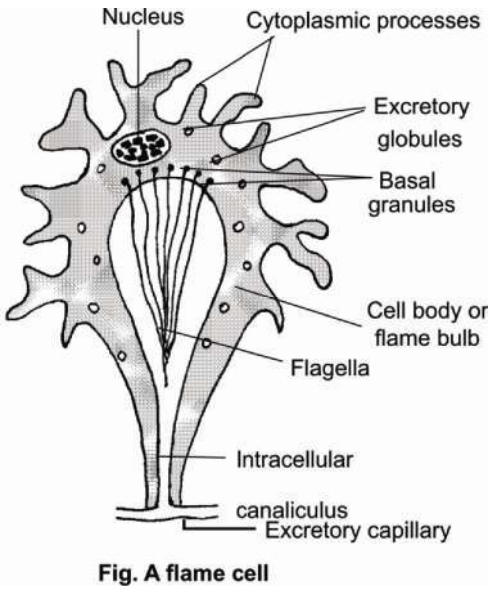
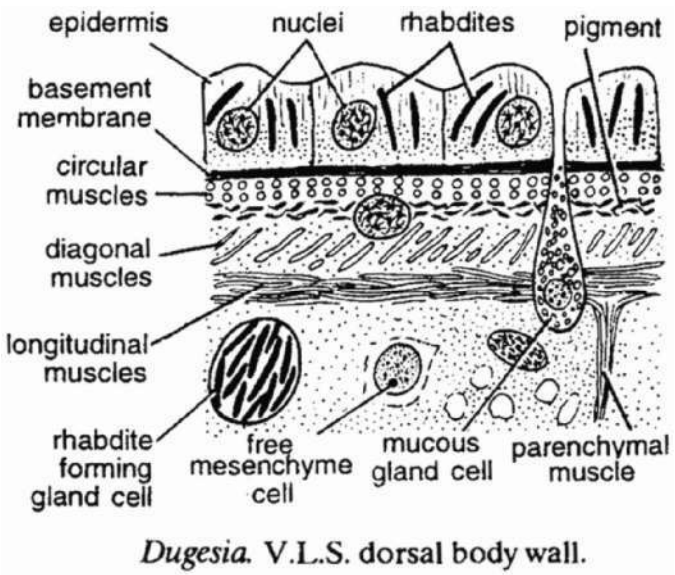


Fig. A flame cell



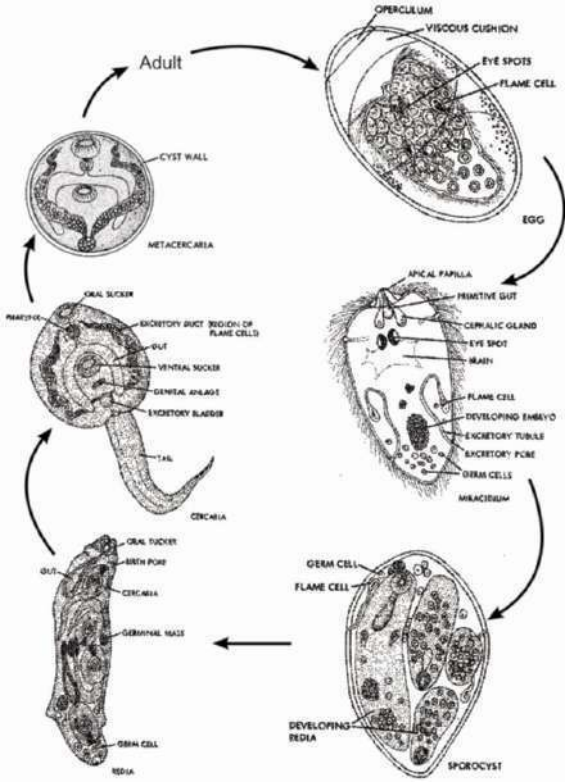
Dugesia. V.L.S. dorsal body wall.

16. All animals of this phylum are **Bisexual** except **Schistosoma** (blood fluke). Reproductive system is **complex** and well-developed. **Fertilization** may be **self** or **cross** and **internal.** Cleavage is **spiral** & **determinate.**
17. Development may be **direct** or **indirect.** In indirect development, larva may be one or of more types. In these animals **yolk/vitelline glands** are present which provide nutrition to the eggs.

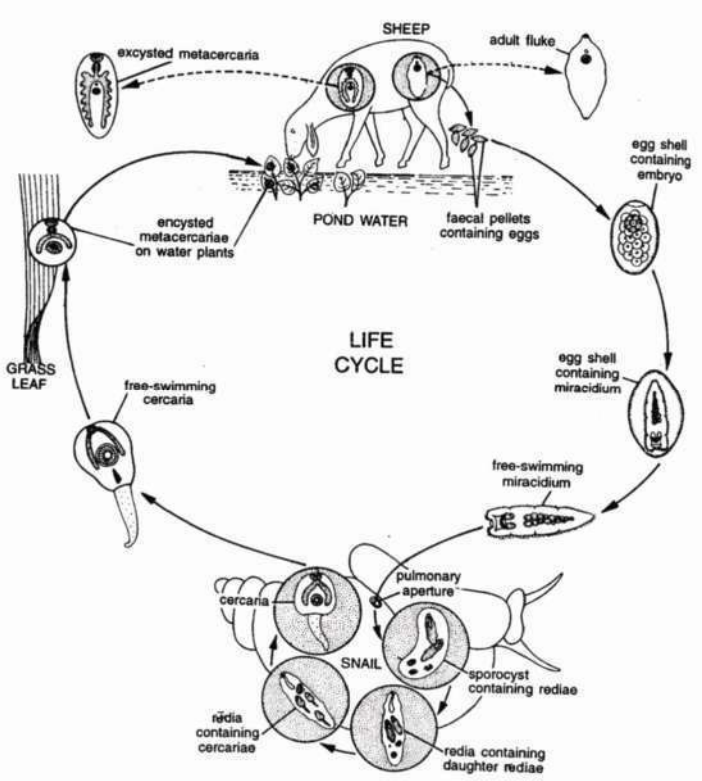
CLASSIFICATION

Divided into three classes

Turbellaria	Trematoda	Cestoda
– Free living fresh water or marine known as Planarians or Eddy worm. – Body is unsegmented and leaf like covered by delicate ciliated epidermis Rod shaped Rhabdites in epidermis. – Mouth is often ventral and anus absent. Alimentary canal is present. (Branched) – Reproduction - asexual sexual and shows good power of regeneration, no larva. – Suckers - absent e.g. **Dugesia - (Planaria)** **Dugesia** (Planaria) - fresh water, Nocturnal, Cannibalism, slow creeping omnivorous. Sexual as well as asexual (Transverse Binary fission), good power of regeneration. Pharynx can be everted. Reproduction **Microstomum** -Enemy of **Hydra** **Macrostomum** **Mesostoma** **Gunda** **Convoluta** - Symbiont on **Zoochlorella** and Diatoms, algae. **Ichthyophaga** -Parasite on fishes.	– Endo-Parasite, known as flukes, or flat worms. – Body-Unsegmented and leaf like, covered by tegument, (Fine spines) No epidermis in adult. – Mouth - anterior & anus is absent. Alimentary canal-branched. – Life history - includes larval stage & involve, more than one host. – Suckers - for attachment in the host e.g. **Fasciola** (Sheep liver flukes) Cause liver rot disease Prim. Host - Sheep & Goat Sec. host – Snail (Planorbis ; Limnea ; Bulinus) Show polyembryony , Life-cycle involves, Miracidium, Sporocyst, Redia, Cercaria and Metacercaria larval form Miracidium (free-swimming larva). **Schistosoma** (the blood flukes) **Paragonimus** (Lung fluke worm) (In lungs of man and pig) **Diplozoon** - Ectoparasite on the gills of fish. (Monogenetic) **Opisthorchis** - Human liver fluk or chinese liver fluk	– Endo-Parasite Intestinal parasite, known as tape worms. – Body-Ribbon like, covered by tegument. No epidermis in adult. – Mouth and Anus absent (food from body surface). Alimentary canal absent. –Life history - includes larval stage & involve, more than one host. Each proglottids has one or two sets of male & female reproductive organ. – Scolex has suckers & hooks for attachment – Body divided into scolex, neck and strobilla of few to numerous proglottids. No true segments **Taenia solium** - Pork tapeworm Prim. Host = Man (cysticercus in the infective stage) Sec. Host = Pig (Concosphere is the infective stage) Shows multiplication in larva stage namely – Oncosphere, Hexacanth, Bladderworm and Cysticercus. Causes disease Taemiasis or Cysticercosis. **Taenia saginata** - Beef tapeworm **Echinococcus** - Dog tapeworm **Hymenolepis** - Smallest tapeworm in man's intestine - 10 cm, 200 proglottids (Monogenetic) **Amphilina** **Rellietina** - Bird's tape worm **Phyllobothrium** **Moniezea** - Endoparisite of ruminates



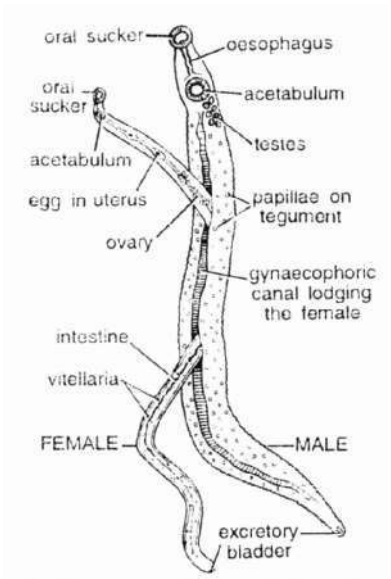
Different Larval forms of Fasciola Hepatica



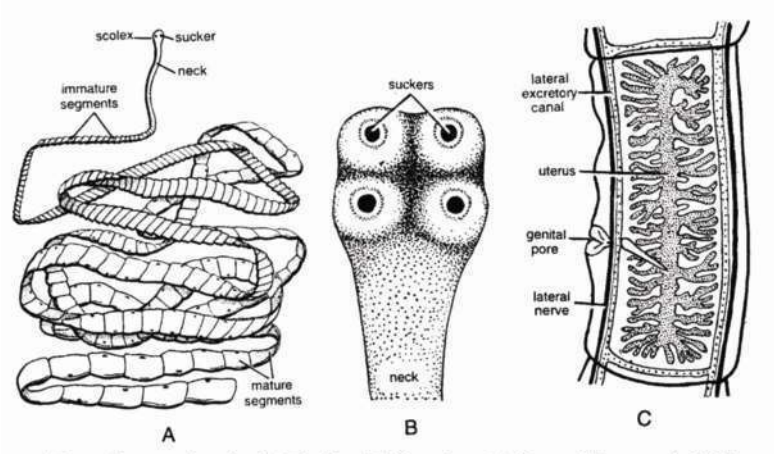
Life Cycle of Fasciola Hepatica

FASCIOLA HEPATICA

It is a sheep liver fluke. It causes liver rot in them. Its complex life cycle have many stages. One larvastage produces many other larva. This is termed as **polyembryony** According to Steenstrup liver fluke also shows metagenesis. It performs asexual reproduction in immature stage i.e. in sporocysts & rediae during adult stage it reproduced sexually.



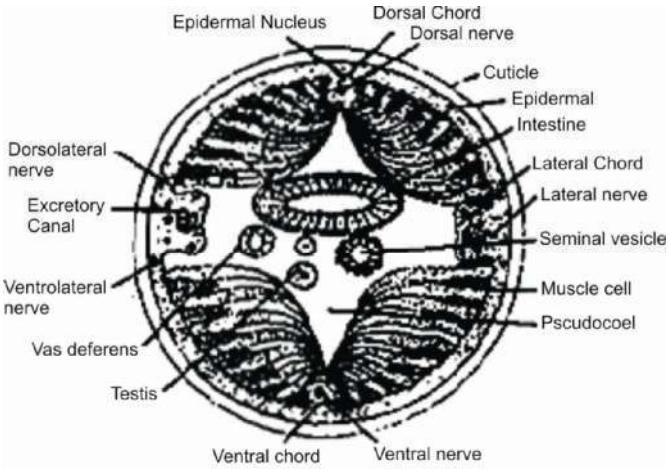
***Schistosoma* Male and Female**



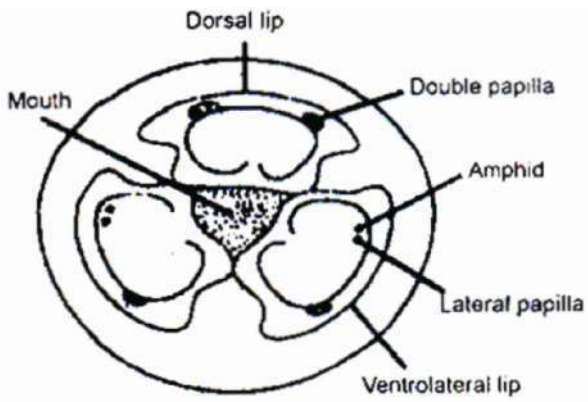
***Taenia saginata* A-Entire B-Scolex C-Gravid proglottid**

PHYLUM - ASCHELMINTHES (NEMATHELMINTHES OR NEMATODA)

1. **Grobben gave the name = Aschelminthes**.
2. **Gagenbaur** named as Phylum Nemathelminthes. Phylum includes round worms.
3. Aquatic, tarrestrial, free-living or parasites.
4. Animal of this phylum are **Cylindrical,** tapering at both end **without** segmentation.
5. **Bilaterally Symmetrical - Triploblastic, Organ-system** level and having **tube within tube plan.**
6. Anterior end does not show distinct head.
7. No appendage.
8. **Body wall** consist of
   Cuticle - Firm, non living, resistant to digestive enzymes of host.
   Moult (changed) many times during growth period (usually four times).
   Epidermis - Syncytial
9. **Muscle layer** - Longitudinal fibres divided into four quadrants. (each with 150 muscle cells)



Body Plan of Ascaris



Mouth and Lips Ascaris

10. **Body cavity** is **Pseudocoel** (developed from blastocoel) and contain **Pseudocoelomic fluid.**
11. High fluid pressure in the pseudocoelom maintains body shape. It is called **Hydroskeleton.**
12. **Digestive tract** is **complete** and differentiated into mouth, pharynx, intestine & Anus. Mouth is surrounded by 3 - lips having sensory papillae and amphids. Pharynx is **muscular.** It is used to suck food. Intestine is non muscular.
13. **Respiration** is through body surface by diffusion.
14. **Circulatory system** is undeveloped.
15. **Nervous system** comprises of circum pharyngeal ring (Brain).
16. Sense organs like **Papillae** (Tangoreceptors), **Amphids** (chemoreceptor) are present on lip. Paired unicellular **Phasmids** (chemoreceptor) are found near hind end of body.
17. **Excretory system** is H-shaped formed by single cell called **Renette cell.** Excretory substance is **ammonia**.
18. **Reproductive system** is developed and sexes are generally separate. **Sexual dimorphism** is present. **Male** is smaller than female and curved from its caudal end.
    Male has penial spicule for copulation. Genital tract joins digestive tract to form cloaca.

Female is larger than male and straight. Genital tract open independently. Female lays numerous eggs with Chitinous shell.

Fertilization is **internal** and development is mostly **direct**.

Cleavage is **Holoblsatic spiral** and **determinate** type.

Number of cells are **fixed** from larva to adult such development is known as **Eutely.**

CLASSIFICATION

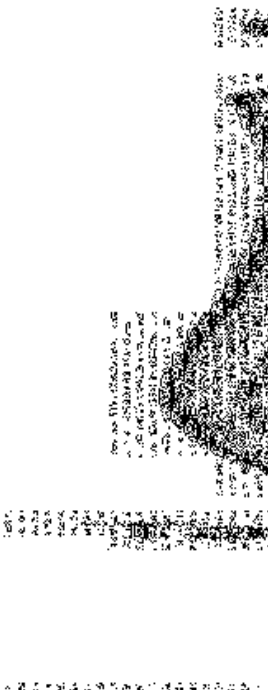
On the basis of caudal receptor or phasmids, Aschelminthes can be divided into 2 classes-

Aschelminthes

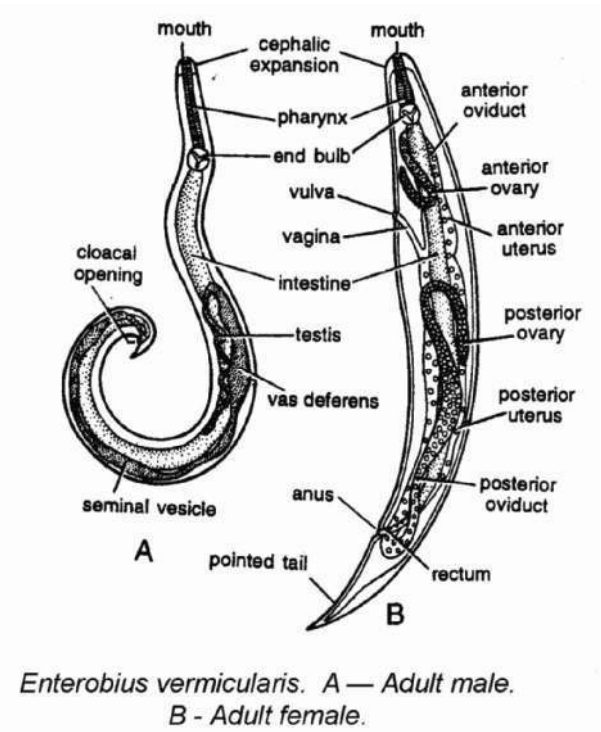
Class

Aphasmidia | Phasmidia

Class–Aphasmidia	**Class–Phasmidia**
(i) Members of this class lack phasmid. (ii) Many types of amphids are found. (iii) One pairs of excretory canal are present. (iv) Caudal adhesive glands are found. **Ex. : Enoplus , Desmoscolex, Trilobus, Lapillaria**	(i) Phasmid is present. (ii) Caudal adhesive glands are not found. **Ex. : Ascaris, Entrobious, Wuchereria**



(A) Male, (B) Female



Enterobius vermicularis. A — Adult male. B - Adult female.

Ex – Ascaris

- It is parasite of small intestine.
- It is also called **round worm**.
- **Rhabditiform larva** exists in the life cycle of Ascaris.
- Ascaris leads to disease called **Ascariasis**.
- **Infective stage** of *Ascaris* to man is embryonated egg with 2nd stage juvenile.

– **Trichinella spiralis (Trichinia worm) :** occur in voluntary muscles cause trichinosis.
– **Trichuris trichiura**
– It is also called **whipworm**.
– It is parasite of large intestine of man.
– No larval stage in the life cycle.
– It leads to **anaemia** and **Diarrhoea.**
– **Enterobius**
– It is also called **pinworm** or **seatworm**.
– It is parasite of human intestine.
– It causes **enterobiasis**.
– No intermediate host.

Ancyclostoma

– Cause - Ancyclostomiasis.
– It is also called hookworm.
– Its larva penetrate through sole of the person.
– Live in intestine and suck tissue fluid.

Wuchereria

– It is also **filaria worm**.
– Its life cycle gets completed in two hosts. Man is the primary host, while female culex/Aedes mosquito is the secondary host.
– It leads to a disease called **Elephantiasis**.
– Adult worm blocks lymph duct this leads to swelling of limbs.
– Females are ovoviviparous. Female lays juvenile microfilaria.
– Infective stage to man is microfilarae.

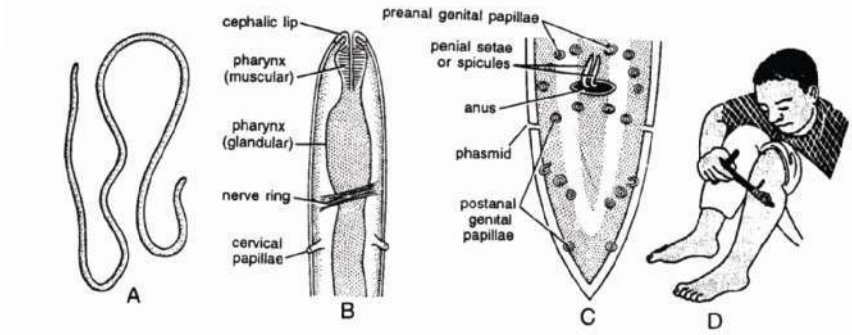
Dracunculus

– They are also called **Guinea worm** and also referred to as "fiery serpent".
– They are digenetic, man is the primary host while **waterflea** (*Cyclops*) is the **secondary host**.
– Completely eradicated from India (eye worm)

Loa-loa (eye worm)

– Found in subdermal connective tissues. Some times they pass across eye ball.
– Tabanas fly act as vector.

Loa loa - Adult across the bulbar conjunctiva ofr human eye



Dracunculus medinensis **A – Entire worm. B – Anterioe end of male. C – Posterior end of male in ventral view. D – Guinea worm being wound on a stick.**

PHYLUM – ANNELIDA

1. **Lamarck** coined the term **Annelida.**
2. Free living found in moist soil, fresh water, sea or few are parasite.
3. Body is Soft, elongated, cylindrical or flattened divided into segments or metameres by ring like, grooves called Annuli.
4. **Symmetry – Bilateral, Triploblstic, Organ-system** level having **tube within tube plan, metamerically segmented.**
5. Anterior end forms a distinct head with sense organ in few annelids.
6. Appendages are simple unjointed, and locomotory having **Chitinous Setae** and **Parapodia with setae.**
7. **Body wall** consist of

   Cuticle – Thin moist albuminoid cutical allow free exchange of gas.

   Epidermis – Single layered epidermis made up of supporting cell, sensory and glandular cell.

   (i) Muscle layer –

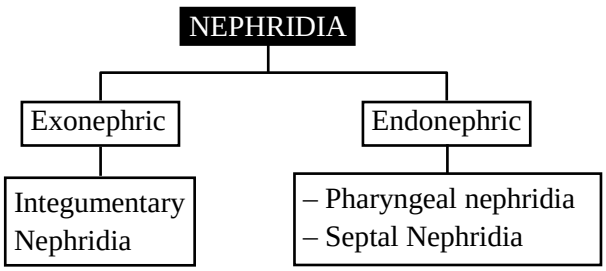
   (1) Circular layer**,**

   (2) Longitudinal layer. Muscle are smooth/unstriated.

   Body wall may have minute chitinous setae.
8. Locomotion by means of setae or parapodia or both. Absent in leeches.
9. **First Protostomi animals.**

   Body cavity is true coelom lined by mesodermal coelomic epithelium **(Schizocoel.)**

   It is divided by transverse septa into compartment. It is filled with coelomic fluid that contains cells.
10. As such there is no **Skeleton.** Fluid filled coelom serves as a **hydrostatic skeleton.**
11. **Digestive tract** is **complete,** straight and extends through entire body. The gut has both circular and longitudinal muscles. Few annelids are **sanguivorous.** Digestive gland are developed for the first time in Annelida.
12. **Respiration** is through moist **skin** i.e. **Cutaneous respiration**. Some have **gills** (branchial respiration).
13. **Circulatory system is closed.** Some blood vessels enlarge to act as pumping heart. (Heart appear first time in annelids). The blood is red with haemoglobin dissolved in plasma **(Erythrocruarin).** It has amoeboid corpuscles only.
14. Few Annelids like ***Sabella*** have **Chlorocruarin** as a respiratory pigment.
15. **Hirudinaria** has circulatory system with **haemocoelomic system.**
16. **Excretory organ is Nephridia.** Coiled tubules also helps in osmoregulation.

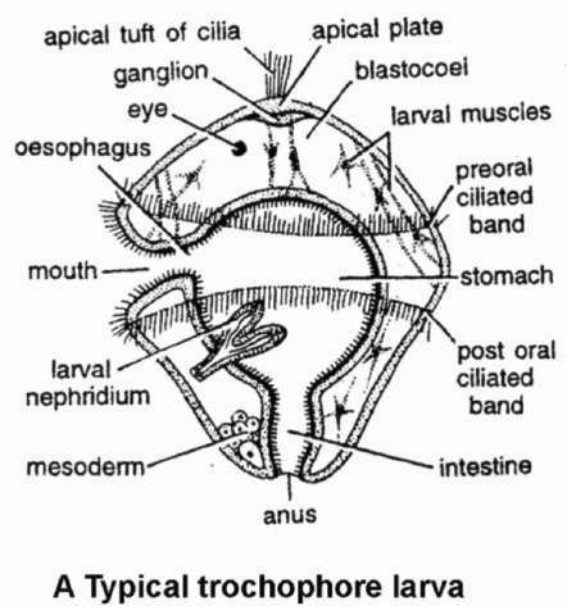


   Excretory matter (1) **Ammonia** in aquatic form (2) **Urea** in land form
17. **Nervous system** consist of a **circumentric nerve ring,** double, midventral, nerve cord with ganglia. Sense organ chemoreceptor, photoreceptor & tentacle, palp, eyes may be present.

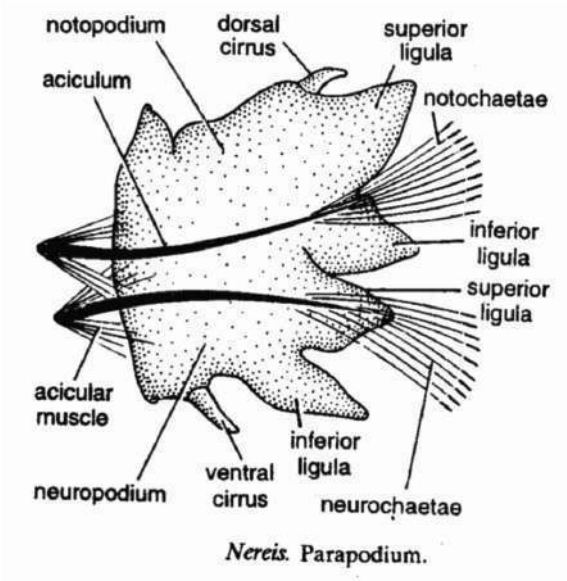
18. Sexes may be separate or united. **Asexual** reproduction by **budding** or fission. In some cases. **Atoke** (asexual), **Epitoke** (sexual) phenomenon also found ***(Nereis).***
19. Cleavage is **spiral** and **determinate unequal & holoblastic.** Regeneration is usually found. Life history includes a **trochophore** larva in few annelids.

NEREIS

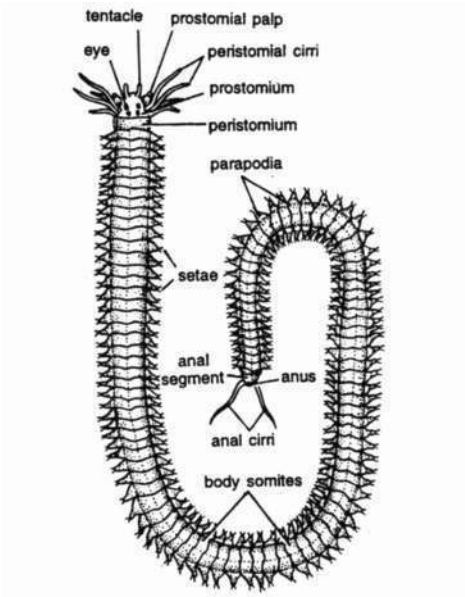
Inhabits in sea - shore between tide mark, burrower, nocturnal, carnivorous, gregarious, fertilization - in sea. Parapodia in each segment except first & last. During breeding body divides in two parts. Anterior asexual part - **Atoke** and posterior sexual portion **Epitoke**. This change is known as **epitoky.**



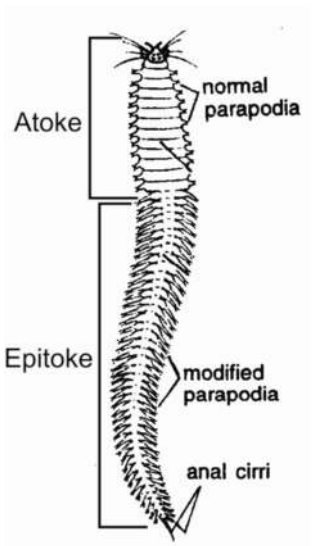
A Typical trochophore larva



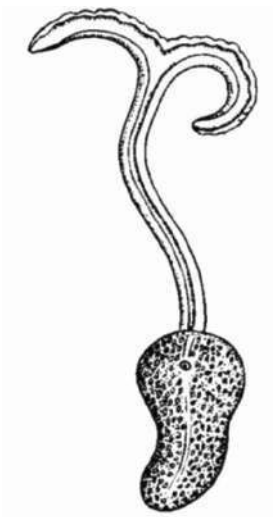
Nereis. Parapodium.



Nereis. External features in dorsal view.



Heteronereis


BONELLIA VIRIDIS, ENTIRE ANIMAL (FEMALE) WITH THE PROBOSCIS MODERATELY EXTENDED

CLASSIFICATION OF ANNELIDA

Based on presence or absence/of Parapodia, Setae and Sense organs

Polychaeta	Oligochaeta	Hirudinea	Archiannelida	Echiuridia
1. Almost all are marine	1. Most of the members are terrestrial, but some are aquatic.	1. Aquatic, terrestrial, ectoparasite and sanguivorous.	1. All Marine	1. Without external and internal segmentation.
2. Cephalisation is more distinct. Head with well developed eyes, tentacles and olfactory palps.	2. Cephalisation absent. No distinct head, eyes, tentacles and olfactory palps.	2. Cephalisation absent. No distinct head, eyes, tentacles and olfactory palps.	2. Cephalistion absent. No distinct head, eyes, tentacle present and olfactory palps.	2. Seate are rare and usually have long prostomium or proboscis. e.g., **Bonelia, Echiuris**
3. Setae numerous and are present in parapodia helps in locomotion and also in respiration. Suckers are absent.	3. Setae for locomotion. Number of seatae is limited and situated in setal sac present in body wall, a single setae is present in a bag. Parapodia & sucker are absent.	3. Parapodia and seatae are absent. Suckers at both the ends.	3. Parapodia and seatae are absent.	
4. Clitellum absent	4. Clitellum is present permanently for cocoon formation. Fertilization is external and is held in cocoon.	4. Clitellum (9-11 segments) develop only in breeding season.	4. Clitellum absent.	
5. Animals unisexual and gonads are formed only during breeding season.	5. Bisexual or hermaphrodite cross fertilization & external.	5. Animals of this class are bisexual. Fertili zation is external.	5. Animals are unisexual	
6. Development is indirect. Larval stage is called Trochophore.	6. Development is direct. No larva.	6. Development is direct.	6. Development is indirect. Larval stage is called Trochophore.	
e.g. ***Nereis*** – Sand worm/clamworm ***Aphrodite*** – Sea mouse ***Arenicola*** – Lug worm ***Seballa*** – Peacock worm ***Chaetopterus*** - paddle worm Shows bio-florescence, great power of regeneration. ***Eunice*** – Palalo worm ***Polynoe*** –	e.g. ***Pheretima*** ***Eutyphaeus*** ***Lumbricus –*** European earthworm ***Dravida*** ***Megascolex –*** Largest earth worm (S. India) ***Dero*** – Fresh watered ***Nais*** – Fresh watered ***Tubifex*** – Blood worm (Fresh water) Indicator of organic loading	– Number of segments are fixed ie. 33 segments. Each segment subdivided into numberous rings. called "Secondary external annulation" – Anticoagulant Hirudin – in the saliva – Saw like chitinous teeth in buccal cavity Circulation with haemo-coelomic system. – Coelom is divide in tubes having coelomic fluid and	– Segmentation is Mainly intermal e.g. ***Polygordius*** – Connecting-link between Annelida & Mollusca (living fossil) Larva known as Loven's Larva ***Protodrillus*** ***Dinophilus*** ***Nerilla***	

Scale worm ***Terebella*** - respire by gills ***Glycera*** – Smooth blood worm		haemoglobin. A special mesodermal tissue Botryoidal tissue made up of adipose tisssue for fat storage /supposed to be excretory. e.g. ***Hirudinaria*** – Fresh water leech ***Pontobdella*** – Skate sucker. ***Hirudo*** – Medicinal leech (Highly modified) ***Glossiphonia*** – Fresh water leech ***Haemadipsa*** – Terrestrial leech ***Haemopis*** – Horse leech ***Acanthobdella*** – Exo-parasite with setae connecting-link between oligochaeta – Hirudinea		

PHYLUM – ARTHROPODA

1. It is the largest phylum in the animal kingdom, including 900,000 species. ***The largest class is insecta with 750,000 species.*** General characters are.
2. They are triploblastic coelomate and bilaterally symmetrical animals.
3. The body cavity is full of haemolymph (blood) and it's known as haemocoel. The true coelom is restricted to gonads.
4. The body is covered by chitinous cuticle, which forms the exoskeleton. Strengthen by deposition of minerals (Cal. Phosphate & Carbonate).
5. They have a segmented body, each segement bearing a pair of jointed appendages covered by a jointed exoskeleton.
6. Exoskeleton is made of chitinous cuticle that is shed at intervals.
7. The process of casting off of skin or integument is known as ***ecdysis*** or moulting. ***Chitinous exoskeleton is secreted by the underlying epidermis***.
8. The body is divided into head, thorax and abdomen. In some cases the head and thorax is fused to form cephalothorax. In insects the thoracic segments have legs and wings, the abdomen has no legs in insects.
9. Muscles are striated.***Respiratory organs are gills, book lungs, book 1st time developed in Arthropoda. lungs or tracheal system***.
10. Excretion takes place through green glands or malpighian tubules, coxal gland.
11. Excretory matter = Ammonia (Aquatic) ; Uric Acid (Terrestrial) Nephridia (Perepatus)

12. Sensory structures in arthropods are **antennae** for perceiving odour, eyes, statocysts or balance organs and sound receptors (in chirping crickets and cicadas). Eyes are compound. In honey bees, butterflies and months and insects, the gustatory receptors are present on their feet.
13. The heart is dorsal pulsatile, many chambered and the circulatory system is open (Haemocoel). Blood haemolymph colourless.
14. The central nervous system consists of a circumentric ring formed by paired pre-oral ganglia connected by commissures to a solid, dorsal ganglionated, ventral nerve chord.
15. In land arthropods, the fertilization is always internal. Few aquatic has external fert.
16. Arthropods are oviparous. In some like the scorpion, the eggs hatch within the female body. They bring forth the young ones alive. They are viviparous.

Advancement Over Annelida

- Distinct-head in all species.
- Jointed appendages serving a variety of functions.
- Jointed exoskeleton for protection and muscle attachment.
- Striped muscles arranged in bundles for moving particular parts.
- Special respiratory organs such as gills, trachea, book lungs in majority of cases.
- Well developed sense organs such as compound eyes, statocysts, auditory organs, taste receptors etc.
- Endocrine glands and pheromone secretion for communication

CLASSIFICATION

- The phylum arthropoda is divided into five classes.

✯ **Class-1 : Crustacea**

- The body is divisible ***into cephalothorax*** (head + thorax) and ***abdomen***.
- Dorsally, the cephalothorax is covered by a thick exoskeletal ***carapace.***
- ***There are present two pairs of antennae and a pair of stalked compound eyes.***
- Respiration is carried out either by body surface or by gills.
- ***Excretion takes place usually by antennary glands (= green glands)***
- Sexes are usually separate. Sexual dimorphism is also seen.
- Development is usually indirect

Examples : Palaemon (Prawn), Macrobrachium (Prawn), Atacus (Cray fish), Palinurus (Lobster), cancer (Crab), Lucifer (Shrimp), Eupagurus (Hermit crab), Oniscus (wood louse), Daphnia (Water-flea), Cyclops, Balanus (barnacle). Tiny crustaceans such as Daphnia and Cyclops act as zooplankton which form important link in the food chain in water.

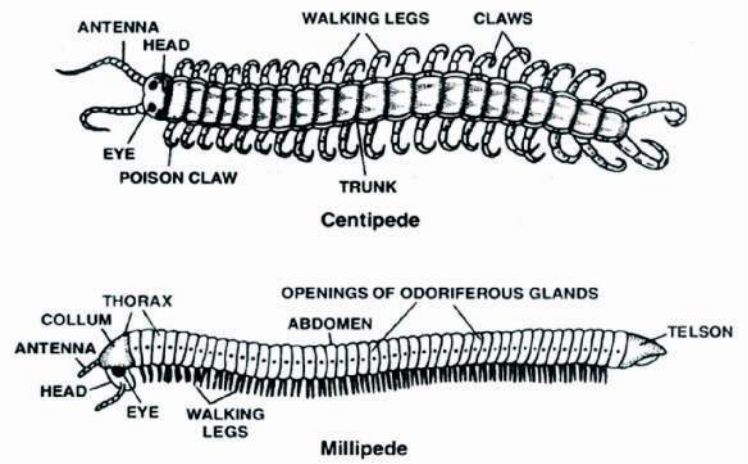
✯ **Class - 2 : Chilopoda**

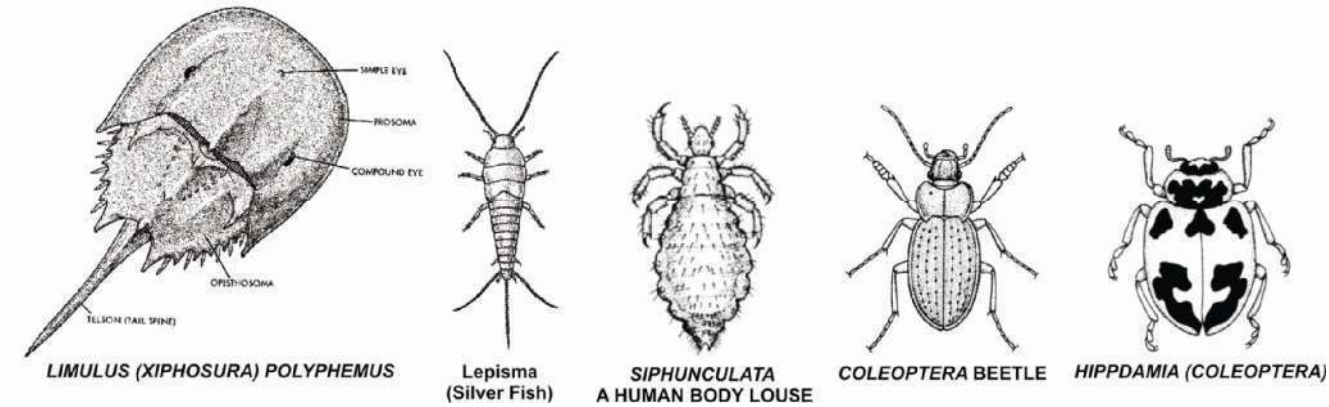
- Body is long and segemented, which is divisible in to head and trunk.
- Each trunk segment bears a pair of legs. The first pair of legs are modified in to poison claws.
- There is a single pair of antennae and ocelli.
- There are present many legs.
- Respiration occurs by tracheae.
- Excretion takes place by Malpighian tubules.
- Development is direct

Examples : Scolopendra (Centipede)

✯ Class-3 : Diplopoda

- Body is divisible into head, thorax and abdomen.
- There is a single pair of antennae and ocelli.
- Except first thoracic segment, (It does not have legs) each thoracic segment bears a pair of legs, ***however each abdominal segment has two pairs of legs***
- Respiration occurs by tracheae
- Excretion takes place by Malpighian tubules
- Development is generally direct e.g. julus (Millipede)





✯ Class-4 : Insecta (Hexapoda) [Largest number of species]

- Body is divisible into head, thorax and abdomen.
- There is a pair of antennae, and a pair of compound eyes.
- The thorax consists of three segments with three pairs of legs and usually two pairs of wings. Mesothorax has thick and leathery false wings called as **tegmina** and membranous metathoracic wings.
- The abdomen may consists of ten segments.
- Respiration usually takes places by tracheae. ***(No respiratory pigments)***.
- Heart is tubular and divided into chambers
- Malpighian tubules are the excretory organs. Uric acid is chief excretory waste.
- Sexes are separate.
- Development may be direct or indirect e.g. silverfish, cockroach, bedbug, locust, termites, butter flies, rat flea, beetle , wasp, aphid***, glow worm*** etc.
- **Maggot is the larva of Housefly**

  Insects communicate with each other by ectohormone called as ***Pheromones***. Pheromones are chemicals secreted to the outside of the body and perceived (as by smell by other individuals of same species). They help in communication amongst the organisms of same species.

Ex.:	Musca domestica	–	House fly
	Tachardia lacca	–	Lac Insect
	Dactylopis	–	Cochineal bug
	Lytta	–	Blister Beetle

The insects may be divided into five groups on the basis of their mode of development.

1. **Ametabola insects** – metamorphosis absent. The young ones resemble adult.

   Eggs ⟶ Young ⟶ Adult ***ex.*** *Lepisma* (Silver fish)

2. **Paurometabola insects –** gradual metamorphosis

   Eggs ⟶ Nymph ⟶ Adult ***ex.*** Cockroach, Grasshopper, Locusts etc.

3. **Hemimetabola insects** – incomplete metamorphosis. Habitat of young ones is different from adults.

   Eggs ⟶ Naiads ⟶ Adult ***ex.*** Dragon flies (Naiads aquatic but adults aerial)

4. **Holometabola insects** – complete metamorphosis

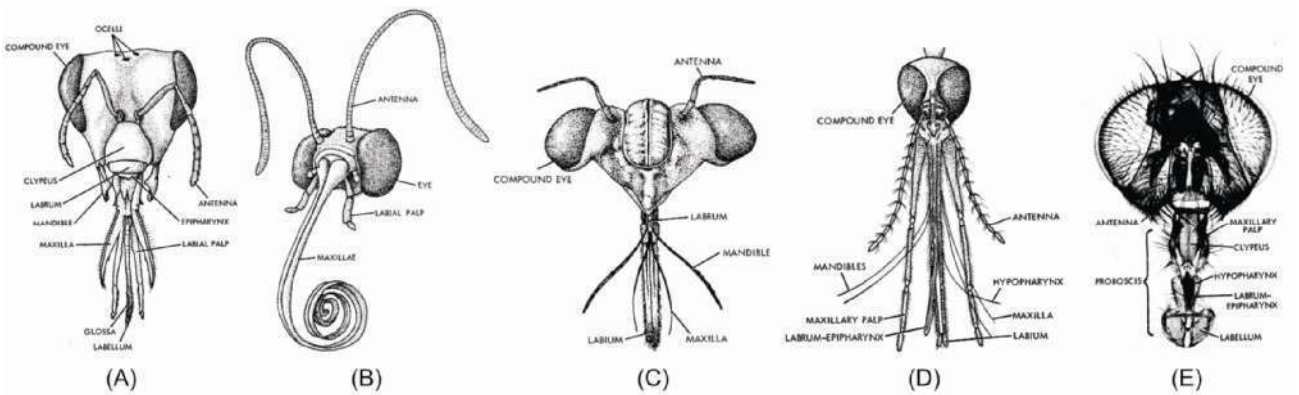
   Eggs ⟶ Larva ⟶ Pupa ⟶ Adult ***ex.*** House flies, Butterflies, Mosquitoes etc.

5. **Hypermetabola insects –** various forms of larvae

   Eggs ⟶ Larva(1) ⟶ Larva(2) ⟶ — ⟶ Pupa ⟶ Adult ***ex.*** Blister beetle.

Type of Mouthparts in insects :

- Generally mouth parts of an insect are one ***labrum***, one ***labium***, one ***hypopharynx***, two ***mandibles*** and two **maxillae.** Following type of mouth parts are found is insects.
- ***Biting and chewing type*** e.g., Grass-hooppers, cockroaches and crickets.
- ***Piercing and sucking type***.e.g. mosquitoes, bedbugs
- ***Chewing and lapping type***. Lap means to drink by scooping with tongue and lapper is that which laps liquid e.g. honey bees.
- ***Sponging type.*** eg. House fly. (Musca domestica.) ***It lacks mandibles. Feeds on sugar by dissolving in saliva and sucking.***
- ***Siphoning type*** e.g. Butterflies and moth. Here the proboscises formed by the modification of maxilla.

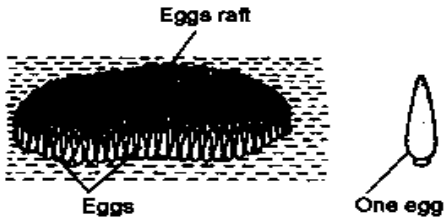
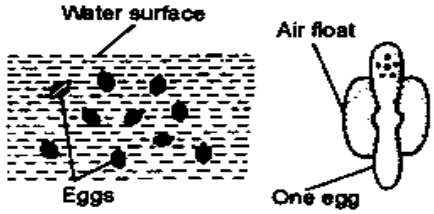
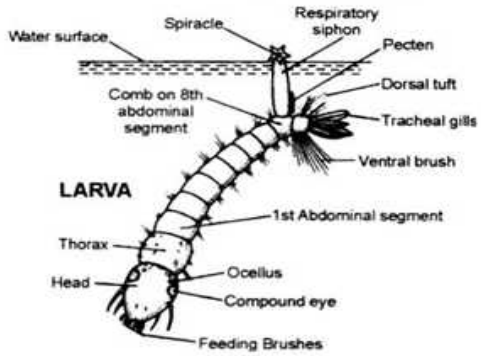
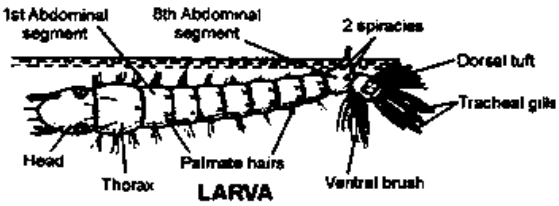
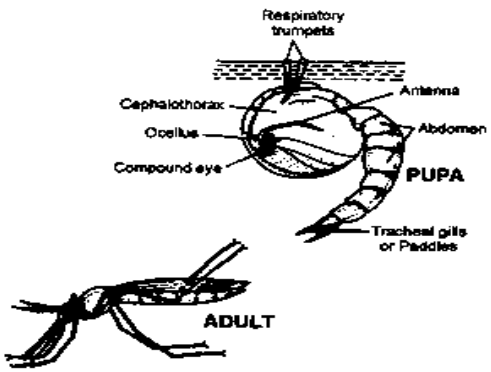
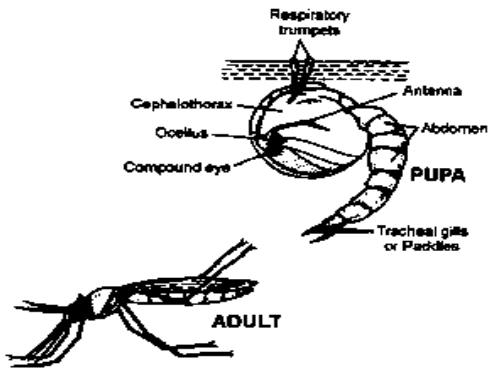


Insect mouthparts : (A) Honeybee. (B) Butterfly. (C) Squash Bug. (D) Mosquito. (E) Housefly

Differences between Butterfly and Moth

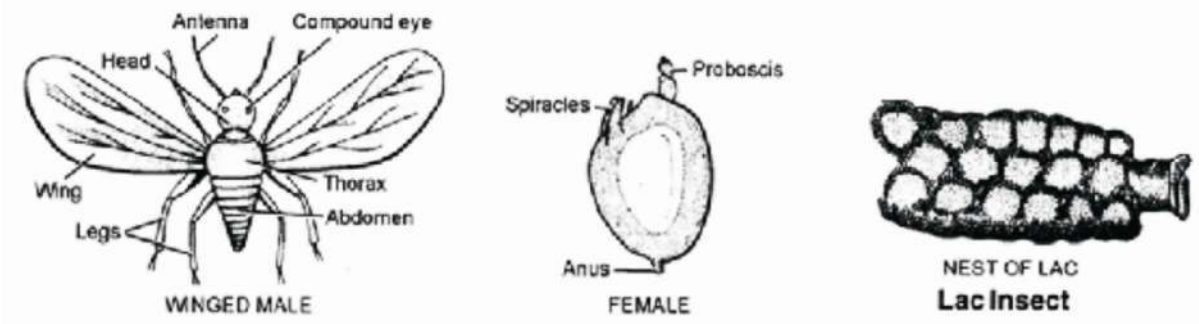
Butterfly	Moth
1. It is diurnal (active in day)	1. It is nocturnal (active in nignt)
2. Its body is not robust	2. Its body is often robust
3. Its antennae are knobbed distally	3. Its antennae taper distally
4. When it is at rest, it keeps the wing held together vertically on its back.	4. When it is at rest it keeps the wings held out horizontally

Table : Differences between Culex and Anopheles

Culex	Anopheles
Eggs	
1. Eggs are laid vertically in clustrers.	Eggs are laid horizontally singly
2. Rafts are formed.	Rafts are not formed
3. Egg cigar-shaped	Egg boat-shaped
4. Egg without lateral air float.	Egg with lateral air floats
5. Usually 200-400 eggs in dirty water 	Usually 40-100 eggs are laid in fresh and clean water 
Larva	
6. Bottom feeder	Surface feeder
7. The head hangs downwards at an angle with the surface	The head lies horizontally parallel to the surface of water
8. Without palmate hairs	With palmate hairs on the abodomen
9. Long conical respiratory siphon 	Respiratory siphon absent (= exceedingly short) 
Pupa	
10. Pupa colourless	Pupa green in colour
11. Respiratory trumpet long 12. No palmate hairs 	Respiratory trumpet short with palmate hairs 

Lac Insect

- Lac is produced commercially by an insect *Tachardia* lacca *(Laccifer lacca).*
- Lac is actually secreted for its protection and not for the food of the insect.
- Male insects are winged and structurally complete, but females are degenerated.
- Lac or shellac is an exuviate (secretion) of mainly female.
- Lac is resinous substance



Cochineal Bug

- Dactylopis cocccus lives upon cactus. Dead and dried bodies are used for making a dye called cochineal dye.

Blister Beetle

- Lytta is a genus of blister beetle. The drug ***cantheridine*** is prepared from its blood.
- Cantheridine is widely used for healthy growth of hair

Red Ants

- Red ants are used for the production of ***formic acid***.

Glow worm

Wingless female and larva of certain beetles like Lymphyris notiluca which emits greenish light. Also yields **luciferin**

Honey Bee

A hive consists of a vertical sheet of wax with a number of hexagonal cells for rearing young bees (**brood cells**), storing food (**storage cells**), **royal chamber** and chamber of themselves.

Honey bee is a social, polymorphic and colonial insect. It has three main castes – ***queen, drones*** and ***workers***.

Queen is the only fertile female of the colony which continues to lay eggs for 2–5 years.

Drones are male honey bees. They develop from unfertilized eggs. Drones and virgin queens take part in ***nuptial flight***. After copulation the drones are not allowed to come back into hive.

Workers are sterile females.

Scout bees search for food and intimate the same to worker bees by ***dances-round dance*** for less than 75m and ***tail wagging dance*** for longer distances.

Prof. karl von Frisch got Nobel prize 1973 for decoding the language of bee dances. Workers have pollen collecting apparatus, honey storing mechanism and wax secreting glands.

Young workers secrete royal jelly. Royal jelly is given to queen or potential queens.

Honey contain simple sugars (**fructose and levulose**), Vitamins and minerals. It is a tonic, laxative and sweetening agent. True product of honey bee is bees wax.

House Fly (*Musca nebulo, M. domestica*)

It is active in warm months and during winter it may die. The body is differentiated into head, thorax and abdomen.

Head has two compound eyes, three simple eyes, a pair of antennae and ***sponging*** type of mouth part.

Labrum forms proboscis, mandibles are absent, maxilla is in the form of maxillary palps, labrum and hypopharynx are represented by chitinous sclerites.

Only liquid food can be taken by housefly. Solid food is first liquidized by action of saliva, then taken by capillary action into pseudotrachea. Mesothrorax bears a pair of transparent wings. Metathorax has a pair of ***halters*** for balancing. Female lays eggs in moist organic debris like dung. Larva is called ***maggot***.

Housefly transmits a number of diseases like conjunctivitis, trachoma, gangrene, plague, cholera, dysentery, poliomyelitis, diarrhoea, typhoid, etc

Mosquito

Mosquitoes are small nocturnal insects having a pair of wings and mouth parts modified for piercing and sucking.

Mandibles are absent in males.

Pedicel of antenna has a auditory receptor called **Johnston's organ** for perceiving vibrations.

Male mosquitoes usually feed on flower sap or nectar while female mosquitoes feed on blood.

The common mosquitoes are Anopheles, Culex and Aedes.

✯ **Class - 5 : Arachnida**

- The body is usually divisible into cephalothorax and abdomen.
- The cephalothorax bears simple eyes and six pairs of appendages (One pair of *chelicerae, one pair pedipalpi and four pairs of legs)*
- *Antennae are absent.*
- *Respiratory organs are book lungs or trachea or both*
- Excretion takes place by Malpighian tubules or *coxal glands* or both
- Development is generally direct.

  Examples : Scorpion, spider, Tick, Mite, Aranaeus (garden spinder), Palamneus (Scorpion), Buthus (Scorpion)
- ***Spiders spins the web by means of a secrection of abdominal glands.***
- There are two more classes in the phylum Arthropods. These classes are **Onychophora** and ***Merostomata. Peripatus is an important examples of the class Onychophora***, which has characters of Phylum Annelida and Arthopoda. Hence it is called ***"connecting link"*** between annelida and arthropoda **.** It breathes by trachea.
- ***Limulus***. ***(the king crab or horseshoe crab)*** is good example of class Merostomata which respires with book gills. The king crab are called "living fossils". A living fossil is a living animal of ancient origin with many primitive characters.
- Larvae of different Arthropods

  (a) Bombyx (Slikworm) — Caterpillar / Silkworm
  (b) Beetles, honey bee — Grub
  (c) Musca (Housefly) — Maggot
  (d) Culex, Anopheles — Wriggler
  (e) Pennaeus (Marine prawn) — Mysis, nauplius, protozoea
  (f) Cancer (Crab) — Megalopa metanauplius, zoea
- Arthopoda is **the biggest phylum.** About 9,00, 000 species are there . Largest class is insecta.
- **Von Siebold** established phylum **Arthoropoda.**
- Arthopods are Aquatic (Freshater/marine), Terrestrial, burrower, parasitic.

PHYLUM – MOLLUSCA

1. It is **second largest** Phylum.
2. Mollusca (Soft bodied) are **marine** or **fresh water** or terrestrial. **Johnston** coined the name **Mollusca.**
3. Study of this phylum is known as **Malacology** & study of shells of molluscan is known as **Conchology.**
4. Body is unsegmented with variety of shapes. **Neopilina** is exceptionally segmented. (connecting link).
5. Molluscs are usually **bilateral.** Few are secondarily **asymmetrical** (snail) due to twisting (Torsion) during growth.
6. Triploblastic with Organ system level.
7. **Body wall** includes one layered epidermis (usually cilited) with unstripped muscles found in bundles.
8. Body parts consist of

   (i) **Head** with sense organ. Head is absent in Pelecypoda & Scaphopoda.

   (ii) Dorsal **visceral mass** containing organ system.

   (iii) **Ventral foot** for locomotion.

(iv) Thin fleshy fold or outgrowth of dorsal body wall covers the body. This fold is called **mantle or pallium.** It encloses a space mantle or pallial cavity between itself and the body. The mantle usually secretes an external limy **shell**. Shell is made up of **Calcium carbonate and Concheolin protein**.

Shell may also be internal (Cuttle fish), reduced and even absent (Octopus)

9. **Coelom** is greatly **reduced.** It is represented by cavities in the **pericardium, kidneys** and **gonads**. Space among the viscera contain blood and form **haemocoel**.
10. **Digestive tract** is complete. Buccal cavity contain a rasping organ the **Radula**, with transverse row of teeth.
11. Anus opens into the mantle cavity.
12. Digestive glands are known as **hepatopancrease.**
13. **Respiration** is usually by **gills** i.e., **Ctenidia.** But respiration may takes place by **body surface** also. **Dentalium** respire by **Mantle.**
14. **Pila** respire by **pulmonary sac on land** and by **gills** in water.
15. **Circulatory system is open.** It includes dorsal **pulsatile heart** and a few arteries that open into sinuses.

    Cephalopoda has **closed** type of circulatory system.

    Blood has a copper containing, blue respiratory pigment **Haemocyanin.** Blood is colourless with amoebocytes.
16. **Excretory system** includes 1 or 2 pairs of sac like **kidneys,** which open into the mantle cavity. Kidney of molluscans are **Metanephridia** known as **Kaber's organs** or **Organ of Bojanus.** Excretory matter is **ammonia** or uric **acid.**
17. **Nervous system** comprises three paired **ganglia**

    (1) **Cerebral** (above the mouth)

    (2) **Pedal** (In the foot)

    (3) **Visceral** (in visceral mass)

    These are inter connected by

    (1) **Commissure** (Joins similar ganglia) (2) **Connectives** (Joins dissimilar ganglia)

    Senses organ includes

    (1) **Eye** - Present over a stalk called **ommatophore** (Gastropoda).

    (2) **Statocyst/Lithocyst -** For equilibrium in foot

    (3) **Osphradia -** Chemoreceptor/Olfactory as well as for testing chemical & physical nature of water.
18. **Sexes** usually **separate** (snail has **ovotestis**). Gonads have ducts.
19. Fertilization may be **external** or **internal.**
20. Cleavage is **spiral, determinate, unequal** and **holoblastic.**

    Development is - **Direct** or **indirect.**

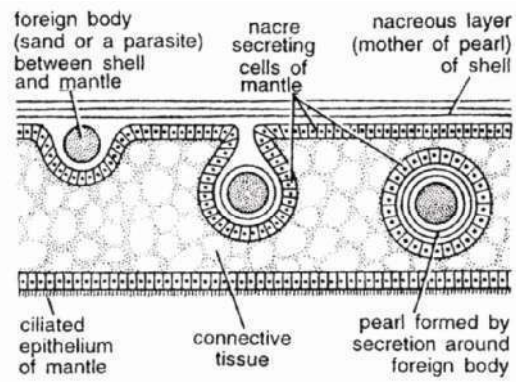
    Trochophore is very common larva of Mollusca phylum.

    Larva - **Glochidium** (Fresh water mussel) and **Veliger (Pila)**

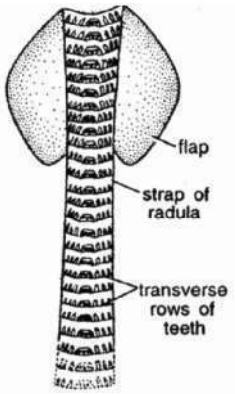
⇒ Precious pearl of the size of tennis - ball is made by a molluscs - **Tridekna**

⇒ **''Nacre layer''** is called **''Mother of Pearl''.** This layer is made up of $CaCO_3$ and choncheolin protein.

⇒ Father of pearl industry - **Kokichi Mikimoto**

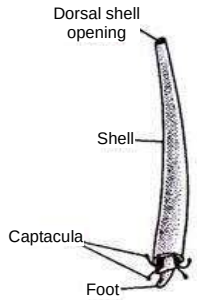


Stages in pearl formation.

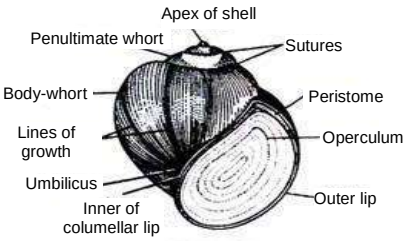


Pila. The radula.

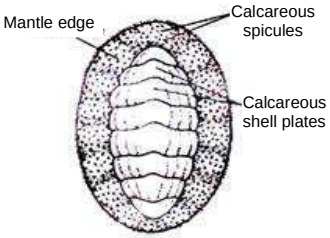
Molluscs are classified on the basis of shell, Foot, Nervous system and Gills into seven classes :



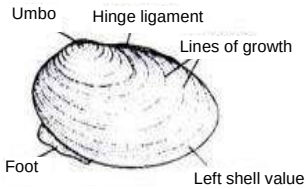
SCAPHOPODA (DENTALIUM)



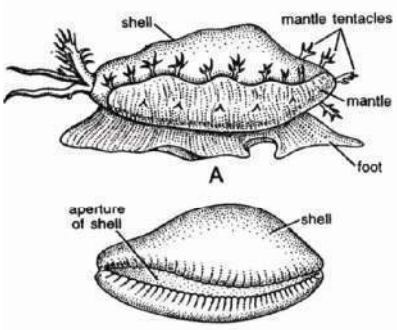
GASTROPODA (PILA)



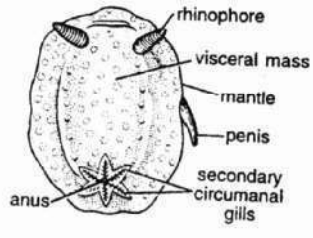
POLYPLACOPHORA (CHITON)



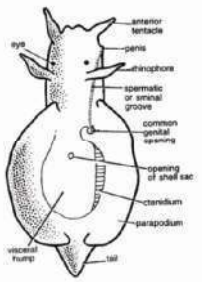
PELECYPODA (UNIO)



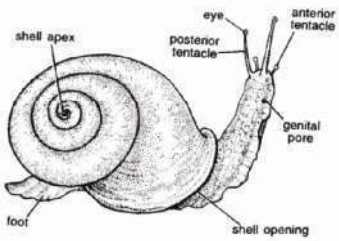
Cypraea (cowrie). A – Living cowrie. B – Shell of cowrie



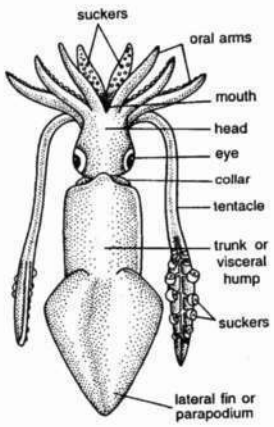
Doris. – Dorsal view



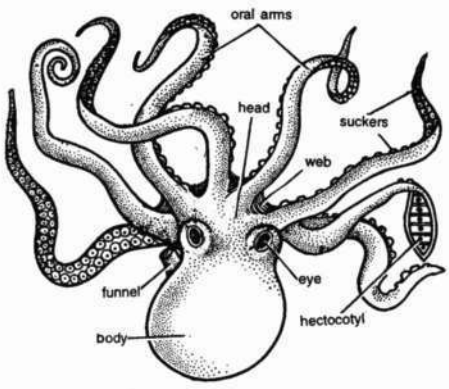
Aplysia. – Dorsal view



Helix



Loligo. – Dorsal view

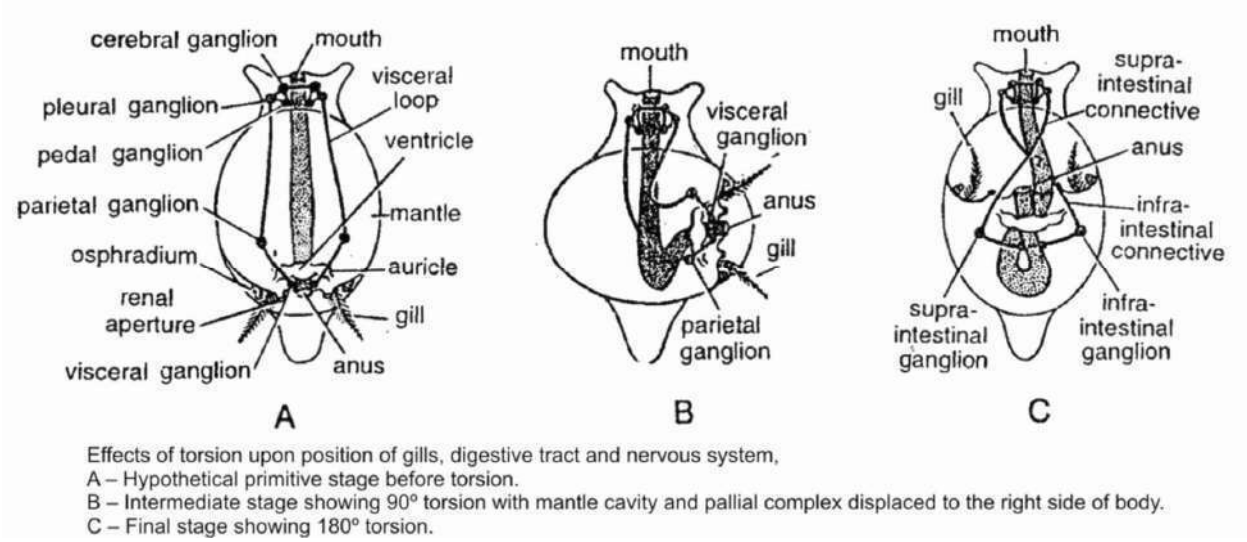


Octopus – Dorsal view

Monoplacophora	Aplacophora	Polyplacophora/ Amphineura	Scaphopoda	Gastropoda	Pelecypoda Bivalvia or Lamellibranchiata	Cephalopoda
- Marine, common character of Annelida and Arthropoda. **Body** - Bilaterally symmetrical and segmented. **Head** - Indistinct **Shell** - Dome-shaped with mantle. **Radula** - Present **Foot** - Flat muscular **Larva** - Trochophore e.g. - **Neopilina** Living fossils Connecting link of Annelida and Mollusca and only segmented molluscs with nephridia.	- Marine, Worm like **Body**-Small covered by thick mantle **Head**-Small without eyes & tentacles **Shell** - Absent. **Redula** - Present **Foot**-Reduce/absent. **Larva**-Trochophore e.g. - **Neomenia**	- Marine **Body** - Bilateral **Head** - reduced without eyes and tentacles. **Shell** - Present or absent. 8 dorsal plates present. (Multivalved) **Radula** – Present **Foot** - Reduced/absent. **Larva**-Trochophore e.g. **Chiton**-The coat of mail shell (Sea-mica) **Chaetopleura**-	- Marine **Body** - Bilateral **Head** - absent. Shell-Tubular, open at both end. **Redula**-Present **Foot** - Conical and use for digging **Larva** - Trochophore e.g. **Dentalium**-Tusk-shell. (Respire by mantle)	- Marine/fresh water /moist soil. largest class. **Body**-Symmetrical embryo grows into an asymmetrical adult due to twisting/torsion of visceral mass during development. mouth & anus lie on same side. **Head**-With eyes & tentacles. **Shell** - Spirally coiled **Radula** – Present **Foot** - Large & flat **Larva** - Trochophore or Veliger. e.g. **Pila**-Apple-snail (Shell used in but-tons) **Cypraea**-Old currency **Limex**-Slug (shell less) **Helix** **Turbinella**-Shankh **Turbo**-Cat's eye **Doris**-Sea lemon **Aplysia**- Sea hare **Planorbis**-Land snail **Lymnea**-Land snail **Achatina**- Land snail **Xancus**-Holy chank **Potella**-Limpet **Fissurella**-Keyhole limpet	- Marine/fresh water **Body**-Bilateral and flat **Head**-Absent **Shell**-Consist of two valves Movably hinged dorsally. **Redula**-Absent Foot-Plough or Wedge shaped for burrowing **Redula**-absent **Larva**-Glochidium, Trochophore e.g. **Unio**-Mussel (fresh water) **Mytilus**-Mussel (marine) **Lamellidens**-mussel **Ostrea** **Teredo**-Ship worm. **Pinctada**-Pearl oysters. **Pteria**- Indian pearl oyster. **Spondilus**-edible oyster **Tridekna**-Highest economic value **Pecten** - Scallop **Cardium**-Jumping bivalvia **Solen** - Blade fish	- Marine **Body** - Bilateral head & foot combined cephalopoda Shell-Internal and reduced it may be external (Nautilus) or absent (Octopus) **Redula** - Present **Foot** - Modified into a funnel and partly into 8 or 10 sucker bearing arms that surround the mouth Locomotion is by expelling water in jet through siphon (Jet propulsion). Ink glands in some squids for offense and defense. When the squid is attacked, it emits a cloud of inky fluid through its siphon. This 'smoke screen' interferes with the vision and chemoreceptors of the predator and thereby helps the squid to escape. - Closed blood circulation. - Hectocotyle for sperm transfer - Larva absent e.g. **Sepia**-Cuttle fish 10 arms having Chromatophores. **Tethys** - Sea-fly **Loligo** - Squid (Radula absent) **Architeuthis** - Giant squid (Largest invertebrate) **Octopus** - Devil fish 8 arms **Nautilus - Tiger shell**

What is torsion ?

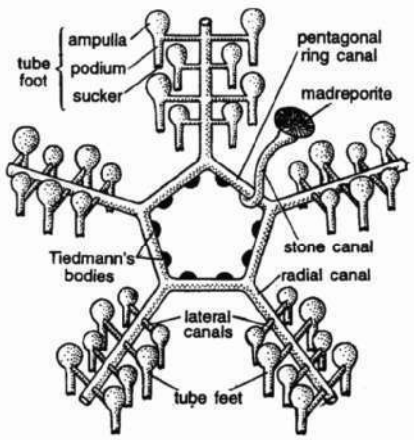
Torsion or twisting is a process during larval development of gastropids, which rotates the viscero-pallium anti-clockwise through 180° from its initial position, so that mantle cavity, with its pallial complex, is brought in front of the body in adult.



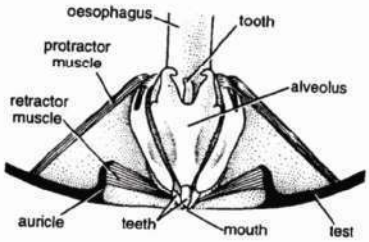
Effects of torsion upon position of gills, digestive tract and nervous system,
A – Hypothetical primitive stage before torsion.
B – Intermediate stage showing 90° torsion with mantle cavity and pallial complex displaced to the right side of body.
C – Final stage showing 180° torsion.

PHYLUM – ECHINODERMATA

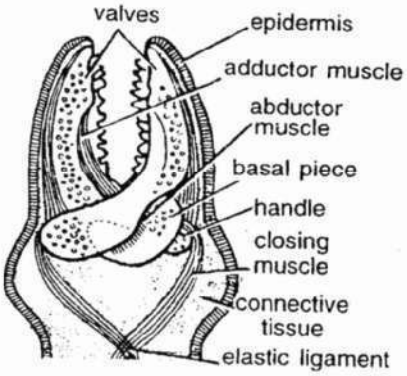
1. Name **Echinodermata** was given by **Jacob Klein.**
   All are Marine except **Synapta similis.**
   Generally live at **bottom** and slow moving.
2. Body shape is **star like, cylindrical like, melon-like, disc-like, flower like.**
3. Body unsegmented with **bilateral symmetry** in larva and **radial pentamerous** (arranged in five or multiple) in adult.
   Echinoderms are **triploblastic** with **organ - system level** of organization
4. Echinoderms do not have **head.**
   Tube feet (podia) which comes out through radial area i.e. **Ambulacral** used for locomotion. They are extended and retracted by variation in **hydraulic pressure** of fluid in them and by contraction of their muscle.
5. **Body wall** of echinoderms consists of
   (i) **Epidermis** - Single layered & ciliated.
   (ii) **Dermis** - Below the epidermis thick dermis having **mesodermal endoskeleton** of calcareous plate (Ossicles). It has spines.
   (iii) **Muscles** - Smooth and lie below dermis.
   Minute pincerlike structure **pedicellariae** comes out through skin. They keep body surface clear of debris by opening & closing. These are made up of three calcareous plates.
6. Echinoderms have true **Coelom** lined by **ciliated mesothelium. Enterocoelous** contain fluids with free amoeboid cells called **coelomocytes.**
7. Coelom is divided into many tubes and sinuses, which together form **3** systems.
   (i) A unique water filled **ambulacral** or **water vascular system** with tube feet to help in locomotion. A perforated plate **madreporite** permits entry of water into ambulacral system which also help in food and gas transport system. Structures like Pollian vesicle, tiedmann body or recemose, stone canal are also found in water vascular system.
   (ii) **Haemal system.**
   (iii) **Perihaemal system.**



Asterias. Water-vascular system.



Aristotle's lantern in situ



***Asterias* - Crossed type pedicellaria**

8. **Respiration** takes place by **gills** called **dermal branchiae** or papulae in most of Echinoderms like Starfish, **genital bursae** in Brittle star, **cloacal respiratory trees** Sea- Cucumber, **Peristomial gills** - Sea urchin. tube - feets also helps in respiration in all Echinoderms
9. **Digestive tract** is **complete,** (incomplete -brittle star).
   Circulation system is reduced and **open type** called **haemal system** /Perihaemal system. No heart or pumping vessel.
10. There is no **specialised excretory organ system**. Nitrogenous waste (ammonia) diffuses out via **gills, bursae, respiratory tree and tube feet**. Amoeboid cells in coelomic fluid also perform excretory function by absorbing excretory matter.
11. **Nervous system** is simple and primitive type includes a Nerve ring and radial nerve cord with simple sense organ. (No brain)
12. Echinoderms resemble **chordates** in early embryonic development.
13. Echinoderms have separate sexes.
14. **Fertilization** is **external** (no copulation). Life history includes ciliated, bilaterally symmetrical larva that undergoes metamorphosis and change into a adult (Deuterostome).

LARVA

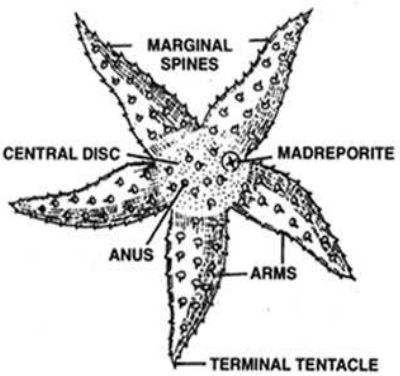
Star fish	➡	**Bipinnaria,**
Brittle star	➡	**Ophiopluteus**
Sea urchin	➡	**Echinopluteus**
Sea cucumber	➡	**Auricularia**
Feather star	➡	**Doliolaria,**

Few echinoderms (star fish) have great power of **regeneration**. They break off their arms fordefence purpose. This phenomenon is known as **Autotomy**

Echinoderms in angry or frightened state vomits out viscera (internal organ). This phenomenon is known as **Evisceration.**

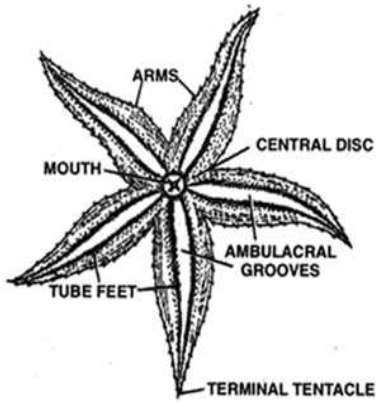
Heart urchin has **lophophore** (Ciliary structure)

Divided into Five classes				
Asteroidea	**Ophiuroidea**	**Echinoidea**	**Holothuroidea**	**Crinoidea**
Body Flat & star like. Arms - Five or multiple of five not sharply marked with the central disc (Show Autotomy). Spines - Present. Pedicellariae - Present. Ambulacral groove - Situated at oral surface. Madreporite - at Aboral surface Anus - At aboral end. Viscera - Extend upto arms Respiration - Dermal branchiae or papulae Suckers - Present Larva - Bipinnaria - Brachiolaria - Dipleura **Asterias** - starfish **Solaster** - Sea star **Pentaceros** - Sea pentagen **Astropecten**	Body form - Flat & star like Arms - Five or multiple of five. Sharply marked with the central disc Spines - Present Pedicellariae - Absent Ambulacral groove - Not visible Madreporite - Oral Anus - Absent Viscera - No Viscera into arms. Respiration - Genital bursae Suckers – Absent Larva - Ophiopluteus **Ophiothrix** (Brittle star) **Ophiura** **Gorgonocephalus**-Basket star.	Body form - Globular/disc like. Arms - Absent Spines - Present Pedicellariae - Present Ambulacral groove – Absent Madreporite - Aboral Anus – Aboral Viscera - No Viscera into arms. Respiration - Peristomium gills Suckers – Present Larva - Pluteus Mouth - with biting & chewing tooth apparatus **Aristotle's lantern** (Masticating apparatus with 5 teeth) **Echinus**-sea urchin **Clypeaster**- Cake urchin **Echinarachinus**-sand dollar **Echinocardium**-heart urchin **Salmacis**	Body form-Long & cylindrical Arms - Absent Spines Absent Padicellariae - Absent Ambulacral groove – Absent Madreporite - Internal Anus – Aboral Viscera - No Viscera into arms. Respiration-Cloacal tree Suckers – Present Larva - Auricularia **Cucumaria** - Sea cucumber **Holothuria** **Synapta**	Body form - Plant like fixed with cirri. Arms - Highly branched Spines - Absent Pedicellariae - Absent Ambulacral groove - Oral and ciliated Madreporite - Absent Anus – Oral Viscera - Extend upto arms Respiration - Tube feet Suckers – Absent Larva - Doliolaria **Antedon** - Sea lilly (most primitive) **Holopus** **Neometra** - Feather star **Neometra** - Feather star

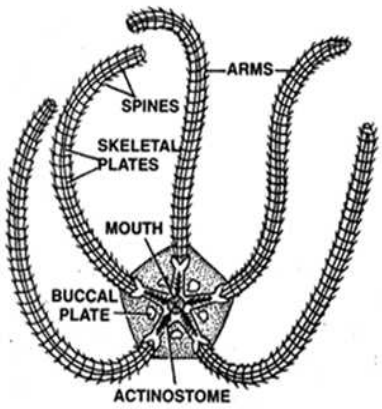


Aboral surface of star fish

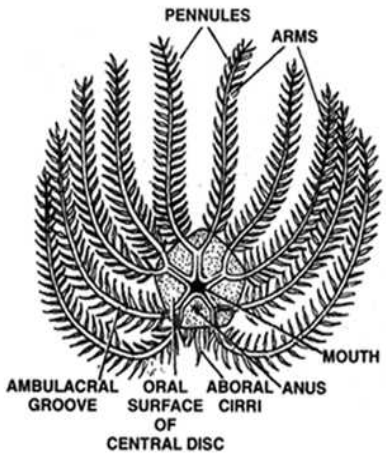
(a)



Oral surface of star fish



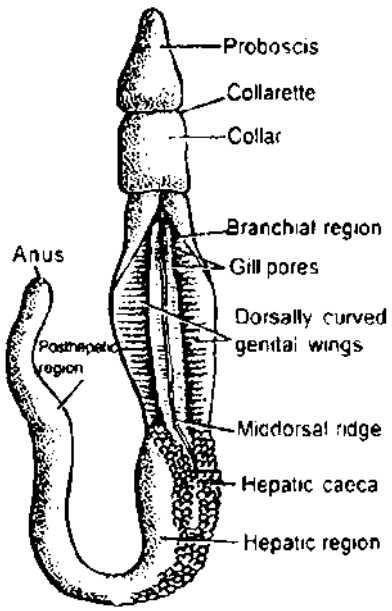
(b) Brittle star



(c) Feather star

HEMICHORDATA

1. The term Hemichordata was given by **Bateson.**
2. Animals of this phylum are all **fossorial,** and their tunnels are 'U' - shaped.
3. Body **worm like,** and soft.
4. Body is divided into **three parts.**
   A - **proboscis** B - **Collar** C - **Trunk**
5. Body wall has **single layered epidermis.** No dermis
6. Body cavity is **enterocoelus,** that is divided into **Protocoel, Mesocoel** and **Metacoel**.
7. Mostly **ciliary feeders.** Complete alimentary canal is present in digestive system. This is **straight or 'U' - shaped.**
8. Circulatory system is **open type.** Blood is colourless with ameoboid corpuscles.
9. Heart is dorsal.
10. Skeletal tissue is absent.
11. **True notochord** is **absent**.
12. A notochord like structure is found in their **buccal cavity,** that is called **''Buccal diverticulum''** or **''Stomochord''** (a hollow out-growth arises from roof of buccal cavity).
13. Post anal tail is Absent.



Balanoglossus :
External features in dorsal view

14. Dorsal heart, ventral nerve cord, no respiratory pigment.
15. Respiration by gills.
16. **Excretion** is done by a **single glomerulus.** This single glomerulus is situated in the proboscis known as **Proboscis gland.**
17. **Central nervous system** is just **like non chordates. Brain** is present in the form of **nerve - ring.**
18. Mostly animals are **unisexual** and reproductin is sexual.
19. Fertilization is **external.** Cleavage holoblastic.
20. **Development** is **direct** or **indirect** because some animals have **tornaria larva** just like **bipinnaria larva** of echinodermata in their developmental stages.

Hemichordata is divided into **two Classes**

(1) Enteropneusta **(2) Pterobranchia**

e.g.

– **Balanoglossus.**
– **Rhabdopleura** (Tongue worm or Acorn worm)
– **Cephalodiscus**
– **Saccoglossus**
– **Protoglossus**
– Earlies included Hemichordata in **Chordata phylum. Hyman** (1959) kept in **separate phylum** Hemichordata in **invertebrates.**
– **Hemichordata is connecting link between Non-Chordata & Chordata.**

EXERCISE – 1

ANIMAL CLASSIFICATION

Q.1 The blind sac body plan is found in the animals of
(1) Coelenterata (2) Gastropoda
(3) Flatworms (4) (1) and (3) both

Q.2 Cell aggregate body plan is found in the
(1) Volvox
(2) Colonial protozoans
(3) Porifera
(4) (1) and (3) both

Q.3 When only single opening is present in the alimentary canal, then the body plan is
(1) Open (2) Blind sac
(3) Cell aggregate (4) Tube in tube

Q.4 The tube in a tube plan is not present in the
(1) Taenia (2) Pheretima
(3) Leech (4) Ascaris

Q.5 Secondarily asymmetrical type of symmetry is present in
(1) Unio (2) Snail
(3) Holothuria (4) Star fish

Q.6 Enterocoelic type of coelom is present in the
(1) Echinodermata (2) Mollusca
(3) Arthropoda (4) Chordata

Q.7 Schizocoelic type of coelom is present in the
(1) Protochordata (2) Echinoderms
(3) Nematodes (4) Annelids

Q.8 Acoelomate group is
(1) Coelenterata only (2) Porifera only
(3) Platyhelminthes (4) All of the above

Q.9 Which one of the following is the connecting link between chordata and non-chordata
(1) Tachyglossus (2) Amphioxus
(3) Balanglossus (4) Sphenodon

Q.10 An animal with unsegmented coelom, superficial radial symmetry and bilateral symmetrical larva belongs to
(1) Arthropoda (2) Mollusca
(3) Echinodermata (4) Annelida

Q.11 Which of the following is represented by the largest number of species
(1) Insects (2) Protozoans
(3) Mammalia (4) Aves

Q.12 Diploblastic acoelomate condition is found in
(1) Planaria (2) Ascaris
(3) Rotifer (4) Sea anemone

Q.13 Which of the following group is Deuterostome
(1) Annelida, Arthropoda, Mollusca
(2) Echinodermata, Hemichordata, Chordata
(3) Annelida, Mollusca. Chordata
(4) Arthropoda, Mollusca, Echinodermata

Q.14 The animals, giving birth to young ones, are called
(1) Coelomate (2) Viviparous
(3) Amphibious (4) Triploblastic

Q.15 Sometimes parasites themselves are parasitised by other organism, such parasites known as
(1) Symbionts (2) Endoparasites
(3) Ectoparasites (4) Hyperparasites

Q.16 Which one of the following pairs of animals is correctly matched with the kind of their body symmetry
(1) *Hydra* and shark – Bilateral symmetry
(2) Tapeworm and octopus – Radial symmetry
(3) *Amoeba* and sea urchin – Asymmetry
(4) Jellyfish and starfish – Radial symmetry

Q.17 Which one feature is common to Amphioxus, frog, sea horse and crocodile
(1) Pharyngeal gill slits, at least in the developmental stages
(2) A three-chambered heart
(3) Dorsal solid nerve chord
(4) Skeleton formed of cartilage and bones

Q.18 Given below are four matchings of an animal and its kind of respiratory organ
1. Silver Fish – trachea,
2. Scorpion – book lung,
3. Sea squirt – pharyngeal gills,
4. Dolphin – skin
(1) 3 and 4 (2) 1 and 4k
(3) 1, 2 and 3 (4) 2 and 4

Q.19 A coelom (body cavity) derived from blastocoel is known as
(1) Enterocoel (2) Schizocoel
(3) Haemocoel (4) Pseudocoelom

Q.20 Maximum diversity is found in which phylum
(1) Chordata (2) Arthropoda
(3) Protozoa (4) Annelida

Q.21 Bilaterally symmetrical but acoelomate animal is
(1) Liver fluke (2) Jelly fish
(3) Round worms (4) Crab

Q.22 When embryo develops in the body of female but it does not obtain nutrients from the mother
(1) Ovo-viviparous (2) Viviparous
(3) Oviparous (4) None of these

Q.23 Genus is a group of similar and related
(1) Order (2) Genera
(3) Families (4) Species

Q.24 Animals of which group are not fresh water
(1) Crustacea (2) Insecta
(3) Echinodermata (4) Sponge

Q.25 Who is/are known as 'Father of Taxonomy'?
(1) C. Darwin (2) Lamarck
(3) Carolus Linnaeus
(4) Bentham and Hooker

PROTOZOA

Q.26 Which is the locomotory organ of class Sporozoa-
(1) Pseudopodia (2) Flagellum
(3) Cilia
(4) None of the above

Q.27 Organellae of defence in Paramecium are-
(1) Nematocyst (2) Oocyst
(3) Sporocyst (4) Trichocyst

Q.28 Conjugation in Paramecium is for-
(1) Binary division
(2) Sexual reproduction
(3) Asexual reproduction
(4) Metamorphosis

Q.29 Why Amoeba has been kept in protozoa-
(1) Due to contractile vacuole
(2) Because of nutrition being insectivorous
(3) Cell wall
(4) Acellular body

Q.30 Nutrition in paramecium-
(1) Holophytic (2) Saprophytic
(3) Saprozoic (4) Holozoic

Q.31 Protozoan considered link between plants and animals-
(1) Paramecium (2) Amoeba
(3) Euglena (4) Plasmodium

Q.32 Character of sporozoa-
(1) Aquatic life
(2) Holophytic nutrition
(3) Spore formation
(4) Holozoic nutrition

Q.33 Which group of protozoans have pseudopodia-
(1) Ciliate (2) Sporozoa
(3) Mastigophora (4) Sarcodina

Q.34 Which animals are of similar genus-
(1) Histolytica and coli
(2) Histolytica and plasmodium
(3) Histolytica and falciparum
(4) Histolytica and bancrofti

Q.35 Micronucleous of paramecium is associated with-
(1) Somaric functions
(2) All body functions
(3) Reproduction (4) Locomotion

Q.36 Contractile vacuole is absent in-
(1) Entamoeba (2) Amoeba
(3) Euglena (4) Paramecium

Q.37 Which of the following is not a parasite-
(1) Monocystis (2) Giardia
(3) Nosema (4) None

PORIFERA

Q.38 Sponges differ from other animals in having-
(1) Dermal papillae (2) Hollow body
(3) Coelenteron (4) Choanocytes

Q.39 Classification of phylum Porifera is based on-
(1) Canal system (2) Spicules
(3) Shape of choanocytes
(4) Ascocytes

Q.40 Sponges are not found in-
(1) Sea water (2) Cold water
(3) Sandy sea shore (4) None

Q.41 The structure which functions as mouth in sponges is-
(1) Osculum (2) Ostia
(3) Prosopyle (4) None

Q.42 The body cavity of sponge is-
(1) Incurrent canal (2) Radial canal
(3) Coelenterone (4) Paragastric cavity

Q.43 Name bath sponge is of-
(1) Spongilla (2) Chalina
(3) Euspongia (4) Cliona

Q.44 Parenchymula is-
(1) An embryonic stage
(2) A type of morula
(3) Coelenterata larva
(4) None

Q.45 Sponges exhibits-
(1) Only intracellular digestion
(2) Only intercellular digestion
(3) Only extra cellular digestion
(4) 1 & 2

Q.46 The water current in the body of sponge is controlled by-
(1) Amoebocyte (2) Porocyte
(3) Choanocytes (4) Pinacocytes

Q.47 Sponges are provided with-
(1) Water vascular system
(2) Water canal system
(3) Sub-vascular system
(4) Sub-canal system

CNIDARIA (COELENTERATA) & CTENOPHORA

Q.48 Common name of fungia is-
(1) Mushroom coral (2) Red coral
(3) Brain coral (4) Organ pipe coral

Q.49 The species of coral which is used in jwellery-
(1) Corallium (2) Anthocodium
(3) Gorgonium (4) Fungia

Q.50 Corals are formed by-
(1) Molluscs (2) Coelenterates
(3) Protozoans (4) Echinoderms

Q.51 Medusae are found in the life history of-
(1) Obelia (2) Hydra
(3) Star fish (4) None of them

Q.52 Statocyst is found in-
(1) Cockroach (2) Obelia
(3) Paramecium (4) Earthworm

Q.53 Mesogloea is found in which group of animals-
(1) Porifera (2) Coelenterata
(3) Hydrozoa (4) Annelida

Q.54 Which level of body organization is found in cnidaria-
(1) Organ grade
(2) Cellular grade
(3) Organ system grade
(4) Tissue grade

Q.55 Sea anemone belongs to phylum-
(1) Porifera (2) Cnidaria
(3) Echinodermata (4) Protozoa

Q.56 Metazoa includes-
(1) Sporozoa (2) Sarcodina
(3) Cnidaria (4) Protista

Q.57 Portuguese man of war is-
(1) A soldier of world war
(2) Portuguese soldier
(3) A sponge
(4) A polymorphic, colonial coelenterate

Q.58 Which of the following is a larva of Hydra-
(1) Planula (2) Parenchymula
(3) Cydipidd (4) No larva in hydra

Q.59 Comb jelly are the animals of which of the following phylum
(1) Ctenophora (2) Coelenterata
(3) Hydrozoa (4) Protozoa

Q.60 Which of the following is associated with corals-
(1) Corallium (2) Corallita
(3) Corallum (4) All

Q.61 Coral animals are found in-
(1) All type of sea water
(2) Fresh & marine water
(3) In equatorial sea on both the sides upto 30°
(4) Antarctica

Q.62 One of the following is not a coelenterata-
(1) Sea pen (2) Sea fan
(3) Sea hare (4) Sea feather

Q.63 Red moonga is a -
(1) Type of stone
(2) Type of shell
(3) Structure similar to pearl
(4) Type of coral skeleton

Q.64 Coloblasts are found in-
(1) Beroe (2) Hydrozoa
(3) Anthozoa (4) Scyphozoa

Q.65 Which of the following is unmatched-
(1) Sea pen (2) Sea fan
(3) Sea feather (4) Sea horse

Q.66 Blue coral is-
(1) Metridium (2) Heliopora
(3) Cavernullaria (4) Renilla

Q.67 Cavernullaria is -
(1) Red coral (2) Sea feather
(3) Sea stick (4) Sea fan

Q.68 Which class exhibits polymorphism-
(1) Hydrozoa (2) Scyphozoa
(3) Crinoidea (4) Gastropoda

Q.69 The body cavity of phylum coelenterata is-
(1) Coelom (2) Haemocoelom
(3) Pseudocoelom (4) None

PLATYHELMINTHES

Q.70 Platyhelminthes are generally called-
(1) Round worms
(2) Flat worms
(3) Tubiculous worms
(4) Blind worms

Q.71 Primary host in the life history of Fasciola-
(1) Pig (2) Sheep
(3) Man (4) Snail

Q.72 Alimentary canal is not found in-
(1) Arachnida (2) Apoda
(3) Gastropoda (4) Cestoda

Q.73 Active movement is not found in Taenia because-
(1) Body is segmented
(2) Hooks and suckers, are found
(3) It is parasite
(4) Alimentary canal is absent

Q.74 Disease filariasis is caused by-
(1) Fasciola (2) Wuchereria
(3) Taenia (4) Ascaris

Q.75 Secondary host of tape worm is-
(1) Cat (2) Man
(3) Horse (4) Pig

Q.76 Tapeworms do not have alimentary canal because they get food from-
(1) Suckers (2) Mouth
(3) Body surface (4) All of them

Q.77 Order-trematoda includes-
(1) Flat-worms (2) Tape-worms
(3) Flukes (4) Round-worm

Q.78 Turbellarians are-
(1) Independent round-worms
(2) Independent flat-worms
(3) Parasitic tape worms
(4) Parasitic-worms

Q.79 Infection of Taenia leads to-
(1) Burning sensation in alimentary canal
(2) Blisters on skin
(3) Itching (4) Hungerlessness

Q.80 Filaria pathogen is a-
(1) Bacterium (2) Mosquito
(3) Protozoan (4) Helminth

Q.81 Bladder worm is a stage found in the development of-
(1) Liver flake (2) Planaria
(3) Thread worm (4) Tape worm

Q.82 Miracidium is found in the life history of-
(1) Leech (2) Ascaris
(3) Taenia (4) Fasciola

Q.83 Cercaria is found in the life history of-
(1) Unio (2) Liver fluke
(3) Tape worm (4) Honey bee

Q.84 Powerful suckers for attachment are found in-
(1) Taenia (2) House fly
(3) Earth worm (4) Mosquito

Q.85 Infective stage for primary host in the life history of liver fluke-
(1) Redia (2) Cercaria
(3) Miracidium (4) Cysticerus

Q.86 Taenia solium passes on to secondary host at which stage-
(1) Onchosphere (2) Hexacanth
(3) Cysticercus (4) Bladderworm

Q.87 Excretory organs of Taenia solium are-
(1) Nephrida
(2) Flame cells
(3) Malpighian corpuscle
(4) Green gland

ASCHELMINTHES

Q.88 Which of the following has no alternative host-
(1) Ascaris (2) Plasmodium
(3) Tapeworm (4) Periplaneta

Q.89 Pseudocoelom is a salient feature of-
(1) Porifera (2) Nematods
(3) Cestoda (4) All

Q.90 One of the following is a group of round worms-
(1) Whipworm, Ascaris, Shipworm
(2) Eyeworm, Filaria, Hookworm
(3) Pin worm, Hook worm, Tapeworm
(4) All

Q.91 Animals which exhibit moulting-
(1) Ascaris
(2) Animals of class hexapoda
(3) Animals of class nematoda
(4) All

Q.92 One of the following is a member of group nematoda-
(1) Ship worm (2) Calm worm
(3) Silk worm (4) Guinea worm

Q.93 Synctitial epidermis is a salient feature of-
(1) Ascaris (2) Tape worm
(3) Amphioxus (4) Opalina

Q.94 Life cycle of which lack secondary host-
(1) Plasmodium (2) Fasciola
(3) Ascaris (4) Taenia

Q.95 Body of which is unsegmented-
(1) Tape worm (2) Mosquito
(3) Earthworm (4) Round worm

Q.96 Animal which completes its life cycle in one host-
(1) Ascaris (2) Monocystis
(3) Entamoeba (4) All

ANNELIDA

Q.97 Which is as annelid-
(1) Ant (2) Crab
(3) Nereis (4) Octopus

Q.98 Larva is not found in the life history of-
(1) Ascaris (2) Taenia
(3) Frog (4) Pheretima

Q.99 Leech is-
(1) Free swimming (2) Parasitic
(3) Flat-worm (4) Round-worm

Q.100 Definite number of body segments are found in-
(1) Cockroach (2) Earthworm
(3) Taenia (4) Hydra

Q.101 Botrydall tissues are found in -
(1) Hirudenaria (2) Aphrodite
(3) Chaetopterus (4) Lumbricus

Q.102 Which of the following does not form cocoon-
(1) Leeches (2) All annelids
(3) Earthworm (4) Nereis

Q.103 Heteronereis is-
(1) A larval stage
(2) An embryonic stage
(3) A sexual stage (4) An inactive stage

Q.104 Common name of nereis is-
(1) Sand worm (2) Calm worm
(3) Rag worm (4) All

Q.105 Which one of the following functions like heparin in blood-
(1) Haematin (2) Histamine
(3) Hirudin (4) Hirudo

Q.106 Annelid which exhibits transverse fission-
(1) Syllis (2) Aphrodite
(3) Sabella (4) Polynoe

Q.107 Which of the following is largest annelid-
(1) Chaetogaster (2) Megascolex
(3) Microchaetus (4) Syllis

Q.108 Animal with red blood & annulated body-
(1) Peacock worm (2) Peanut worm
(3) Paddle worm (4) All

Q.109 In which the body is segmented-
(1) Coelenterata (2) Porifera
(3) Mollusca (4) Annelida

Q.110 Animal which inhabits deep fresh water-
(1) Tubifex (2) Leech
(3) Nereis (4) All

ARTHROPODA

Q.111 Blood in Arthropods may be light blue due too presence of
(1) Haemoglobin (2) Haematin
(3) Haemocyanin (4) Haemapoetin

Q.112 Indian species are-
(1) Periplanata americana and Blata indica
(2) Periplanata americana and Blata americana
(3) Periplanata americana and Blata orientalis
(4) Periplanata indica and Blata orientalis

Q.113 Which structure is found in male cockroach but is absent in female-
(1) Anal cerci (2) Anal style
(3) Antennae (4) Gonapophyses

Q.114 Myriapod has-
(1) Chitinous exoskeleton, ventral nerve cord, three pair of antennae
(2) Chitinous exoskeleton, ventral nerve cord, many body segments, one pair of antennae
(3) Soft body, ventral nerve cord, many body segments, two pair of antennae
(4) Chitinous exoskeleton, dorsal nerve cord, three body segments, one pair of antennae

Q.115 Chitinous exoskeleton is found in-
(1) Birds (2) Turtle
(3) Insects (4) Fishes

Q.116 Palaemon belongs to which phylum-
(1) Crustacea (2) Insecta
(3) Arthropoda (4) Mollusca

Q.117 Which is not an insect-
(1) Mosquito (2) Spider
(3) Housefly (4) Bedbug

Q.118 Number of (paired) legs in centipede are approximately-
(1) 100 (2) 50
(3) 40 (4) 20

Q.119 Which of the following is colonial insect-
(1) Mosquito (2) Locust
(3) Bed bug (4) Termites

Q.120 Which is not a fish-
(1) Cat fish (2) Dog fish
(3) Silver fish (4) Lung fish

Q.121 Common character of mosquito, rat flea, bedbug and leech is-
(1) All have nephridia
(2) Saliva contains anticoagulant
(3) Lay eggs in stagnant water
(4) All are insects

Q.122 Common character in almost all insects-
(1) 2 pair of wings (2) 3 pair of legs
(3) 2 pair of antennae
(4) One pair of abdominal appendage

Q.123 Respiratory organs of insects-
(1) Book lungs (2) Trachea
(3) Lungs (4) Fat body

Q.124 Which set includes pathogenic arthropods-
(1) Tse-tse fly, mosquito, flea-plague
(2) Crab, Culex, prawn
(3) Anopheles, culex, cray-fish
(4) Silver-fish, housefly, sand-fly

Q.125 The blood in the body of insects-
(1) Flows in open circulation
(2) Contains haemoglobin in erythrocytes
(3) Flows in arteries and veins
(4) Resembles human beings in colour

Q.126 Which animal has fixed number of legs-
(1) Hydra (2) Ant
(3) Amoeba (4) Earth-worm

Q.127 Which phylum has highest number of species-
(1) Protozoa (2) Metazoa
(3) Arthropoda (4) Insecta

Q.128 Respiratory pigment in insects-
(1) Haemoglobin (2) Cytochrome
(3) Haemocyanin (4) None

Q.129 Locusts are closely related to-
(1) Butterfly (2) Moth
(3) Grasshopper (4) Beetle

Q.130 Malpighian tubules are-
(1) Excretory organs of frog
(2) Respiratory organs of insects
(3) Excretory organs of insects
(4) Endocrine glands

Q.131 Glow worm is a-
(1) Mollusc (2) Annelid
(3) Insect (4) Helminth

Q.132 Spiders form web which is secreted from-
(1) Salivary glands
(2) Mouth
(3) Last part of abdomen
(4) Legs

MOLLUSCA

Q.133 The elephant tusk shell is
(1) Cypraea (2) Dentalium
(3) Limax (4) Nautilus

Q.134 Which are the exclusive marine molluscs
(1) Gastropods (2) Pelecypods
(3) Cephalopods (4) Scaphopods

Q.135 Mytilus belongs to class
(1) Amphineura (2) Cephalopoda
(3) Gastropoda (4) Pelecypoda

Q.136 Ovo testis is found in-
(1) Snail (2) Housefly
(3) Cockroach (4) Prawn

Q.137 Sepia and Octopus are two common marine animals. They show active movement in water by-
(1) Movement of oral arms
(2) Jet of water propelled through siphon
(3) Attachment with other animals through its suckers
(4) Undulating movement of lateral fins

Q.138 Cephalopoda has character-
(1) Foot located on head
(2) Head is located on foot
(3) Head fused with thorax
(4) Notochord found in head

Q.139 Pearl oyster belongs to-
(1) Gastropoda (2) Cephalopoda
(3) Scaphopoda (4) Pelecypoda

Q.140 Molluscan animals with reduced or without shell
(1) Octopus (2) Teredo
(3) Aplysia (4) All

Q.141 Animal which is solitary, free living & marine-
(1) Terado (2) Glossiphonia
(3) Balanus (4) All

Q.142 Common name of Doris is-
(1) Sea lemon (2) Sea hare
(3) Sea mussel (4) Sea mouse

Q.143 A free living animals whose larva is ectoparasite-
(1) Pila (2) Unio
(3) Snail (4) Octopus

Q.144 The phylum of largest invertebrate is-
(1) Annelida (2) Mollusca
(3) Arthropoda (4) Echinodermata

Q.145 The class of amphibious molluscs is-
(1) Gastropoda (2) Pelecypoda
(3) Cephalopoda (4) Bivaliva

Q.146 What is studied under conchiology-
(1) Shells (2) Worms
(3) Insects (4) Scorpion

Q.147 Study of molluscans is called as-
(1) Conchology (2) Etiology
(3) Acrology (4) Malacology

Q.148 Ospharadium is_
(1) Chemoreceptor (2) Thermoreceptor
(3) Olfactoreceptor (4) Excretory organ

ECHINODERMATA

Q.149 In which class of Echinodermata, a pluteus larva is formed
(1) Holothuroidea (2) Echinoidea
(3) Asteroidea (4) Ophiuroidea

Q.150 Which group includes all marine animals-
(1) Mollusca (2) Porifera
(3) Echinodermata (4) Coelenterata

Q.151 Water vascular system is found in-
(1) Echinodermata (2) Cnidaria
(3) Sponges (4) Arthropoda

Q.152 In star-fish which has dual function of locomotion and respiration-
(1) Axial sinus (2) Ampullae
(3) Tube feet (4) Tiedmann's body

Q.153 The connecting link between, echinodermata & chordata is-
(1) Balanoglossus (2) Peripatus
(3) Archeopteryx (4) None

Q.154 Star fish for protection leaves it's arm. It is called as-
(1) Autotomy (2) Autophagy
(3) Autogamy (4) Autolysis

Q.155 Animals which respire by respiratory tree belong to-
(1) Mollusca (2) Protochordata
(3) Echinodermata (4) Proterospongia

Q.156 Larva of holothuria is-
(1) Auricularia (2) Hexacanth
(3) Tornaria (4) Trochosphere

Q.157 Skeleton in echinoderms is -
(1) Chitinous
(2) Siliceous
(3) Made up of tunicin
(4) Calcareous

Q.158 Echinoderms keep -
(1) Radial symmetry
(2) Bilateral symmetry
(3) Elastic skin
(4) Porous body

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	2	1	2	1	4	4	3	3	1	4	2	2	4	4	1	3	4	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	4	3	3	4	4	2	4	4	3	3	4	1	3	1	4	4	2	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	4	3	4	1	3	2	1	1	2	1	2	2	4	2	3	4	4	1	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	3	4	1	4	2	3	1	4	2	2	4	3	2	4	3	3	2	4	4
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	4	2	1	2	1	2	1	2	2	4	4	1	3	4	4	3	4	2	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	1	3	4	3	1	3	4	4	1	3	3	2	2	3	3	2	3	4	3
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	2	2	1	1	2	3	3	3	3	3	3	2	3	4	1	2	1	4	4
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158		
Ans.	1	1	2	3	1	1	4	1	2	3	1	3	1	1	3	1	4	1		

EXERCISE – 2

ANIMAL CLASSIFICATION

Q.1 A species is defined as ''the group of actually or potentially inter-breeding natural population producing fertile offspring and reproductively isolated from such other groups''. The above statement is given by
(1) Carolus Linnaeus (2) Mayr
(3) J.B. lamarck (4) Charles Darwin

Q.2 Which set is correct
(1) Euglena–cilia
(2) *Paramecium*–Flagella
(3) Snail–Foot
(4) *Amoeba*–Foot

Q.3 Which phylum belongs to *Duterostomia*
(1) Echinodermata (2) Mollusca
(3) Arthropoda (4) Annelida

Q.4 Metazoans without tissue grade organization are called as
(1) Parazoa (2) Protozoa
(3) Eumetazoa (4) Deuterostomia

Q.5 Among the following organisms point out a completely non-parasitic form
(1) Sea anemone (2) Leech
(3) Tape worm (4) Mosquit

Q.6 On the basis of body organization, animals are grouped as
(1) Metazoa and eumetazoa
(2) Protozoa and parazoa
(3) Parazoa and metazoa
(4) Protozoa and metazoa

Q.7 Binomial nomenclature means writing the name of animals in two words which are
(1) Genus and species
(2) Order and family
(3) Genus and variation
(4) Family and genus

Q.8 *Systema Naturae* is concerned with
(1) Solar system (2) Ecosystem
(3) Classification of plants and animals
(4) Natural selection

Q.9 Which of the following classes has largest number of animals
(1) Mammalia (2) Pisces
(3) Insecta (4) Reptilia

Q.10 An animal that transforms from bilateral to radial symmetry in its life history is
(1) Hydra (2) Obelia
(3) Starfish (4) Sponge

Q.11 Which of the following does not have any alimentary canal
(1) Earthworm (2) Frog
(3) *Taenia* (4) *Ascaris*

Q.12 Founder of ''*Taxonomy''* is
(1) Aristotle (2) John Ray
(3) Haeckel (4) Linnaeus

Q.13 The meaning of taxon in the classification of animals
(1) A group of same species
(2) A group of animals on the basis of number of chromosomes
(3) A group of same type of animals
(4) A group of similar genera

Q.14 Which one of the following is a matching set of the class and some of its main distinguishing features
(1) Sporozoa – Infection by sporozoites, transmision by intermediate host and a contractile vacuole
(2) Trematoda – Well developed suckers, flat unsegmented body
(3) Arachnida – 3 pairs of legs, chitinous exoskeleton and poisonous sting
(4) Insecta – Compound eyes, segmented body and nephridia

Q.15 Most important criteria used for the present day classification of living organisms is based on
(1) Presence and absence of notochord
(2) Resemblances in external features
(3) Breeding habits
(4) Anatomical and physiological characteristics

Q.16 Radial symmetry is usually exhibited in animals which
(1) Have one opening of alimentary canal
(2) Have ciliary mode of feeding
(3) Are attached to the substratum
(4) Live in water

Q.17 The suffix '*idae*' refers to
(1) Family (2) Genus
(3) Order (4) Division

Q.18 Segmentation of body is not represented in
(1) Cray fish (2) Frog
(3) Grasshopper (4) Star fish

Q.19 Members of which phylum exhibit adaptations to widely varied environmental conditions
(1) Annelida (2) Platyhelminthes
(3) Echinodermata (4) Mollusca

Q.20 Alternation of generation is exhibited by
(1) Porifera (2) Protozoa
(3) Platyheminthes (4) Nemathelminthes

Q.21 Radial symmetry is seen in
(1) Molluscs (2) Star fishes
(3) Sponges (4) Fishes

Q.22 Two or more species occupying identical or overlapping areas are known as
(1) Sympatric species (2) Allopatric species
(3) Sibling (4) Subspecies

Q.23 The term '*New systematics*' was introduced by
(1) Adolf Engler (2) Karl prantl
(3) George Bentham (4) Julian Huxley

Q.24 Which one of the following phylums is characterized by the absence of a true coelom
(1) Echinodermata (2) Mollusca
(3) Annelida (4) Nematoda

Q.25 Animal in which larval stage is absent-
(1) Cockroach & Ascaris
(2) Earthworm & Hydra
(3) Frog & Amoeba
(4) Ascaris & Earthworm

Q.26 Tube feet for locomotion are found in-
(1) Porifera (2) Echinodermata
(3) Cnideria (4) Some annelida

Q.27 Protozoans reproduce by many methods. Which of the following reproduces both by binary fission & conjugation-
(1) Monocystis (2) Paramecium
(3) Amoeba (4) Euglena

Q.28 Excretion in Taenia is by-
(1) Malpighian body (2) Flame cell
(3) Green gland (4) Nephridia

Q.29 Entamoeba is a member of which class-
(1) Sporozoa (2) Sarcodina
(3) Protozoa (4) Calcaria

Q.30 Two nuclei dimorphism is found in-
(1) Amoeba (2) Paramecium
(3) Hydra (4) None

Q.31 The classification of porifera is based on-
(1) Ascocystes (2) Canal system
(3) Spicules (4) Choanocytes

Q.32 Aristotle lantern is found in-
(1) Star fish (2) Sea Urchin
(3) Sea anemone (4) Aurelia

Q.33 The salient feature of Echinodermata is-
(1) Bilateral symmetry & spiny skin
(2) Asymmetry & spiny skin
(3) Radial symmetry & spiny skin
(4) Radial symmetry & normal skin

Q.34 Sponges are provided with water canal system. The simplest type of water canal system is-
(1) Ascon type (2) Sycon type
(3) Leucon type (4) Regon type

Q.35 Filariasis can be irridicated out completely by destroying-
(1) Cockroach (2) Fly
(3) Culex (4) Anopheles

Q.36 Mollusca of which class has large & vertebrate-like eyes-
(1) Gastropoda (2) Bivalvia
(3) Pelecypoda (4) Cephalopoda

Q.37 Star fish is member of which class-
(1) Cephalopoda (2) Ophiuroidea
(3) Asteroidea (4) Pisces

Q.38 The species of coral which is used in jwellery-
(1) Corallium (2) Anthocodium
(3) Gorgonium (4) Fungia

Q.39 The important feature of sponges is-
(1) Choanocytes in all
(2) Sexual reproduction in all
(3) Coelenterone in all
(4) All herbivorous

Q.40 Precious Red Coral is/Coral used in ornaments is
(1) Astraea (2) Fungia
(3) Corallium (4) Tubipora

Q.41 Which one of the following animals possesses nerve cells but no nerves
(1) Hydra (2) Tapeworm
(3) Earthworm (4) Frog's tadpole

Q.42 Planaria, liver fluke & tapeworms are-
(1) All segmented (2) All endoparasites
(3) All coelomate (4) All flat worms

Q.43 The correct statement regarding *Taenia saginata* is-
(1) Absence of rostellar hooks
(2) Presence of 2 rows of hooks on the rostellum
(3) Pig is a secondary host in the life cycle
(4) Scolex has 2 large suckers

Q.44 Cyclops is intermediate host of-
(1) Planaria/Dugesia (2) Echinococcus
(3) Drancunculus (4) Ancyclostoma.

Q.45 Limulus belongs to group-
(1) Insecta (2) Crustacea
(3) Merostomata (4) Onchophora

Q.46 Respiratory pigment found in the Mollusca animal-
(1) Haemoglobin (2) Myoglobin
(3) Haemocyanin (4) None

Q.47 Which of the following is not a class of Mollusca
(1) Decapoda (2) Gastropoda
(3) Scaphopoda (4) Cephalopoda.

Q.48 Echinoderms are
(1) Fresh water forms
(2) Both fresh water and marine
(3) Exclusively marine
(4) None of the above

Q.49 Corals belong to phylum
(1) Cnidaria (2) Porifera
(3) Mollusca (4) Annelida

Q.50 Special character of coelenterates is-
(1) Polymorphism (2) Nematocysts
(3) Flame cells (4) Hermaphroditism

Q.51 Bladderworm/cysticercus is the larval stage of
(1) Tapeworm (2) Roundworm
(3) Pinworm (4) Liver Fluke

Q.52 Anus is absent in-
(1) Fasciola (2) Pheretima
(3) Periplaneta (4) Unio

Q.53 Ascaris larva is called
(1) Cysticercus (2) Rhabditiform
(3) Hexacanth (4) Onchosphere

Q.54 Pseudocoel occurs in
(1) Hydra (2) Ascaris
(3) Cockroach (4) Earthworm

Q.55 Vestigial wings occur in-
(1) Housefly (2) Mosquito
(3) Blatta (4) Periplaneta.

Q.56 Natural parthenogenesis is found in
(1) Pheretima (2) Frog
(3) Star Fish (4) Honey Bee

Q.57 Insects excrete nitrogen as-
(1) Uric acid (2) Guanine
(3) Urea (4) Ammonia

Q.58 Closed circulatory system occurs in-
(1) Snail (2) Cockroach
(3) Cuttle Fish (4) All the above

Q.59 Animals producing natural pearls belong to
(1) Echinodermata (2) Cyclostomata
(3) Mollusca (4) Fishes.

Q.60 Mollusca blood contains
(1) Haemoglobin (2) Haemozoin
(3) Haemocyanin (4) All the above

Q.61 Which molluscan group is primarily used in pearl production ?
(1) Pelecypoda (2) Gastropoda
(3) Cephalopoda (4) Monoplacophorana

Q.62 Which group does not contain polyp-
(1) Hydrozoa (2) Scyphozoa
(3) Anthozoa (4) Calcarea

Q.63 An insect without mandibles is-
(1) Musca (2) Aphids
(3) Anopheles (4) Blatta

Q.64 Which is nonpoisonous-
(1) Scorpion (2) Centipede
(3) Crab (4) Spider

Q.65 Filter feeding occurs in
(1) Dentalium (2) Unio
(3) Pila (4) Amoeba

Q.66 Which one is an ophiuroid
(1) Brittle Star (2) Sea Star
(3) Sand Dollar (4) Sea Urchin.

Q.67 The basis of protozoan classification is-
(1) Measurement (2) Shape
(3) Locomotory organelles
(4) Number of nuclei

Q.68 The correct statement for sponge is-
(1) They are found in sea water only
(2) They are radial symmetry
(3) They have spicules
(4) They have power of regeneration

Q.69 Excretion in *Entamoeba histolytica* is by-
(1) Contractile vacuole
(2) Normal body surface
(3) Food vacuole
(4) None

Q.70 Cnidaria is characterised by
(1) Nematoblasts
(2) Coelenteron
(3) Tissue level of organisation
(4) All the above

Q.71 Mesogloea of Hydra is made of-
(1) Mucopolysaccharides
(2) Protein
(3) Protein and fat
(4) Reticulate tissue

Q.72 Common name of Fungia is
(1) Mushroom Coral (2) Red Coral
(3) Brain Coral (4) Organ Pipe Coral

Q.73 Wuchereria causes a disease in parts of India
(1) Filariasis-South India
(2) Elephantiasis -Bihar
(3) Elephantiasis –Karnataka
(4) None of the above

Q.74 Sandfly is-
(1) Ancyclostoma (2) Musca
(3) Phlebotomus (4) Drosophila

Q.75 Which is associated with pearl formation ?
(1) Pecten (2) Ostrea
(3) Nautilus (4) Pinctada.

Q.76 Salient feature of cephalopoda is-
(1) Head & thorax are fused
(2) Presence of arms in place of head
(3) Arms on the head
(4) All the above

Q.77 The sailent feature of class sporozoa of phylum protozoa is-
(1) Flagella (2) Cilia
(3) Parasitism (4) Pseudopodia

Q.78 Polymorphism occurs in
(1) Anthozoa (2) Scyphozoa
(3) Rhizopoda (4) Hydrozoa.

Q.79 The animal which does not show any metamorphosis or larval stage is-
(1) Pheretima posthuma
(2) Astarias
(3) Musca domestica (4) Butterfly

Q.80 Nereis belongs to
(1) Mollusca (2) Arthropoda
(3) Echinodermeta (4) Annelida.

Q.81 Endocrine glands of insects which releases juvenile hormone are-
(1) Corpora allata
(2) Corpora albicans
(3) Corpora myecaena
(4) All the above

Q.82 Honey is-
(1) Alkaline
(2) Acidic
(3) Neutral
(4) Basic after some days

Q.83 Which is presently most infective ?
(1) Aedes (2) Anopheles
(3) Culex (4) Trilobite

Q.84 Rocky Mountain Fever is spread by-
(1) Tick (2) Housefly
(3) Cockroach (4) Mosquito

Q.85 Silk is a product of
(1) Laccifera indica (2) Nosema bombycis
(3) Bombyx mori (4) Apis dorsata

Q.86 Class bivalvia is characterised by-
(1) Presence of tentacles around mouth
(2) Absence of head
(3) Coiled shell
(4) Absence of gills

Q.87 Structure of paramecium for protection is-
(1) Sporocyst (2) Trichocyst
(3) Nematocyst (4) Oocyst

Q.88 Which character differentiates sponges from other animals-
(1) Coelenterone (2) Hollow body
(3) Collar cells (4) Dermal papilla

Q.89 Body cavity of Hydra is called-
(1) Enterocoel (2) Coelenteron
(3) Gastrovascular cavity
(4) Both 2 and 3

Q.90 Which is a coelenterate
(1) Sea Pen (2) Sea Urchin
(3) Sea Fish (4) Sea Cucumber

Q.91 Laurer's canal is found in -
(1) Amoeba (2) Paramecium
(3) Fasciola (4) Hydra

Q.92 Which is true of Taenia ?
(1) Anterior proglottides contain male organs while ripe proglottides have uterus filled with eggs
(2) All proglottides have both male and female organs
(3) Female organs are confined to anterior proglottides
(4) Male organs are confined to posterior proglottides

Q.93 Solenocytes are found in-
(1) Platyhelminthese (2) Arthropoda
(3) Annelida (4) Aschelminthese

Q.94 Animals having multiple or numerous setae are included under
(1) Polychaeta (2) Oligochaeta
(3) Hirudinea (4) Onchophora.

Q.95 In which of the following setae are found in parapodia-
(1) Oligochaeta (2) Polychaeta
(3) Hirudenia (4) Arthropoda

Q.96 Matching pair of vector and disease is
(1) Sandfly-Plague
(2) Culex-Filariasis
(3) Body Louse –Typhoid
(4) Housefly-Yellow Fever.

Q.97 A class with the largest number of animals is
(1) Mammalia (2) Insecta
(3) Reptilia (4) Pisces

Q.98 Cray Fish is-
(1) Crustacean (2) Edible fish
(3) Poisonous fish (4) Mammal.

Q.99 Green glands found in some arthropods take part in
(1) Excretion (2) Respiration
(3) Digestion (4) Both 1 and 2.

Q.100 Most common silkworm of India is
(1) Bombyx mori (2) Antherea assamensis
(3) Antherea roylei (4) Antherea paphia

Q.101 A respiratory pigment is absent in-
(1) Earthworm (2) Frog
(3) Rabbit (4) Cockroach

Q.102 Millipede (Julus) and Centipede (Scolopendra) are both included under-
(1) Arachnida (2) Myriapoda
(3) Scaphopoda (4) Pelecypoda.

Q.103 Yellow fever is transmitted by
(1) Culex (2) Aedes
(3) Anopheles (4) Bed Bug

Q.104 Father of pearl industry is-
(1) Ivanovisky (2) Luis Pasteur
(3) C. Mikimotto (4) Harvey

Q.105 Pearl oyster is associated with-
(1) Cephalopoda (2) Scaphopoda
(3) Gastropoda (4) Pelecypoda

Q.106 Aristotle's lantern occurs in class
(1) Echinoidea (2) Asteroidea
(3) Holothuroidea (4) Ophiuroidea

Q.107 Which class of protozoa includes all parasitic forms-
(1) Sarcodina (2) Mastigophora
(3) Sporozoa (4) Opalina

Q.108 Sponge which is found in river water-
(1) Pheronema (2) Chalina
(3) Cliona (4) Spongilla

Q.109 Members of which phylum are commonly called as comb jelly-
(1) Ctenophora (2) Coelenterata
(3) Echinodermata (4) Hemi-chordata

Q.110 Sense organs of Aurelia are
(1) Tentilla (2) Tentaculocyst
(3) Nematocyst (4) Otolith

Q.111 Enterobius infection Occurs through
(1) Mosquito (2) Contamination
(3) Inoculation (4) Piercing

Q.112 Which of the following worm is unsegmented & viviparous-
(1) Ascaris (2) Wuchereria
(3) Taenia (4) Fasciola

Q.113 Annelida is advanced over nematoda in having
(1) Closed circulation
(2) Metameric segmentation
(3) True coelom
(4) All the above

Q.114 Which of the following exhibit "tube-within-a tube" arrangements-
(1) Arthropoda (2) Oligochaeta
(3) Mollusca (4) Echinodermata

Q.115 Mouth parts of Cockroach are meant for-
(1) Biting and chewing
(2) Sponging
(3) Sucking (4) Cutting

Q.116 Silver Fish, Lepisma, is
(1) Mammal (2) Insect/Arthropod
(3) Fish (4) Echinoderm

Q.117 Metamorphosis of insects is regulated through-
(1) Haemolymph (2) Thyroxine
(3) Ecdysone (4) All the above

Q.118 Hind wings of Mosquito are represented by-
(1) Elytra (2) Halteres
(3) Tentorium (4) Coxa

Q.119 Spider prepares the web with the help of-
(1) Legs (2) Mouth
(3) Spinnerets (4) Salivary glands

Q.120 Shell is internal in
(1) Loligo (2) Chiton
(3) Dantalium (4) Unio

Q.121 One of the following is called as elephant tusk shell-
(1) Chitin (2) Dentalium
(3) Teredo (4) Antedon

Q.122 An enterocoelomate invertebrate group is -
(1) Annelida (2) Echinodermata
(3) Arthropoda (4) Mollusca.

Q.123 Which of the following is not found in the water of river-
(1) Arthropoda (2) Crustacean
(3) Mollusca (4) Echinodermata

Q.124 One of the following is autotroph-
(1) Amoeba (2) Monocystis
(3) Euglena (4) None

Q.125 Cells forming skeleton in sponges-
(1) Scleroblasts (2) Spongioblasts
(3) Chorioblasts (4) Thesocytes

Q.126 Characteristic larva of coelenterates is
(1) Onchosphere (2) Rhabditiform
(3) Planula (4) Cysticercus

Q.127 Dropping of gravid proglottides by cestodes is-
(1) Autophagy (2) Autotomy
(3) Paedogenesis (4) Apolysis

Q.128 Free swimming ciliated stage of Liver Fluke is-
(1) Redia (2) Miracidium
(3) Metacercaria (4) Cercaria

Q.129 Which organism resides in lymph nodes ?
(1) Taenia (2) Wuchereria
(3) Plasmodium (4) Diplococcus

Q.130 Which nematoda worm are discovered first-
(1) *Enterobios vermicularis*
(2) Ancylostoma
(3) *Ascaris lumbricoides*
(4) *Dracunculus medinesis*

Q.131 Hard exoskeleton, cephalothorax and gills for respiration are characteristics of
(1) Insecta (2) Myriapoda
(3) Polychaeta (4) Crustacea.

Q.132 Which among the following is a social. insect
(1) White Ants (2) Locusts
(3) Bed Bugs (4) Mosquitoes.

Q.133 Arthropods lack
(1) Jointed appendages
(2) Cilia
(3) Respiratory organs
(4) Segmented body

Q.134 Which of the following invertebrate is pentamerous & enterocoelic-
(1) Pila (2) Ascaris
(3) Aphrodite (4) Asterias

Q.135 Structure present in amoeba for motility is-
(1) Cilia (2) Flagella
(3) Pseudopodia (4) None of them

Q.136 Amphiblastula is a larva of-
(1) Hydra (2) Sycon
(3) Planaria (4) Leucosolenia

Q.137 Filariform is a larva of-
(1) Arthopoda (2) Platyhelminthes
(3) Aschelminthes (4) Protozoan

Q.138 Ancylostoma effects through-
(1) Contaminated food
(2) Skin
(3) Blood
(4) Kissing

Q.139 Which of the following structure will help in identifying Arthropoda from Annelida-
(1) Segmented body (2) Nephridia
(3) Eyes (4) None

Q.140 Which of the following is most modified annelid-
(1) Arenicola (2) Chaetopterus
(3) Pontobdella (4) Hirudo medicinalis

Q.141 Sand fly is a vector host of-
(1) Sleeping sickness (2) Kala-azar
(3) Diarrhoea (4) Pyorrhoea

Q.142 Name bath sponge is of-
(1) Spongilla (2) Chalina
(3) Euspongia (4) Cliona

Q.143 Food is ingested in sponges by-
(1) Trophocytes (2) Choanocytes
(3) Pinococytes (4) Porocytes

Q.144 Which of the following group has cnidoblasts-
(1) Porifera (2) Ctenophora
(3) Coelenterata (4) Platyhelminthese

Q.145 Cells which are found only in cnideria animals-
(1) Nematoblasts (2) Gland cells
(3) Muscle cells (4) All

Q.146 In Metaphire, the glands that help in binding the worms during copulation are-
(1) Prostate glands (2) Albumin glands
(3) Accessory cells (4) Mucous glands

Q.147 Sycon belongs to a group of animals, which are best described as-
(1) Unicellular or acellular
(2) Multicellular with a gastrovascular system
(3) Multicellular without any tissue organization
(4) Multicellular having tissue organization, but no body cavity

Q.148 In Arthropoda, head and thorax are often fused to form cephalothorax, but in which one of the following classes, is the body divided into head, thorax and abdomen ?
(1) Insecta (2) Crustacea
(3) Myriapoda
(4) Arachnida and Crustacea

Q.149 'Filarial worm' is technically called-
(1) *Echinococcus* (2) *Fasciola hepatica*
(3) *Wucheria bancrofti*
(4) *Ancyclostoma duodenale*

Q.150 Some insects feed on fluids using specialized mouthparts for piercing and sucking, as for example-
(1) Aphids (2) Fruitfly
(3) Butterfly (4) Housefly

Q.151 Visceral mass undergo torsion in-
(1) Gastropoa (2) Cephalopoda
(3) Pelecypoda (4) None of the these

Q.152 Contractile vacuole is absent in-
(1) Sporozoa (2) Sarcodina
(3) Zooflagellate (4) Slime molds

Q.153 Which is wrongly matched ?
(1) Euglenoidae – Myonemes
(2) Ciliophora – Axonema
(3) Annelida – Notopodia
(4) Cnidaria – Parapodia

Q.154 In evolution..... evolved first time in annelids-
(1) True coelom
(2) Cephalization
(3) Bilateral symmetry
(4) Triploblastic nature

Q.155 Which is not correctly matched-
(1) Annelida–Enterocoelomata
(2) Arthropoda–Schizocoelomata
(3) Platyhelminthes– Acoelomate
(4) Nemathelminthes–Pseudocoelomata

Q.156 Metameric segmentation is the main feature of-
(1) Annelida (2) Echinodermata
(3) Porifera (4) Coelenterata

Q.157 It lives underwater for upto three years in 'nymph' before emerging as a flying insect. Fossils of this insect dating back about 300 million years have been found-
(1) May fly (2) Stone fly
(3) Caddis fly (4) Scropion fly

Q.158 Which one of the following animals belongs to class Scaphopoda ?
(1) Oyster (2) Loligo
(3) Chiton (4) Dentalium

Q.159 The animals with bilateral symmetry in young stage, and radial pentamerous symmetry in the adult stage, belong to the phylum-
(1) Cnidaria (2) Annelida
(3) Mollusca (4) Echinodermata

Q.160 From the following statements select the wrong one-
(1) Prawn has two pairs of antennae
(2) Nematocysts are characteristics of the phylum Cnidaria
(3) Millepedes have two pairs of appendages in each segment of the body
(4) Animals belonging to phylum porifera are exclusively marine

Q.161 The coelom of the animals which are commonly known "tooth shells" originates-
(1) from the blastocoel
(2) by enterocoelic method
(3) by schizocoelic method and filled with coelomic fluid
(4) by splitting of embryonic mesoderm and filled with the blood

Q.162 Which of the following features is common in silverfish, scorpion, dragonfly and prawn?
(1) Three pairs of legs and segmented body
(2) Chitinous cuticle and two pairs of antennae
(3) Jointed appendages and chitinous exoskeleton
(4) Cephalothorax and tracheae

Q.163 Food storage in Leucosolenia occur by-
(1) Ostia (2) Osculum
(3) Thesocyte (4) Spongocoel

Q.164 The following are the features associated with Cnidaria-
(I) Radial symmetry
(II) Presence of gastrovascular cavity
(III) Animals are in either of the two forms- polyp and medusa or both
(IV) Alternation of generation in their history
(1) All
(2) Only (I) and (II)
(3) Only (II) and (III)
(4) Only (I), (II) and (IV)

Q.165 Which one is mismatched?
(1) *Obelia* – Sea water
(2) *Physalia* – Sea water
(3) *Hydra vulgaris* – Sea water
(4) *Hydra gangetica* – Freshwater

Q.166 A triploblastic pseudocoelomate, bilaterally symmetrical human parasite which is oviparous and the transmission is by contact. It is-
(1) Tapeworm (2) Hookworm
(3) Palaloworm (4) Filarial worm

Q.167 Solenocytes and nephridia are respectively found in-
(1) Cnidaria and Mollusca
(2) Annelida and Nematoda
(3) Molluscs and Echinodermata
(4) Platyhelminthes and Annelida

Q.168 Earthworm are-
(1) Ureotelic when plenty of water is available
(2) Uricotelic when plenty of water is available
(3) Uricotelic under conditions of water scarcity
(4) Ammonotelic when plenty of water is available

Q.169 What is common about Trypanosoma, Noctiluca, Monocystis and Giardia ?
(1) They have flagella
(2) They produce spores
(3) These are all parasites
(4) These are all unicellular protists

Q.170 Biradial symmetry and lack of cnidoblasts are the characteristics of-
(1) Hydra and starfish
(2) Ctenoplana and Beroe
(3) Aurelia and Paramecium
(4) Starfish and sea anemone

Q.171 Two common characters found in centipede, cockroach and crab are-
(1) Book lungs and antennae
(2) Green gland and tracheae
(3) Compound eyes and anal cerci
(4) Jointed legs and chitinous exoskeleton

Q.172 Which one of the following is matching set of a phylum and its three examples-
(1) Mollusca – Loligo, Teredo, Octopus
(2) Cnidaria – Bonellia, Physalia, Aurelia
(3) Porifera– Spongilla, Euplectella, Pennatula
(4) Platyhelminthes – Planaria, Schistosoma, Enterobius

Q.173 Diagnostic character of the phylum Echinodermata is the presence of-
(1) Spiny skin
(2) Pedicellariae
(3) Water vascular system
(4) All of these

Q.174 Which one of the following is a matching pair of a body feature and the animal possessing it?
(1) Ventral Central — Leech nervous system
(2) Pharyngeal gill slits absent in embryo — Chamaeleon
(3) Ventral heart — Scorpion
(4) Post-anal tail — Octopus

Q.175 Which one of the following pairs is mismatched-
(1) Apis indica — honey
(2) Kenia lacca — lac
(3) Bombyx mori — Silk
(4) Pila globosa — Pearl

Q.176 Which of the following pairs are correctly matched-

Animals Morphological features

(1) Crocodile – 4-Chambered heart
(2) Sea Urchin – Parapodia
(3) Obelia – Metagenesis
(4) Lemur – Thecodont

(1) B, C and D (2) Only A and D
(3) Only A and B (4) A, C and D

Q.177 Middle layer of sponge is-
(1) Mesoderm (2) Ectoderm
(3) Mesenchyma (4) Mesoglea

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	1	1	1	4	1	3	3	3	3	1	3	2	4	3	1	4	1	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	4	2	2	2	2	2	2	2	3	2	3	4	3	4	3	1	1	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	4	1	3	3	3	1	3	1	2	1	1	2	2	3	4	1	3	3	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	2	1	4	1	2	3	3	2	4	1	1	1	3	4	3	3	4	1	4
Ques.	81	82	83	84	85	86	87	3	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	3	2	1	3	2	2	3	4	1	3	1	1	1	2	2	2	1	1	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	2	2	3	4	1	3	4	1	2	2	2	4	2	1	2	3	2	3	1
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	2	4	3	1	3	4	2	2	2	4	1	2	4	3	2	3	2	2	4
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	2	3	2	3	1	3	3	1	3	1	1	1	4	1	1	1	1	4	4	4
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177			
Ans.	3	3	3	2	3	2	4	4	4	2	4	1	4	1	4	4	3			

EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Which of the following amimal have lophophore **[RPMT 2000]**

(1) Waldheimia (2) Wallago

(3) Wall-lizard (4) Heart-urchin

Q.2 Which animal is eukaryotic unicellular **[RPMT 2000]**

(1) Synapta (2) Sun animalcule

(3) Mitre jelly fish (4) Sea lemon

Q.3 In which of the following class polymorphism is very distinct **[RPMT-2000]**

(1) Eucestoda (2) Hydrozoa

(3) Crinoidea (4) Gastropoda

Q.4 Which of the following animal has rhabdites **[RPMT 2000]**

(1) Syllis (2) May fly

(3) Bongainvillea (4) Dugesia

Q.5 Which animal has pseudocoelom : **[RPMT 2000]**

(1) Dragon fly

(2) Wouchereria bancroftii

(3) Amia (4) Lepisma

Q.6 Which of the following Nematode parasite to be first discovered **[RPMT 2000]**

(1) Ancylostoma duodenale

(2) Enterobius vermicularis

(3) Ascaris lumbricoides

(4) Dracunculus medinensis

Q.7 Highly modified annelids is **[RPMT 2000]**

(1) Pontobdella (2) Chetopterus

(3) Arenicola (4) Hirudo medicinalis

Q.8 Which of the following is a free living flat worm **[RPMT 2001]**

(1) Planaria (2) Taenia

(3) Fasiola (4) Pheretima

Q.9 Now protozoans are not included in kingdom Animalia because these are **[RPMT 2001]**

(1) Unicellular prokaryotes

(2) Multicellular prokaryotes

(3) Unicellular eukaryotes

(4) Mostly asymmetrical

Q.10 Which type of coelom is found in frog **[RPMT 2001]**

(1) Enterocoel (2) Schizocoel

(3) Pseudocoel (4) Heamocoel

Q.11 Correct order of excretory organs in cockroach, Earthworm and Rabbit respectively : **[RPMT 2001]**

(1) Skin, malpighi tubules, kidney

(2) Malpighi tubules, nephridia, kidney

(3) Nephridia, malpighi tubules, kidney

(4) Nephridia, kidney, green gland

Q.12 In Cephalopod-Sepia **[RPMT 2001]**

(1) Inner shell is found

(2) Outer shell is found

(3) A folded shell is found

(4) Shell is absent

Q.13 What will happen if a Sponge is cut into maximum possible pieces **[RPMT 2001]**

(1) These will die

(2) These will differentiate

(3) Every piece will form a sponge

(4) Some pieces will develop in organs

Q.14 Which one of the following is not a correct pair **[RPMT 2001]**

(1) Trochophore - Annelida

(2) Bipinnaria - Echinodermata

(3) Tornaria - Arthropoda

(4) Planula - Coelenterata

Q.15 Why does the Ctenophora is a minor phylum **[RPMT 2001]**

(1) It includes small sized animals

(2) It includes only few genera

(3) It does not includes animals of economic Importance

(4) It was included earlier in cnidaria

Q.16 In which of the following water vascular system is present **[RPMT 2001]**

(1) Porifera only

(2) Echinodermata only

(3) Both Porifera and Echinodermata

(4) None of them

Q.17 Pila is the example of which class **[RPMT 2001]**

(1) Gastropoda (2) Pelecypoda

(3) Cephalopoda (4) Scaphopoda

Q.18 In which class of phylum mollusca Octopus is included **[RPMT 2001]**

(1) Gastropoda (2) Cephalopoda

(3) Pelecypoda (4) Scaphopoda

Q.19 In which class of Coelenterata the polyp and medusa both are found in one animal **[RPMT 2001]**

(1) Hydrozoa (2) Scyphozoa

(3) Anthozoa (4) None of them

Q.20 Which of the following group is Duterostome **[RPMT 2001]**

(1) Annelida, Arthropoda, Mollusca

(2) Echinodermata, Hemichordata, Chordata

(3) Annelida, Mollusca, Chordata

(4) Arthropoda, Mollusca, Echinodermata

Q.21 Which is not an adaptation of parasitic life in flat worms **[RPMT 2001]**

(1) Flat body

(2) Thick cuticle on body

(3) Production of eggs in great number

(4) Presence of hook

Q.22 Which of the following phylum are included in enterozoa **[RPMT 2001]**

(1) Annelida, Mollusca, Porifera

(2) Echinodermata, Hemichordata, Porifera

(3) Mollusca, Arthropoda, Hemichordata

(4) Porifera, Mollusca, Arthropoda

Q.23 Which of the following have ‘‘omatidia’’ as unit of eye **[RPMT 2001]**

(1) Pheretima (2) House fly

(3) Pila (4) Sepia

Q.24 In Demospongia skeleton is composed of- **[RPMT 2001]**

(1) Calcium spicules (2) Silicious spicules

(3) Keratin fibres (4) Spongin fibres

Q.25 In which phylum nerve cells are found but nerves are absent **[RPMT 2001]**

(1) Porifera (2) Coelenterata

(3) Platyhelminthes (4)Nematohelminthes

Q.26 Blind sac is characteristic of which animal **[RPMT 2001]**

(1) Sponge (2) Hydra

(3) Pheretima (4) Periplenata

Q.27 In which class of Echinodermata stalk is found for attachment with substratum -**[RPMT 2001]**

(1) Asteroidea (2) Echinoidea

(3) Ophiuroidea (4) Crinoidea

Q.28 Conjugation in Protozoa is found in :- **[RPMT 2001]**

(1) Sarcodina (2) Flagellata

(3) Sporozoa (4) Ciliata

Q.29 Classification of sponges is primarily based on the **[RPMT 2002]**

(1) Body organisation (2) Body plan

(3) Skeleton (4) Canal system

Q.30 In crustaceans, respiration takes place by **[RPMT 2002]**

(1) Gills (2) Book lungs

(3) Ctenidia (4) Trachea

Q.31 Ctenophora shows affinities with **[RPMT 2002]**

(1) Cnidaria (2) Aschehelmenth

(3) Cephalopoda (4) Turbelaria

Q.32 Which of the following molluscs is formed by a larva which have torsion **[RPMT 2002]**

(1) Lamelledens (2) Pila

(3) Sepia (4) Octopus

Q.33 Insect's eggs are **[RPMT 2002]**

(1) Microlecithal & centrolecithal

(2) Megalecithal & isolecithal

(3) Megalecithal & centrolecethal

(4) Megalecithal & telolecithal

Q.34 Solenocytes and Nephridia are respectively found in **[RPMT 2002]**

(1) Platyhelmenth and Annelids

(2) Annelids and Nematoda

(3) Cenidaria and Mollusca

(4) Mollusca and Echinodermata

Q.35 Arthropoda characterised by **[RPMT 2003]**

(1) Chitinous exoskeletan, segmentation and jointed appendages

(2) Hairs, exoskelaton and three pairs of legs

(3) Exocutaneous scales, metamerism, one pair antennae

(4) One pair chelicerae, one pair pedipalp and one pair antennae

Q.36 Class sporozoa of phylum protozoa consists of **[RPMT 2003]**

(1) Fresh water forms (2) Free living forms

(3) Parasites (4) Hosts

Q.37 Coelentrata differ from other animals in having **[RPMT 2003]**

(1) Polymorphism

(2) Nematocyst

(3) Bilateral symmetry

(4) Skeleton

Q.38 Chitin exoskeleton is found in **[RPMT 2004]**

(1) Cockroach (2) Ascaris

(3) Nematoda (4) None

Q.39 Haemocoel is found in **[RPMT 2004]**

(1) Hydra (2) Ascaris

(3) Earthworm (4) Cockroach

Q.40 Metamerism is characteristic of **[RPMT 2004]**

(1) Ascaris (2) Pheretima

(3) Periplaneta (4) Hydra

Q.41 Radial symmetry is found in **[RPMT 2004]**

(1) Planaria (2) Taenia

(3) Fasciola (4) Sea anemone

Q.42 Crab, lobster & cray fish are **[RPMT 2004]**

(1) Isopods (2) Copepods

(3) Decapods (4) Diplopods

Q.43 Which of the following is pseudoc-eolomate **[RPMT 2004]**

(1) Hydra (2) Periplaneta

(3) Ascaris (4) Pheretima

Q.44 Which of the following is not an insects **[RPMT 2004]**

(1) House fly (2) Cockroach

(3) Spider (4) Mosquito

Q.45 Alimentary canal is absent in **[RPMT 2004]**

(1) Gastropoda (2) Monogenia

(3) Cestoda (4) Nematoda

Q.46 Botryoidal tissue is found in **[RPMT 2004]**

(1) Porifera (2) Acanthocephala

(3) annelida (4) Echinodermata

Q.47 Which organism is considered of non-photosynthetic form of originally photosynthetic flagellates **[RPMT 2005]**

(1) Zoo-flagellates (2) Sarcodina

(3) Sporozoa (4) None

Q.48 Which cell absent in sponge **[RPMT 2005]**

(1) Nerve cell (2) Sensory cell

(3) Gland cell (4) All of these

Q.49 In which of the following animal of echinodermata, arms, spines and pedicillariae are absent **[RPMT 2005]**

(1) Sea cucumber (2) Sea lily

(3) Sea star (4) Sea urchin

Q.50 Which is the visual unit of compound eye of insects **[RPMT 2005]**

(1) Ommatidia (2) Rod

(3) Rhabdom (4) None

Q.51 Cryfish belongs to which of the following group **[RPMT 2005]**

(1) Pisces (2) Mollusca

(3) Arthropoda (4) Echinodermata

Q.52 Canal system is the speciality of which phylum **[RPMT 2006]**

(1) Porifera (2) Coelenterata

(3) Echinodermata (4) None

Q.53 Enzyme Hirudin is present in the saliva of **[RPMT 2006]**

(1) Leech (2) Earthworm

(3) Scorpion (4) Cobra

Q.54 Solenocytes occur in **[AIPMT 1998]**

(1) Platyhelminthes (2) Arthropoda

(3) Annelida (4) Aschelminthes

Q.55 Which characteristic is true for Obelia **[AIPMT 1998]**

(1) Metagenesis (2) Morphogenesis

(3) Apolysis (4) Pedogeny

Q.56 Practical purpose of taxonomy or classification **[AIPMT 1999]**

(1) Facilitate the identification of unknown species.
(2) Explain the origin of organisms.
(3) To know the evolutionary history
(4) Identification of medicinal plants

Q.57 Which arrangement is in correct ascending order **[AIPMT 1999]**

(1) Species < genus < order < family
(2) Genus < species < family< order
(3) Order < family < Genus < species
(4) species < genus < family < order

Q.58 Similarity in Ascaris lumbricoides and Anopheles stephensi **[AIPMT 2000]**

(1) Sexual dimorphism
(2) Metamerism
(3) Anaerobic respiration
(4) Endoparasitism

Q.59 Which of the following animals have scattered cells with cell - tissue grade orgnisation **[AIPMT 2000]**

(1) Sponge (2) Hydra
(3) Liver fluke (4) Ascaris

Q.60 In Hydra, waste material of food digestion and nitrogenous waste material removed from **[AIPMT 2001]**

(1) Mouth and mouth
(2) Body wall and body wall
(3) Mouth and bodywall
(4) Mouth and tentacles

Q.61 In Protozoa like Amoeba and Paramecium, a organ is found for osmoregulation which is **[AIPMT 2002]**

(1) Contractile vacuole
(2) Mitochondria
(3) Nucleus (4) Food vacuole

Q.62 In which of the animal dimorphic nucleus is found **[AIPMT 2002]**

(1) Amoeba proteus
(2) Trypanosoma gambiens
(3) Plasmodium vivax
(4) Paramoecius caudatum

Q.63 Given below are four matchings of an animal and its kind of respiratory organ **[AIPMT 2003]**

A. Silver fish - trachea
B. Scorpion - book lung
C. Sea squirt - pharyngeal gills
D. Dolphin - skin

The correct matchings are :-

(1) A and D (2) A, B and C
(3) B and D (4) C and D

Q.64 Which one of the following is a matching pair of an animal and a certain phenomenon it exhibits **[AIPMT 2003]**

(1) Pheretima - Sexual dimorphism
(2) Musca - complete metamorphosis
(3) Chameleon - Mimicry
(4) Taenia - Polymorphism

Q.65 During its life-cycle, Fasciola hepatica (liver fluke) infects its intermediate host and primary host at the following larval stages respectively **[AIPMT 2003]**

(1) Redia and miracidium
(2) Cercaria and redia
(3) Metacercaria and cercaria
(4) Miracidium and metacercaria

Q.66 Sycon belongs to a group of animals, which are best described as **[AIPMT 2003]**

(1) Unicellular or acellular
(2) Multicellular without any tissue organization
(3) Multicellular with a gastrovascular system
(4) Multicellular having tissue organization, but no body cavity

Q.67 The animals with bilateral symmetry in young stage and radial pentamerous symmetry in the adult stage, belong to the phylum **[AIPMT 2004]**

(1) Mollusca (2) Cnidaria
(3) Echinodermata (4) Annelida

Q.68 In Arthropoda, head and thorax are often fused to form cephalothorax, but in which one of the following classes, is the body divided into head, thorax and abdomen **[AIPMT 2004]**

(1) Myriapoda
(2) Crustacea
(3) Arachnida and Crustacea
(4) Insecta

Q.69 Which one of the following is not correctly matched **[AIPMT 2004]**

(1) Culex pipiens - Filariasis

(2) Aedes aegypti - Yellow fever

(3) Anopheles culifacies - Leishmaniasis

(4) Glossina palpalis - Sleeping sickness

Q.70 In contrast to Annelids the Platyhelminths show **[AIPMT 2005]**

(1) Absence of body cavity

(2) Presence of pseudocoel

(3) Radial symmetry

(4) Bilaterla symmetry

Q.71 Which of the following unicellular organism has a macronucleus for trophic function and one or more micronuclei for reproduction **[AIPMT 2005]**

(1) Trypanosoma (2) Paramecium

(3) Euglena (4) Amoeba

Q.72 Evolutionary history of an organism is known as **[AIPMT 2006]**

(1) Ontogeny (2) Phylogeny

(3) Ancestry (4) Paleontology

Q.73 What is common about Trypanosoma, Noctiluca, Monocystis and Giardia **[AIPMT 2006]**

(1) These are all prasites

(2) These are all unicellular protists

(3) They have flagella

(4) They produce spores

Q.74 Which one of the following is a matching set of a phylum and its three examples **[AIPMT 2006]**

(1) Porifera : Spongilla, Euplectella, Pennatula

(2) Cnidaria : Bonellia, Physalia, Aurelia

(3) Platyhelminthes : Planaria, Enterobius Schistosoma

(4) Mollusca : Loligo, Teredo, Octopus

Q.75 Metameric segmentation is the characteristic of- **[AIPMT 2006]**

(1) Mollusca and Chordata

(2) Platyhelminthes and Arthropoda

(3) Echinodermata and Annelida

(4) Annelida and Arthropoda

Q.76 Two common characters found in Centipede, Cockroach and Carb are - **[AIPMT 2006]**

(1) Book lungs and antennae

(2) Compound eyes and anal cerci

(3) Jointed legs and chitinous exoskeleton

(4) Green gland and tracheae

Q.77 Biradial symmetry and lack of cnidoblasts are the characteristic of : **[AIPMT 2006]**

(1) Hydra and Starfish

(2) Starfish and Sea Anemone

(3) Ctenophora and Beroe

(4) Aurelia and Paramoecium

Q.78 Which one of the following has an open circulatory system **[AIPMT 2006]**

(1) Octopus (2) Pheretima

(3) Periplaneta (4) Hirudinaria

Q.79 Biological organization starts with - **[AIPMT 2007]**

(1) Atomic level

(2) Submicroscopic molecular level

(3) Cellular level

(4) Organismic level

Q.80 Which one of the following is a matching pair of a body feature and the animal possessing it **[AIPMT 2007]**

(1) Ventral heart - Scorpion

(2) Post-anal tail - Octopus

(3) Ventral central nervous system -Leech

(4) Pharyngeal gill slits absent in embryo- Chamaeleon

Q.81 What is true about Nereis, Scoprion, cockroach and Silver fish **[AIPMT 2007]**

(1) They all belong to the same phylum

(2) They all have jointed paired appendages

(3) They all possess dorsal heart

(4) None of them is aquatic

Q.82 Which one of the following pairs is mismatched **[AIPMT 2007]**

(1) Bombyx mori - Silk

(2) Pila globosa - Pearl

(3) Apis indica - Honey

(4) Kenia lacca - Lac

Q.83 Which one of the following is NOT a characteristic of phylum annelida **[AIPMT 2008]**

(1) Closed circulatory system
(2) Segmentation
(3) Pseudocoelom
(4) Ventral nerve cord

Q.84 Which one of the following phyla is correctly matched with its two general characteristics **[AIPMT 2008]**

(1) **Arthropoda :** Body divided into head, thorax and abdomen and respiration by tracheae
(2) **Chordata :** Notochord at some stage and separate anal and urinary openings to the outside
(3) **Echinodermata :** Pentamerous radial symmetry and mostly internal fertilization
(4) **Mollusca :** Normally oviparous and development through a trochophore or veliger larva

Q.85 Ascaris is characterized by **[AIPMT 2008]**

(1) absence of true coelom but presence of metamerism
(2) presence of neither true coelom nor metamerism
(3) presence of true coelom but absence of metamerism
(4) presence of true coelom and metamerism

Q.86 Which one of the following group of the three animals each is correctly matched with their one characteristic morphological feature **[AIPMT 2008]**

	Animals	**Morphological feature**
(1)	Liver fluke, Sea anemone, Sea cucumber	- Bilateral symmetry
(2)	Centipede, Prawn, Sea urchin	- Joined appendages
(3)	Scorpion, Spider, Cockroach	- Ventral solid central nervous system
(4)	Cockroach Locust, Taenia	- Metameric segmentation

Q.87 The middle layer in body wall of Porifera is **[AIIMS 1999]**

(1) Mesoderm (2) Mesenchyme
(3) Mesoglea (4) Mesentery

Q.88 Medusa of Obelia is **[AIIMS 1999]**

(1) Carnivorous (2) Hrbivorous
(3) Detritous feeder (4) Omnivorous

Q.89 Sense organ of Aurelia are **[AIIMS 1999]**

(1) Tenlitta (2) Tentaculocyst
(3) Nematocyst (4) Otolith

Q.90 Characteristic of class crustacea is **[AIIMS 2001]**

(1) Cephalothorax, biramous appendages and gills
(2) Head & Thorax, book lung and chitinous exoskeleton
(3) Cephalothorax, book lungs and chitinous exoskeleton
(4) Head & thorax, biramous appendages & book lungs

Q.91 After drying, a bath sponge contains **[AIIMS 2002]**

(1) hold fast (2) Tentacles
(3) spicules (4) spongin fibre

Q.92 Which organism resides in Lymph nodes **[AIIMS 2000]**

(1) Taenia (2) Wuchereria
(3) Plamodium (4) Diplococcus

Q.93 Adult Wuchereria bancrofti attacks **[AIIMS 2002]**

(1) Nervous system (2) Lymph vessels
(3) Muscular system (4) Blood vessels

Q.94 Just as Xenopsylla is for Yersenia pestis, so is **[AIIMS 2003]**

(1) Glossina palpalis to Wuchereria bancrofti
(2) Culex to Plasmodium falciparum
(3) Homo sapiens to Taenia solium
(4) Phlebotomus to Leishmania donovani

Q.95 Which one of the following features is common in silverfish, scorpion, dragonfly and prawn **[AIIMS 2005]**

(1) Three pairs of legs and segmented body
(2) Chitinous cuticle and two pairs of antennae
(3) Jointed appendages and chitinous exoskeleton
(4) Cephalothorax involves

Q.96 Tape worms obtain their food from the host by **[BHU 1982]**

(1) Sucking
(2) Scraping
(3) Absorption through integument
(4) Autotrophic

Q.97 Tapeworm does not possess digestive system as it **[BHU 1984, 85]**

(1) Does not require solid food
(2) Obtains food through general surface
(3) Does not require food
(4) Lives in intestine

Q.98 Haemoglobin is dissolved in blood plasma of **[BHU 1985]**

(1) Frog (2) Rabbit
(3) Cockroach (4) Earthworm

Q.99 Which is characteristic feature of Echinodermata **[BHU 1992]**

(1) Vascular system (2) Radial symmetry
(3) Radial canal (4) Ambulacral system

Q.100 Anus is absent in **[BHU 1994]**

(1) Fasciola (2) Pheretima
(3) Periplaneta (4) Unio

Q.101 Pick up the correctly matched pair **[BHU 1994]**

(1) Water vascular system - Sponge
(2) Blubber - Kangaroo
(3) Marsupium - Platypus
(4) Flame cell - Flatworm

Q.102 Body of Euspongia is mainly composed of **[BHU 1995]**

(1) Spicules (2) Spongin fibres
(3) Mesogloea (4) Nematoblasts

Q.103 Trochophore larva occurs in **[BHU 1995]**

(1) Annelida and Porifera
(2) Coelenterata and Annelida
(3) Mollusca and Coelenterata
(4) Annelida and Mollusca

Q.104 An animal having unsegmented coelom superficial radial symmetry in adult but bilateral symmetry in larva is member of **[BHU 1996]**

(1) Mollusca (2) Echinodermata
(3) Arthropoda (4) Annelida

Q.105 Osculum occurs in **[BHU 1997]**

(1) Star fish (2) Ray fish
(3) Hydra (4) Sponge

Q.106 Trilobites evolved in **[BHU 1997]**

(1) Precambrian (2) Ordovician
(3) Silurian (4) Cambrian

Q.107 Limulus belongs to group **[BHU 1998]**

(1) Insecta (2) Crustacea
(3) Merostomata (4) Onychophora

Q.108 Cray fish belongs to **[BHU 1998]**

(1) Pisces (2) Mollusca
(3) Arthropoda (4) Anthozoa

Q.109 Green glands found in some Arthropods take part in **[BHU 1998]**

(1) Excretion (2) Respiration
(3) Digestion (4) Both 1 and 2

Q.110 In sponges there is **[AFMC 1985]**

(1) The symmetry is radial
(2) Present a true coelom
(3) A single exit and a number of mouths
(4) A single mouth and a number of exist

Q.111 Miracidium is the larval stage of **[AFMC 1985]**

(1) Tapeworm (2) Roundworm
(3) Pinworm (4) Liver Fluke

Q.112 In insects, oxygen is carries to different tissues by **[AFMC 1985]**

(1) Diffusion through surface
(2) Tracheal tubes
(3) Respiratory pigment through blood
(4) Gills

Q.113 The excretory structures of flatworms /Taenia are **[AFMC 1987]**

(1) Flame cells (2) Protonephridia
(3) Malpighian (4) Green glands

Q.114 Cephalization is absent in **[AFMC 1989]**

(1) Molluscs (2) Arthopods
(3) Both 1 and 2 (4) Echinoderms

Q.115 Larva of Schistosoma is **[AFMC 1991]**

(1) Cercaria (2) Planula
(3) Cysticercus (4) Muller's larva

Q.116 A radially symmetrical diploblastic animal is **[AFMC 1993]**

(1) Roundworm (2) Earthworm
(3) Hydra (4) Liver fluke

Q.117 Antedon is a member of class **[AFMC 1993]**

(1) Echinoidea (2) Asteroidea
(3) Crinoidea (4) Ophiuroidea

Q.118 A sponge harmful to oyster industry is **[AFMC 1997]**

(1) Spongilla (2) Euspongia
(3) Hyalonema (4) Cliona

Q.119 In which book has Binomial Nomenclature been used for the first time **[MP PMT 1999]**

(1) Histoire Naturelle (2) Systema Naturae
(3) Historia Naturalis (4) Historia Plantarum

Q.120 Who developed the ''key'' for identification of animals **[MP PMT 1999]**

(1) John Ray (2) Goethe
(3) Georges Cuvier (4) Theophrastus

Q.121 What is the name of the book written by Aristotle **[MP PMT 1999]**

(1) Historia Animalium
(2) Histoire Naturelle
(3) Systema Naturae
(4) Philosophie Zoologique

Q.122 Who is the ''Father of Zoology'' **[MP PMT 1999]**

(1) Aristotle (2) Theophrastus
(3) Lazzaro Spallanzani
(4) Carolus Linnaeus

Q.123 Karyotaxonomy is the modern branch of classification which is based on **[MP PMT 1999]**

(1) Number of chromosomes
(2) Bands found on chromosomes
(3) Organic Evolution
(4) Trinomial Nomenclature

Q.124 Phylum Annelida resembles Mollusca in Embryonic features because both have **[MP PMT 1999]**

(1) Spiral cleavage and mesoderm formation
(2) Identical conspicuous segmentation in body muscles and nervous system
(3) Meroblastic cleavage and ectoderm formation
(4) Special types of mouth parts

Q.125 In which phylum is Water Vascular System found **[MP PMT 1999]**

(1) Protozoa (2) Arthropoda
(3) Porifera (4) Echinodermata

Q.126 In Honey bee, drones are produced by **[MP PMT 1999]**

(1) Unfertilized eggs
(2) Fertilized eggs
(3) Low feed larvae
(4) Larva feed with Royal Jelly

Q.127 Which disease is caused be female Culex **[MP PMT 1999]**

(1) Malaria (2) Pneumonia
(3) Typhoid (4) Filaria

Q.128 Which one of the following invertebrates is a deuterostome and enterocoelous coelomate **[MP PMT 2000]**

(1) Pila (2) Ascaris
(3) Aphrodite (4) Asterias

Q.129 Echinoderms are Heartless, brainless headless yet from evolutionary point of view, they have been placed on the top of the invertebrate phyla because of the presence in them of **[MP PMT 2000]**

(1) power of reproduction
(2) great power of regeneration
(3) exclusively marine
(4) presence of enterocoel

Q.130 Holophytic nutrition is found in **[MP PMT 2000]**

(1) Amoeba (2) Giardia
(3) Entamoeba (4) Euglena

Q.131 The class of Trichonympha is **[MP PMT 2000]**

(1) Calcaria (2) Scyphozoa
(3) Sporozoa (4) Mastigophora

Q.132 In poriferans the skeleton forming cells are **[MP PMT 2000]**

(1) Amoebocytes (2) Thesocytes
(3) Archiocytes (4) Sclerocytes

Q.133 Dropping of gravid proglottids by cestodes is called **[MP PMT 2000]**
(1) Apolysis (2) Autotomy
(3) Paedogenesis (4) Autophagy

Q.134 Which of the following does not belongs to phylum coelenterate **[MP PMT 2002]**
(1) Sea pen (2) Sea feather
(3) Sea cucumber (4) Sea fan

Q.135 Nematocysts are found in **[MP PMT 2002]**
(1) Porifera (2) Coelenterata
(3) Nematodes (4) Annelida

Q.136 Commercial bath sponge is called **[MP PMT 2002]**
(1) Euspongia (2) Spongilla
(3) Euplectella (4) Cliona

Q.137 "Systema Naturae" was written by : **[Kerala PMT 2010]**
(1) Ariostotle (2) Linnaeus
(3) Lamarck (4) Charles Darwin

Q.138 Basic unit of taxonomy is : **[MPPMT 2010]**
(1) Genus (2) Order
(3) Species (4) Phylum

Q.139 A group of related genera is classified as : **[AFMC 2009 ; DUMAT 2010]**
(1) Order (2) Class
(3) Phylum (4) Family

Q.140 Who has added the word "Phylum" in taxonomy? **[MPPMT 2010]**
(1) Plato (2) John Ray
(3) Leopold Cuvier (4) Linnaeus

Q.141 The correct sequence of taxa is : **[Orissa JEE 2010]**
(1) Class – Order – Family – Tribe – Genus – Species
(2) Class – Order – Tribe – Family – Genus – Species
(3) Phylum – Order – Class – Tribe – Genus – Species
(4) Phylum – Tribe – Class – Order – Genus – Species

Q.142 Mayr's biological concept of species is mainly based on : **[CPMT 2009]**
(1) Morphology
(2) Reproductive isolation
(3) Modes of reproduction
(4) Morphology and reproduction

Q.143 The five kingdom classification of living organisum was proposed by : **[MPPMT Pharmacy 2009]**
(1) Altmann (2) Hutchinson
(3) Whittaker (4) Adolf Engler
(5) Bentham and Hooker

Q.144 Prokaryotes are included in the kingdom : **[JKCMEE 2009]**
(1) Monera (2) Protista
(3) Protozoa (4) Basidiomycetes

Q.145 Which one of the taxonomic aids can give comprehensive account of complete compiles information of anyone genus or family at a particular time? **[Kerala PMT 2009]**
(1) Flora (2) Dictionary
(3) Herbarium (4) Monograph
(5) taxonomic key

Q.146 Single-celled eukaryotes are included in : **[CBSE 2010]**
(1) Protista (2) Fungi
(3) Archaea (4) Monera

Q.147 A common means of sympatric speciation is : **[DUMET 2010]**
(1) Polyploidy
(2) Temporal segregation of breeding season
(3) Spatial segregation of mating sites
(4) Imposition of geographic barrier

Q.148 Populations are said to be sympatric when …… **[Karnataka CET 2010]**
(1) Two populations live together and freely inbreed to produce sterile offspring
(2) Two populations are physically isolated by natural barriers
(3) Two populations are isolated but occasionally come together to interbreed
(4) Two populations share the same environment but cannot interbreed

Q.149 Classification of organism based on evolutionary as well as genetic relationships is called : **[DUMET 2010]**
(1) Phenetics (2) Cladistics
(3) biosystematics
(4) Numerical taxonomy

Q.150 "Taxa" differs from "taxon" due to this being : **[DUMET 2010]**

(1) A higher taxonomic category than taxon

(2) A lower taxonomic category than taxon

(3) The singular of taxon

(4) The plural of taxon

Q.151 Which of the following statements regarding universal rules of nomenclature is wrong? **[Kerala PMT 2010]**

(1) The first word in a generally name represents the genus

(2) Biological names are generally in Greek and written in italics

(3) The first word denoting the genus starts with a capital letter

(4) Both words ina biological name when hand written are separately underlined

Q.152 Which one of the following group of animal is bilaterally? **[CBSE 2009]**

(1) Sponges (2) Ctenophores

(3) Coelenterates (Cnidarians)

(4) Aschelminthes (Roundworms)

Q.153 Deuterostome condition and indeterminate radial cleavage are characteristics of : **[AMU 2009]**

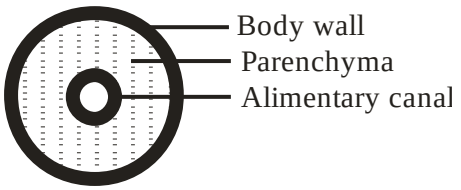
(1) Chordates and arthropods

(2) Chordates and echinoderms

(3) Arthropods and echinoderms

(4) Chordates, arthropods and annelids

Q.154 The cross section of the body of an invertebrate is given below. Identify the animal which has body plan. **[Karnataka CET 2009]**



(1) Planaria (2) Earthworm

(3) Cockroach (4) Roundworm

Q.155 What is the best way to test relatedness 0f two species? **[Orissa JEE 2009]**

(1) RNA and Proteins

(2) DNA and Proteins

(3) Antibodies and transposons

(4) None of the above

Q.156 Which one of the following statements about all the four of *Spongilla*, Leech, Dolphin and Penguin is correct? **[CBSE 2010]**

(1) Spongilla has special collared cells called choanocytes, not found in the remaining three

(2) Penguin is homoeothermic while the remaining three are poikilothermic

(3) Leech is a freshwater form white all others are marine

(4) All are bilaterally symmetrical

Q.157 Which of the following statements are correct witgh regard to Deuterostomes? **[EAMCET 2010]**

A. The blastopore develops into anus in adult.

B. The balstopore develops into mouth in adult.

C. Cleavage is radial and indeterminate.

D. Cleavage is spiral and determinate.

(1) 1 and 3 (2) 1 and 2

(3) 2 and 4 (4) 2 and 3

Q.158 Choose the animal which exhibits the following characteristics : **[EAMCET 2010]**

A. Marine habitat.

B. Bilateral symmetry and cephalization.

C. Haemocoel as principal body cavity.

D. Eyes similar to that of vertebrates.

(1) Silverfish (2) Dogfish

(3) Jellyfish (4) Cuttle fish

Q.159 The plane that divides the body into right and left haves : **[EAMCET 2010]**

(1) Transverse (2) Frontal

(3) Sagittal (4) Radial

Q.160 The mian basis of classification of Protozoa is : **[AFMC 2009 ; MPPMT 2010]**

(1) Size (2) Shape

(3) locomotory device (4) Number of nuclei

Q.161 Which class of Protozoa includes all parasitic forms? **[CPMT 2009]**

(1) Mastigophora (2) Ciliata

(3) Sporozoa (4) Sarcodina

Q.162 Infective stage of Entamoeba histolytica : **[BHU 2007; CPMT 2009]**

(1) Trophozoite (2) Precystic form

(3) Metacystic form (4) Quadrinucleate cyst

Q.163 Stage of Plasmodium infective to man and injected into human blood by mosquito is : **[Orissa JEE 2010]**

(1) Trophozoite (2) Merozoite
(3) Sporozoite (4) Cyst

Q.164 Which of the following glands is enlarged in malaria? **[Orissa JEE 2009]**

(1) Pancreas (2) Liver
(3) Spleen (4) All of these

Q.165 Which is not true for Paramecium? **[Orissa JEE 2009]**

(1) Use pseudopodia for capturing prey
(2) Under unfafvourable conditions form cysts
(3) Presence of large number of cilia on whole body surface
(4) Contain contractile vacuoles for osmoregulation

Q.166 Match the following : **[EAMCET 2010]**

List I	List II
A. Reticulopodia	1. Lecithium
B. Lobopodia	2. Collozoum
C. Filopodia	3. Globigerina
D. Axopodia	4. Ceratium
	5. Entamoeba

The correct match is :

(1) A = 3, B = 4, C = 2, D = 1
(2) A = 3, B = 5, C = 1, D = 2
(3) A = 4, B = 5, C = 1, D = 3
(4) A = 2, B = 3, C = 1, D = 4

Q.167 When a freshwater protozoan is placed in marine water, … : **[Karnataka CET 2010]**

(1) The contractile vacuoles becomes bigger in size
(2) The number of contractile vacuoles increase
(3) The contractile vacuoles disapper
(4) The contractile vacuoles remain unchanged

Q.168 Which of the following is a flagellated protozoan? **[Kerala PMT 2010]**

(1) Amoeba (2) Entamoeba
(3) Palsmodium (4) Trypanosoma

Q.169 The type of nutrition present in Entamoeba is : **[Orissa JEE 2010]**

(1) Saprozoic (2) Parasitic
(3) Autotrophic (4) None of these

Q.170 Sponges possess : **[CPMT 2009]**

(1) No tissues
(2) Epithelial tissues only
(3) Epithelial and connective tissues only
(4) All four types of tissues

Q.171 Which one of these is referred to as "Venus Flower basket"? **[Kerala PMT 2009]**

(1) Euplectella (2) Sycon
(3) Cliona (4) Spongilla
(5) Proterion

Q.172 Choanocytes form the lining of paragastric cavity in : **[JKCMEE 2009]**

(1) Jellyfish (2) Sponges
(3) Helminthes (4) Echinoderms

Q.173 Which is not correct for spongers? **[Orissa JEE 2009]**

(1) Internal fertilization
(2) External fertilization
(3) Gemmule formation
(4) Gametes are formed from epidermal cells

Q.174 One of the following is not a characteristic feature of sponges : **[Kerala PMT 2010]**

(1) Presence of ostia
(2) Indirect development
(3) Intracellular digestion
(4) Body supported by chitin
(5) Cellular level of organization

Q.175 Ephyra is the larva of : **[AFMC 2009]**

(1) Obelia (2) Sea anemones
(3) Physalia (4) Aurelia

Q.176 Which one of the following has a biradial symmetry? **[JKCMEE 2007, Orissa JEE 2010]**

(1) Jellyfish (2) Cockroach
(3) Paramecium (4) Sea anemone

Q.177 Digestion in Hydra takes place within : **[Orissa JEE 2009]**

(1) Pelvic cavity
(2) Abdominal
(3) Gastrovascular cavity
(4) Pericardial cavity

Q.178 Budding as normal mode of asexual reproduction occurs in : **[Orissa JEE 2010]**
(1) Hydra and starfishes
(2) Hydra and Sponges
(3) Hydra and tapeworms
(4) Sponges and starfishes

Q.179 The type of asexual reproduction found in Hydra is : **[Kerala PMT 2009]**
(1) Budding (2) Multiple fission
(3) Sporulation (4) Binary fission

Q.180 Primitive nervous system is formed in : **[PMT 2009]**
(1) Sponge
(2) Cnidaria
(3) Porifera
(4) Cnidaria(Coelenetrata)

Q.181 Siphonophora is the order in : **[JKCMEE 2009]**
(1) Protozoa (2) Cnidaria
(3) Porifera (4) Annelida

Q.182 Biradial symmetry is found in : **[Orissa JEE 2010]**
(1) Beroe (2) Hydra
(3) Sponges (4) Labeo

Q.183 Cysticercus is the larval stage of : **[WB. JEE 2010]**
(1) Liver fluke (2) Pinworm
(3) Tapeworm (4) Roundworm

Q.184 Which of the following animals does not have a body composed of many segments? **[Orissa JEE 2009]**
(1) Lobster (2) Earthworm
(3) Flatworm (4) Grasshopper

Q.185 All flatworm differ from all roundworms in having : **[CBSE 2010]**
(1) Solid mesoderm
(2) Triploblastic body
(3) Bilateral symmetry
(4) Metamorphosis in the life history

Q.186 One example of animals having a single opening to the outside that serves both as mouth as well as anus is: **[CBSE 2010]**
(1) Octopus (2) Asterias
(3) Ascidia (4) Fasciola

Q.187 Which one of the following kinds of anilmals are triploblastic? **[CBSE 2010]**
(1) Corals (2) Sponges
(3) Flatworms (4) Ctenophores

Q.188 Which of the following is found in the lymph nodes? **[CPMT 2007, 2009]**
(1) Taenia (2) Plasmodium
(3) Wuchereria (4) Diplococcus

Q.189 Pesudocoelom is the characteristic of : **[Orissa JEE 2009]**
(1) Annelida (2) Mollusca
(3) Nematoda (4) Echinodermata

Q.190 Which one of the following statements about certain given animals is correct? **[CBSE 2010]**
(1) Molluscs are acoelomates
(2) Insect are pseudocoelemates
(3) Flatworms (Platyhelminthes)
(4) Roundworm (Aschelminthes) are pseudo-coelomates

Q.191 The pseudocoelomate among these is : **[Kerala PMT 2010]**
(1) Porifera (2) Annelida
(3) Aschelminthes (4) mollusca
(5) Platyhelminthes

Q.192 Wuchereria bancrofti is transmitted by : **[MPPMT Pharmacy 2010]**
(1) Flies (2) Pigs
(3) Louse (4) mosquitoes

Q.193 Which of the following has closed circulatory system? **[AFMC 2009]**
(1) Molluscs (2) Arthropods
(3) Annelids (4) Platyhelminthes

Q.194 The clitellum of Metaphire is present in segments : **[AFMC 2010]**
(1) 12, 13 and 14 (2) 13, 14 and 15
(3) 14, 15 and 16 (4) 16, 17 and 18

Q.195 In earthworm, septa are absent in segments : **[EAMCET 2010]**
(1) 8 – 12 (2) 17 – 21
(3) 1 – 4 (4) 14 – 26

Q.196 The gas exchange surface in an earthworm is : **[Orissa JEE 2009]**
(1) Skin (2) Gills
(3) Ctenidia (4) Tracheae

Q.197 Animal which respires, but has no respiratory organs : **[VMMC– Safdarjung 2008]**

(1) Fish (2) Frog

(3) Earthworm (4) Cockroach

Q.198 Paired spermatheceae occur in MEtaphire in segments : **[Ketala PMT 2010]**

(1) 4, 5, 6 , 7 (2) 5, 6, 7, 8

(3) 6, 7, 8, 9 (4) 3, 4, 5, 6

Q.199 In earthworm, gizzard is found in : **[CPMT 2009]**

(1) 8 – 10 segment (2) 27^{th} segment

(3) 8 th segment (4) 8 – 11 segment

Q.200 Metameric segmentation is the main feature of: **[MPPMT 2010]**

(1) Annelida (2) Echinodermata

(3) Porifera (4) Coelenterata

Q.201 If a live earthworm is pricked with a needle on its outer surface without damaging its gut, the fluid that comes out is : **[CBSE 2009]**

(1) Slimy mucus (2) Heamolymph

(3) Excretory fluid (4) Coelomic fluid

Q.202 Which one of the following correctly describes the location of some body parts in the earthworm Pheretima? **[CBSE 2009]**

(1) Four pairs of spermathecae in 4 – 7 segments

(2) Two pairs of testes in 10th and 11th segments

(3) Two pairs of accessory glands in 16 – 18 degment

(4) One pair of ovaries attached at intersegmental septum of 14th and 15th segment

Q.203 In the earthworm : **[AMU 2009]**

(1) Intergumentary and pharyngeal nephridia are exonephric

(2) Intergumentary and septak nephridia are enteronephric

(3) Pharygeal and septal nephridia are enteronephric

(4) Pharygeal and septal nephridia are exonephric

Q.204 Choose the correct combination of labeling from the options given : **[Kerala PMT 2009]**

(1) A = Testis, B = Specmatheca, C = Seminal vesicle, D = ovary, E = vas defferns, F = Accessory gland

(2) A = Specmatheca, B = Testis, C = Seminal vesicle, D = ovary, E = vas defferns, F = Accessory gland

(3) A = Specmatheca, B = Testis, C = ovary, D = Seminal vesicle, E = vas defferns, F = Accessory gland

(4) A = Specmatheca, B = Testis, C = Accessory gland, D = ovary, E = vas defferns, F = Seminal vesicle

(5) A = Specmatheca, B = ovary, C = Seminal vesicle, D = Testis, E = vas defferns, F = Accessory gland

Q.205 In pheretima, the open type of nephridia are located in these segment : **[EAMCT 2010]**

(1) 4^{th} , 5^{th} and 6^{th} (2) 2^{nd} to the last

(3) 16^{th} to the last (4) 7^{th}, 9^{th} and 13^{th}

Q.206 The lateral hearts in earthworm have : **[AMU 2010]**

(1) Four pairs of valves and are situated in the segments 7 and 9

(2) Four pairs of valves and are situated in the segments 6 and 8

(3) Four pairs of valves and are situated in the segments 8 and 10

(4) Four pairs of valves and are situated in the segments 6 and 11

Q.207 Which one of the following species of earthworm is not recommended for vermicomposting? **[EAMCT 2010]**

(1) Eudrilus eugeniae (2) Elsenia fetidae

(3) Perionyx excavates

(4) Pheretima postuma

Q.208 Number of chambers in the heart of cockroach is : **[CPMT 2001, 2009]**

(1) 23 (2) 13

(3) 4 (4) 3

Q.209 oxygen carrying respiratory pigment of cockroach and other insects are : **[Orissa JEE 2010]**

(1) Haemoglobin (2) Haemocyanin

(3) Haemoerythrin (4) None of these

Q.210 Main excretory product in cockroach and other insects is : **[CPMT 2009]**
(1) Ammonia (2) Urea
(3) Uric acid (4) Amino acid

Q.211 Hormone produced by corpora allata in insects is : **[AMU 2009]**
(1) Growth hormone (2) Juvenile hormone
(3) Inhibiting hormone
(4) Moulting hormone

Q.212 Which of the following hormones regulates growth and metamorphosis in insect? **[DUMET 2009]**
(1) Ecdyson (2) Brain hormone
(3) Juvenila hormone
(4) Prothoracicotropic hormone

Q.213 Stink gland is found in : **[CPMT 2007, 2009]**
(1) Bird (2) Insect
(3) Reptile (4) Worm

Q.214 Periplaneta Americana has thermoreceptor sensillae on : **[EAMCET 2007, 2010]**
(1) 1^{st}, 2^{nd} and 3^{rd} segment of tarsus of legs
(2) 3^{rd}, 4^{th} and 5^{th} segment of tarsus of legs
(3) 15^{th} segment of anal cerci
(4) Pedical of antenna

Q.215 Which of the following are examples of Arthropoda? **[Orissa JEE 2010]**
(1) Silverfish, Starfish, Prawn
(2) Clamworm, Apple snail, Honebee
(3) Seastar, Tongueworm, Scorpion
(4) Cockroach, Scorpion, Prawn

Q.216 Which animal of the following belongs to class Crustacea? **[CPMT 2007, 2009]**
(1) Cockroach (2) Cyclops
(3) Grasshopper (4) Mosquito

Q.217 The cells present in the fat bodies of cockroach, which contain certain symbiotic that synthesize amino acids are : **[EAMCET 2010]**
(1) Trophocytes (2) Mycetocytes
(3) Oenocytes (4) Urate cells

Q.218 Which one of the following arthropods is viviparous? **[EAMCET 2010]**
(1) Palaemon (2) Palamnaeus
(3) Pediculus (4) Periplaneta

Q.219 Malpighian tubules are analogous to : **[AFMC 2010]**
(1) Trachea of cockroach
(2) Gills
(3) Flame cells
(4) None of these

Q.220 In the mouthparts of cockroach, the galea and lacinia form parts of the : **[AMU 2010]**
(1) Mandible (2) Maxilla
(3) Labium (4) Labrum

Q.221 Cockroaches can climb smooth or steep surfaces due to the presence of adhesive pads found on the tarsus of their legs. They are called …….. : **[Karnataka CET 2010]**
(1) Plantulae (2) Tibia
(3) Pretarsus (4) Arolium

Q.222 Bee keeping is known as : **[MPPET 2010]**
(1) Sericulture (2) Tissue culture
(3) Apiculture (4) Pisciculture

Q.223 The larva of bombyx mori is : **[DUMET 2009]**
(1) nymph (2) Trochophopre
(3) Cocoon (4) Caterpillar

Q.224 Of the following, which is the largest bee? **[MPPET Phaemacy 2010]**
(1) Apis florae (Little Bee)
(2) Apis dorsata (Rock Bee)
(3) Apis indica (Indian Bee)
(4) Apis mellifera (European Bee)

Q.225 Workers of honeybee society are : **[CPET 2009]**
(1) Sterile males (2) Sterile females
(3) Females without gonads
(4) Males without gonads

Q.226 The lifespan of honeybee drone is : **[WB. JEE 2009]**
(1) 1 – 2 months (2) 3 – 4 months
(3) 6 – 7 months (4) 10 – 12 months

Q.227 In honey the percentage of maltose and other sugars is : **[WB. JEE 2010]**
(1) 9.2 (2) 8.81
(3) 10.5 (4) 11.2

Q.228 Nosema bombycis which causes pebrine in silkworms is a : **[Karnataka CET 2009]**
(1) Virus (2) Fungus
(3) Bacterium (4) Protozoan

Q.229 A dorsal horn is present on the mulberry silkworm (caterpillar) :
[Karnataka CET 2009]
(1) Head
(2) 2nd thoracic segment
(3) 8th abdominal segment
(4) 5th abdominal segment

Q.230 The scirpophaga incertulas is an example of :
[WB. JEE 2009]
(1) Aedes aegypti
(2) Aedas albopictus
(3) Aedes albolineatus
(4)Aedes taeniorhynchus

Q.231 Scirpophaga incertulas is an example of :
[WB. JEE 2009]
(1) Diphagous pest
(2) Polyphagous pest
(3) Oligophagous pest
(4) Monophagous pest

Q.232 Which one of the following diseases is spread by housefly? **[WB. JEE 2010]**
(1) Filariasis (2) Typhoid
(3) Encephalities (4) Dengue fever

Q.233 **Statement (S) :** Biting and chewing mouthparts are the most primitive type of mouthparts of insects.
Reason (R) : Holometabolous insects have biting and chewing type of mouthparts in their larvae. **[EAMCET 2010]**
(1) Both (S) and (R) are true and (R) is correct explanation to (S)
(2) Both (S) and (R) are true and (R) does not explain (S)
(3) (S) is correct but (R) is wrong
(4) (S) is wrong but (R) is correct

Q.234 Similarity between Anopheles and Culex is :
[AFMC 2010]
(1) Eggs have lateral air floats
(2) Eggs are laid in floating raft
(3) Respiratory siphon is present
(4) Males of both suck juices of flowers and fruits

Q.235 The most commonly maintained species of bee by bee keepers is : **[AMU 2010]**
(1) Apis mellifera (2) Apis dorsata
(3) Apis indica (4) Apis florae

Q.236 How do you differentiate a butterfly from a moth? **[Karnataka CET 2010]**
(1) Moth has feathery antennae but butterfly has club-shaped antennae
(2) Moth has one pair of wings but butterfly has two pairs of wings
(3) Moth is diurnal but butterfly is nocturnal
(4) Moth has simple eyes but butterfly has compound eyes

Q.237 Which one of the following diseases is caused by Nosema bombycis?**[Karnataka CET 2010]**
(1) Pebrine (2) Flacherie
(3) Grasserie (4) Muscadine

Q.238 Percentage composition of fibroin and sericin in silk is : **[WB. JEE 2010]**
(1) 50 : 40 (2) 80 : 20
(3) 30 : 70 (4) 40 : 60

Q.239 Radula is presentin : **[WB. JEE 2010]**
(1) Loligo (2) Mytilus
(3) Unio (4) Pila

Q.240 Neopilina is a connecting link between :
[AFMC 2010]
(1) Arthropoda and Mollusca
(2) Annelida and Mollusca
(3) Mollusca and Echinodermata
(4) Mollusca and Helminthes

Q.241 Which one of the following molluscs was formerly used as currency (money)?
[MPPMT Pharmacy 2010]
(1) Dentalium (2) Chiton
(3) Oyster (4) Loligo

Q.242 The second largest phylum in the animal kingdom is : **[JKMCEE 2009]**
(1) Annelida (2) Arthropoda
(3) Cephalopoda (4) Amphineura

Q.243 The phenomenon of torsion occurs in :
[AMU 2010]
(1) Gastropoda (2) Pelecypoda
(3) Cephalopoda (4) Amphineura

Q.244 Phylum Mollusca can be distinguished from other invertebrates by the presence of :
[DUMET 2010]
(1) Bilateral symmetry and exoskeleton
(2) A mantle and gills
(3) Shell and non-segmented body
(4) A mantle and non-segmented body

Q.245 Arrange the shell layers of pearl oyster in correct order and select the answer from the code given below :

1. Mantle 2. Periostracum
3. Nacreous layer 4. Prismatic layer

[WB. JEE 2010]

(1) 1, 4, 3, 1 (2) 4, 2, 1, 3
(3) 2, 4, 3, 1 (4) 1, 2, 3, 4

Q.246 Which of the following traits is not characteristic of echinoderms?

[Orissa JEE 2009]

(1) Water vascular system
(2) Trochophore larva
(3) Tube feet
(4) Enterocoel

Q.247 Organs of locomotion in Echiniodermata are :

[Orissa JEE 2010]

(1) Pseudopodia (2) Parapodia
(3) Foot (4) Tube feet

Q.248 The presence of tube feet is a characteristic feature of the phylum : **[Kerala PMT 2009]**

(1) Annelida (2) Mollusca
(3) Arthropoda (4) Echinodermata
(5) Nemathelminthes

Q.249 Tube feet are characteristic structures of :

[CPMT 2009]

(1) Starfish (2) Cuttlefish
(3) Crayfish (4) Jellyfish

Q.250 Which of the following is properly matched?

[Karnatake CET 2009]

(1) Arthropoda – Insecta – Spider
(2) Mollusca – Cephalopoda – Unio
(3) Echinodermata – Asteroidea – Starfish
(4) platyhelminthes – Trematoda – Planaria

Q.251 Which of the following is an exclusively echinoderm character? **[AMU 2010]**

(1) Tube feet
(2) Coelom divided
(3) Rasial sysmmetry
(4) Mesodermal endoskeleton

Q.252 Water vascular system is found in :

[WB. JEE 2010]

(1) Sea pen (2) Sea horse
(3) Sea anemone (4) Sea cucumber

Q.253 What will you look for to identify the sex of the following? **[CBSE PMT 2011]**

(1) Female Ascaris-sharply curved posterior end
(2) Male frog – a copulatory pad on the first digit of the hind limb
(3) Female cockroach – anal cerci
(4) Male shark – claspers borne on pelvic fins.

Q.254 One very special feature in the earthworm Pheretima is that **[CBSE PMT 2011]**

(1) Fertilization of eggs occurs inside the body
(2) The typhlosole greatly increases the effective absorption area of the digested food in the intestine
(3) The S-shaped setae embedded in the integument are the defensive weapons used against the enemies
(4) It has a long dorsal tubular heart.

Q.255 Which one of the following groups of animals is correctly matched with its characteristic feature without any exception?

[CBSE PMT 2011]

(1) Reptilia : Possess 3-chambered heart with an incompletely divided ventricle.
(2) Chordata : Possess a mouth with an upper and a lower jaw
(3) Chondrichthyes : posses cartilaginous endoskeleton.
(4) Mammalia : Given birth to young ones.

Q.256 Which of the following happens in the common cockroach? **[CBSE PMT 2011]**

(1) Malpighian tubules are excretory organs projecting out from the colon
(2) Oxygen is transported by haemoglobin in blood
(3) Nitrogenous excretory product is urea
(4) The food is grind by mandibles and gizzard.

Q.257 In which one of the following, the genus name, its two characters and its phylum are not correctly matched, whereas the remaining three are correct ? **[AIPMT Pre 2012]**

	Genus Name	Two characters	Phytum
(1)	*Asterias*	(a) Spiny skinned (b) Water vascular system	Echinodermata
(2)	*Sycon*	(a) Pore bearing (b) Canal system	Porifera
(3)	*Periplanein*	(a) Jointed appendages (b) Chitinous exoskeleton	Arthropoda
(4)	*Pila*	(a) Body segmented (b) Mouth with Radula	Mollusca

ANSWER KEY

EXERCISE – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	2	2	4	2	4	4	1	3	1	2	1	3	3	2	2	1	2	1	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	3	2	4	2	2	4	4	3	1	1	2	3	1	1	3	2	1	4	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	3	3	3	3	3	1	4	1	1	3	1	1	1	1	1	4	1	2	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	4	2	2	4	2	3	4	3	1	2	2	2	4	4	3	3	3	2	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	2	3	4	2	3	2	1	2	1	4	2	2	4	3	3	2	4	4	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	2	4	2	4	1	3	3	1	3	4	2	1	4	1	3	3	4	2	1
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	1	2	1	4	1	4	4	4	4	4	4	1	3	2	1	2	3	4	3
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	1	2	3	1	4	1	2	4	2	4	2	4	2	1	2	1	1	4	3	3
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	3	4	3	3	1	2	3	4	2	1	1	2	2	4	4	4	3	2	1	4
Ques.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
Ans.	2	1	3	3	1	4	3	3	3	4	3	4	3	3	3	1	3	3	3	1
Ques.	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
Ans.	4	2	3	3	3	1	4	2	4	3	2	3	2	1	4	2	2	2	3	2
Ques.	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Ans.	1	3	4	2	2	1	2	4	3	2	4	2	1	4	1	1	1	2	4	2
Ques.	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257			
Ans.	2	3	1	4	3	2	4	4	1	3	1	4	4	2	3	4	4			

Q.1 What are not true about Taenia saginata?
(a) Taenia saginata is longer than Taenia solium
(b) The scolex bears four adhesive suckers
(c) Rostellum and hooks are present
(d) Life history has pig as an intermediate host
(1) a, c and d (2) a and c
(3) c and d (4) c only

Q.2 Which of the following statements are correct about metagenesis in the life cycle of Cnidarians?
(a) Alternation of asexual and sexual phases in the life cycle of Obelia is called as metagenesis
(b) It is similar to alternation of generation found in plants
(c) Both the asexual and sexual forms are diploid
(d) Asexual form (polyp) is haploid and sexual form (medusa) is cijploid
(1) a, b and c (2) a, band d
(3) a and d (4) a and c only

Q.3 What are not true?
(a) Karl von Frisch got Nobel Prize for decoding the language of 'bee dances
(b) The bee wax is secreted by the abdominal glands of worker bee
(c) Queen bee lays two types of eggs one forming queen and workers and second forming drones
(d) Queen bee lays one type of eggs from which all castes develop
(e) 'Royal jelly' to feed young larvae is secreted by queen bee
(1) c and e (2) a, band c
(3) b, c and e (4) d and e

Q.4 Locust are the plant pests which can be solitary or gregarious. It depends upon
(1) Season (2) Availability of food
(3) Their population size
(4) Their species

Q.5 Third and fourth moulting during development of Ascaris takes place in which part of its host?
(1) Alveoli, intestine (2) Intestine, alveoli
(3) Soil, intestine (4) Stomach, uterus

Q.6 Select the true statement
(1) Male Schistosoma has a gynaecophoric canal on dorsal side for holding the female
(2) Male Schistosoma has a gynaecophoric canal on ventral side for holding the female
(3) Female Schistosoma has a gynaecophoric canal on dorsal side for holding the male
(4) Female Schistosoma has a gynaecophoric canal on ventral side for holding the male

Q.7 In case of honey bees, the queen bee substance or antiqueen pheromone is given out by
(1) Developing queen bee
(2) Worker
(3) Drones (4) Adult queen

Q.8 Blood of cockroach function as transporter of various materials like waste products etc. However, it doesn't have any role in
(1) Phagocytic activity
(2) Healing of injuries
(3) Respiration (4) Nutrient reservoir

Q.9 Which of the following cells control the inflammation during heliminthic infection?
(1) Neutrophils (2) Basophils
(3) Eosinophils (4) Monocytes

Q.10 In earthworm testis are present in
(1) 10^{th} and 11^{th} segment
(2) 18^{th} segment
(3) 17^{th} and 19^{th} segment
(4) 12^{th} and 13^{th} segment

Q.11 Find the odd one out
(1) Mushroom gland (2) Phallic gland
(3) Spermatheca (4) Ejaculatory duct

Q.12 Which of the following is not a character of Pheretima posthuma?
(1) The skin of earthworm is brown due to the presence of porphyin
(2) The first segment is called as prostomium
(3) Blood glands are present in 4^{th} , 5^{th} and 6^{th} segments, they produce blood cells and haemoglobin which is dissolved in plasma
(4) There are four pairs of spermathecal pores in Pheretima which are located in intersegmental grooves between segments 5/6, 6/7, 7/8, 8/9

Q.13 Which blood vessel of earthworm acts as collecting as well as distributing blood vessel?
(1) Dorsal (2) Ventral
(3) Lateral (4) Subneural

Use the following options of the following questions (Q.14 to Q.23) for chose the correct answer.

(1) If both **Assertion** & **Reason** are true and the reason is the correct explanation of the assertion.
(2) If both **Assertion** & **Reason** are true but the reason is not the correct explanation of the assertion.
(3) If **Assertion** is true statement but **Reason** is false.
(4) If both **Assertion** and **Reason** are false statements.

Q.14 **A :** Spongocoel of the sponges is also called paragastric cavity.
R : Trophocytes are present in the spongocoel & release digestive enzyme outside causing the digestion of food in spongocoel.

Q.15 **A :** Blood in the insects is colourless i.e., without any respiratory pigment.
R : Tracheal network is present all over the body, supplies oxygen directly to the different body parts.

Q.16 **A :** Type of metamorphosis in Periplaneta is of paurometabolus type.
R : The development of Periplaneta involves.

Egg $\longrightarrow$ naiad $\longrightarrow$ imago

Q.17 **A :** In earthworm, lymph glands are white, fluffy bodies which are arranged on either side of dorsal blood vessel from 26^{th} segment.
R : These lymph glands produce the phagocytes of coelomic fluid.

Q.18 **A :** Bidder's canal are present in the kidney of frog for passage of sperms.
R : Vasa efferentia from the testes open into the anterior part of Bidder's canal.

Q.19 **A :** Collaterial glands play important role in the reproductive system of Male cockroach.
R : Collaterial glands take part in the secretion of layer around spermatozoa to form spermatophore.

Q.20 **A :** The pearl may be considered an 'inside out' shell.
R : The normal outer material of the shell is secreted first and forms the nucleus of pearl. Around this core layers of iridescent pearly layers are then secreted.

Q.21 **A :** Giardia is called as **grand old man** of intestine.
R : It is a protozoan transmitted by mosquito.

Q.22 **A :** Ancylostoma duodenale is odd world hook worm.
R : Human are infected when filariform larvae in the moist soil penetrate the skin, usually of feet or legs.

Q.23 **A :** Taenia solium is a cestode acquired by eating undercooked pork.
R : Adult Taenia causes cysticercosis in humans.

ANSWER KEY

EXERCISE – 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Ans.	3	4	4	4	1	2	1	3	3	1	3	2	1	3	1	3	2	1	4	1	3	2	3

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

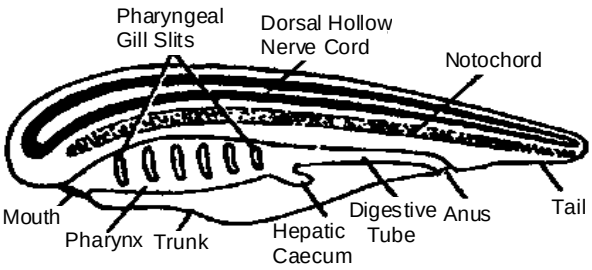
EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

ANIMAL – CLASSIFICATION PROTOCHORDATA TO MAMMALIA

- Chordates were evolved during **ordovician** period of **palaeozoic era.**
- The term **''Chordata ''** was coined by **''Frances Balfour''** for animals having notochord.
- Notochord supports the body of these animals.
- So, chordates are the animals in which notochord is present in any stage of their life – span.



Body Plan of Chordates

- Animals, which do not have notochord, are called **non - chordates.**
- In chordates, species of maximum life animals is pisces group and minimum life animals is Amphibian group.

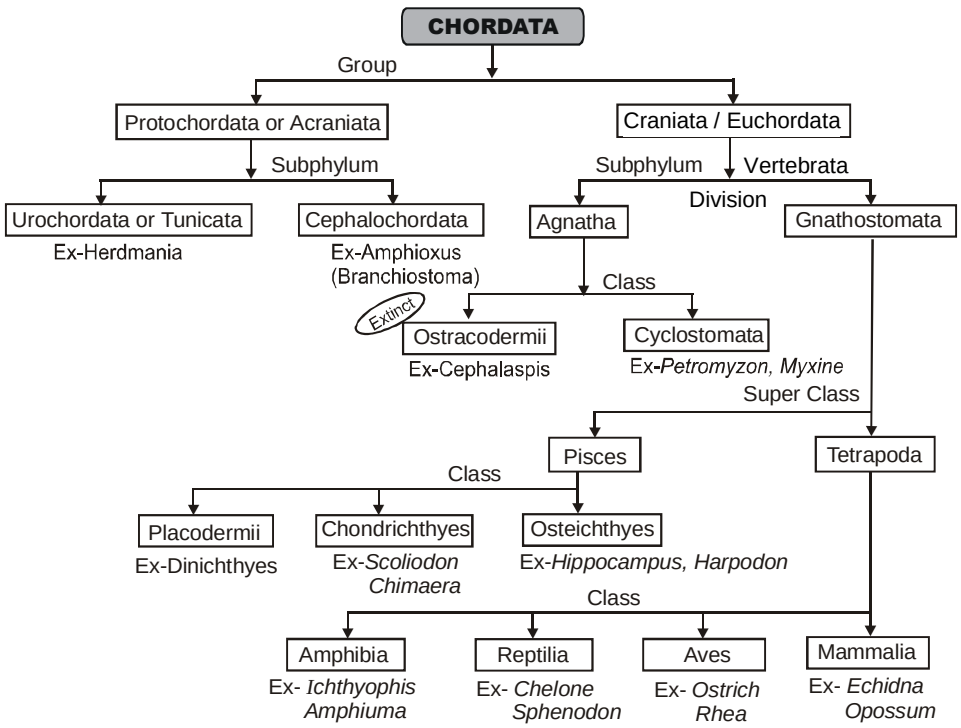
Three Fundamental Characters of Chordates :

- In all choradate animals, there are some specific characters in any stage of their life span, these are called fundamental chordate characters.
  These are as follows : -
  <u>Presence of notochord/Chorda dorsalis</u> : - In the embryonal stage of chordate animals there is a solid rod like structure (Just below the central nervous system and above the alimentary canal), this is called **notochord.**
- Extend from anterior end to posterior end of the body at the mid dorsal surface.
- Mesodermal in origin. It forms a primary endoskeleton which gives support to central nervous system and muscles.
- In **Protochordata** group, notochord is present throughout the life span but in **vertebrata**, it is modified into **back bone** or **vertebral column** in adults.
- **Notochord** is replaced by **vetebral column** around spinal cord and Cranium around the brain.
  <u>Presence of Dorsal Tubular Nerve Cord</u> : -
- In chordates **nerve cord** is situated at the mid **dorsal surface** of body.
- A **hollow, tubular** structure is present which is situated just **beneath the bodywall** and just **above the notochord.**
- **Ectoderma**l in origin.
- **Ganglia** are **absent** in the nerve cord of chordates.
  <u>Presence of pharyngeal gill –clefts</u> : -
- In each chordate animal, there are paired, lateral **gill clefts** in the walls of pharynx for **respiration** in any stage of its life span.
- In **higher chordate** animals, pharyngeal **gill clefts** are found only in **embryonic stages.** These are absent in adults.
- In **aquatic chordates** (pisces) and **lower chordates,** Pharyngeal gill clefts are present **throughout their life span** for respiration.
- In **terrestrial chordates,** gill clefts are absent in adults, because main respiratory organ is **lung** for adults.

– Above three fundamental characters are necessarily found in primary embryonic stages of chordates, but in adult stage, these are either absent or modified into other structure.
– Apart from this, post anal Tail which may be reduced or absent in higher chordates is another important character.

General characters of chordata : -

– These animals are **aquatic, terrestial** or **aerial**, free living.
– Body is **bilaterally symmetrical.**
– Bodywall **triploblastic,** in which all the three germinal layers **ectoderm, mesoderm** and **endoderm** are present.
– **Metamerism** is found in (arrangement of **muscles in embryonic stages)** and in **adults** (arrangement of **vertebrae** and **ribs.**)
– True **coelom** (**enterocoelous** type) & Deuterostomous animals.
– Alimentary canal and digestive system is **complete**. Digestive glands are present and digestion is **extracellular.**
– In these animals, **heart** is **Ventral.**
– Blood vascular system is **closed** type. Respiratory pigment is haemoglobin present in RBC.
– **Hepatic portal system** is found in **all chordates** but **Renal portal system** is present in all except **birds** and **mammals.**
– **Exoskeleton** is present.
– **Mesodermal endoskeleton** is present which is made up of **cartilage** and **bones**
– In **embryonic stages** of chordates a muscular tail is found that is known as **post anal tail.** In some Chordates this tail is reduced/Absent e.g. man, apes.
– **Proto, meso** and **metanephric kidneys** are found in the form of **excretory organs.**
– **Sexual** reproduction is **dominant.**
– **Males** and **females** are separate. Metamorphosis or development of embryo is **direct**. In some it is indirect.
– May be **cold blooded** (Poikilothermous) e.g. – **Fishes, Amphibians, Reptiles** or **warm blooded** (Homeothermous) e.g. **Birds** and **Mammals**.



– Phylum **chordata** is divided into **two groups** on the basis of **cranium, vertebral column** and **paired appendages** : -
[A] Acraniata or **Protochordata**
[B] Craniata or **Euchordata.**

Group A. Acrania (Protochordata) or Lower Chordata	Group B. Craniata (Euchordata) or Higher Chordata
Exclusively marine, small-sized chordates	Aquatic or terrestrial, mostly large sized vertebrates
No appendages, cephalization and exoskeleton	Usually 2 pairs of appendages, well-developed head and exoskeleton present
Coelom enterocoelic, budding off from embryonic archenteron.	Coelom schizocoelic, arising by splitting of mesoderm
Notochord persistent. No skull, cranium and verterbral column	Notochord covered or replaced by a vertebral column. Skull and cranium well developed.
Phyrynx with permanent gill clefts. Endostyle present	Phraryngeal gill clefts persist or disappear Endostyle absent
Heart chamber less when present. No red blood corpuscles in blood	Heart made of 2, 3 or 4 chambers. Blood contains R.B.C
Kidneys protonephridia	Kidneys meso– or metanephric
Sexes separate or united. Reproduction asexual as well as sexual. Gonoducts usually absent	Sexes separate. Only sexual reproduction, Gonoducts always present
Development indirect with a free-swimming larval stage	Development indirect or direct, with or without a larval stage

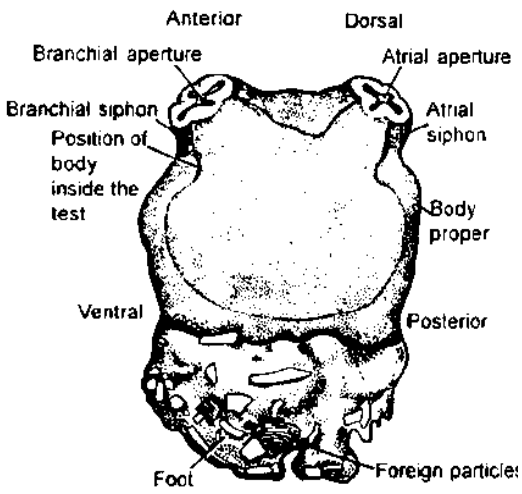
Acraniata or Protochordata

– All **marine.**
– Respiration is by **gills.**
– **Pharyngial gill clefts** throughout life
– **Notochord** persists through out the life, **Skull, brain** and **vertebral column** is **absent** in them.
– **Exoskeleton, head** and **paired appendages** are also **absent.**
– These are **unisexual** or **bisexual** animals. Reproduction is **asexual** as well as **sexual.**
– **Larval stage** is present and shows metamorphosis.

• **Acraniata** group is divided into two subphylums :-
(1) Urochordata
(2) Cephalochordata

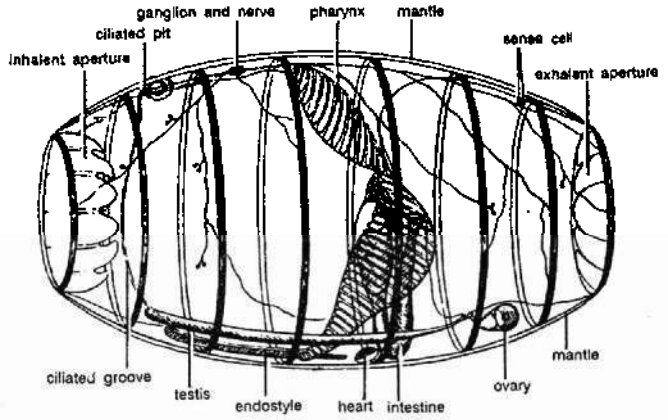
1. UROCHORDATA OR TUNICATA

– All are exclusively marine, Sedentary.
– **Adults** are normally **fixed** and larva is free swimmng.
– All the adult members have leathery test all over their body, made up of cellulose like material called **tunicin** so these animals are also called tunicata. The test is secreted by specific cells of **mesoderm.**
– Metameric segmentation and coelom are also absent.
– **Ciliary** feeder.
– A ciliary glandular slit is present at the ventral surface of pharynx it is called **endostyle,** it absorbs iodine from marine water.



Herdmania : External features in left view

- **Endostyle** is homologous to **thyroid gland** of mammals.
- The pharynx is perforated by numerous apertures called **stigmata** formed by sub-division of the larval gill slits : The stigmata open into an ectoderm lined cavity, the **atrium.**
- Blood vascular system is **open type** heart is **ventral**, tubular and **neurogenic shows alternate forward & backward.**
- Respiratory pigment is **Vanadium** in blood which is stored in purple blood corpuscles known as **Vanadocytes.** Absent in Herdmania.



Doliolum : SEXUAL GONOZOOOID IN LATERAL VIEW

- Notochord is limited only in tail of larva. Tail is lost during metamorphosis therefore named as **Urochordata.**
- Excretion is by **supra neural gland, pyloric gland** and **nephrocytes.**
- Dorsal tubular nerve cord is found only in larval stage. In adult nerve cord is modified into a neural ganglion.
- Mostly bisexual.
- **Asexual** reproduction if present is normaly by **budding.**
- Gonads are termed as ovo- testes.
- Fertilisation is **external** and mostly cross-fertilisation.
- A free swimming larva stage is found called **tadpole larva.**
- All the members of this subphylum show **''Retrogressive metamorphosis''.** During this metamorphosis, a well developed free swimming larva is changed into less developed, fixed adult.
- In these animals larval stage is more developed.
- Only one chordata character is found in adults i.e. **pharyngeal gill clefts**.
- Subphylum Urochordata is divided into **three classes** on the basis of test, atrial cavity, gill apertures and condition of life - cycle.

CLASSIFICATION OF SUB PHYLUM-UROCHORDATA

(Based on Test, Life cycle, Atrial cavity, Gill slits)

Class-I	**Class-II**	**Class-III**
ASCIDIACEA	**THALIACEA**	**LARVACEA**
1. Solitary or Colonial	Solitary or colonial	Solitary
2. Bottom living	Pelagic	Pelagic
3. Test thick, parmanent	Permanent thin with muscle bands	Test temporary jelly like
4. Atriopore dorsal Posterior	Absent	
5. Gills-many	2 to many gills	One large gill slit
eg. *Ascidia, Cliona, Herdmania*	eg. *Pyrosoma, Doliolum, salpa*	eg. *Oikopleura*

Class (a) Ascdiacea : –

Herdmania - Sea - potato or sea - squirts.

Ascidia, Ciona, Molgula, Botryllus

Class (b) Thaliacea : -

e.g.* : –** ***Pyrosoma **-** Biolumniscene is found. (Strongest light among marine organism)

Doliolum – Barrel shaped.

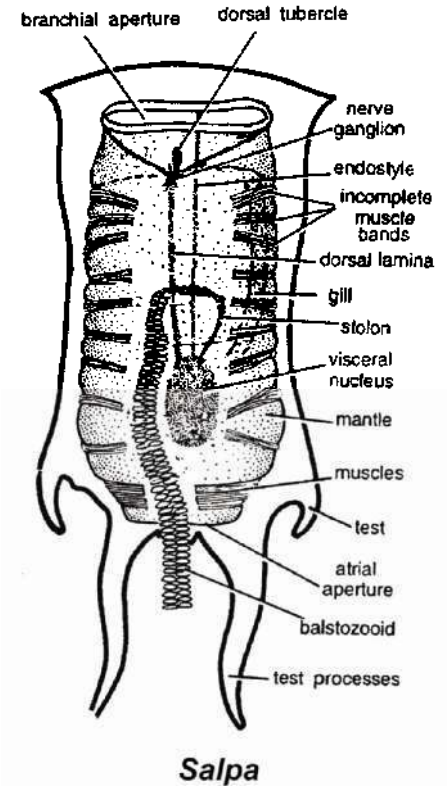
Salpa

Class (c) Larvacea -

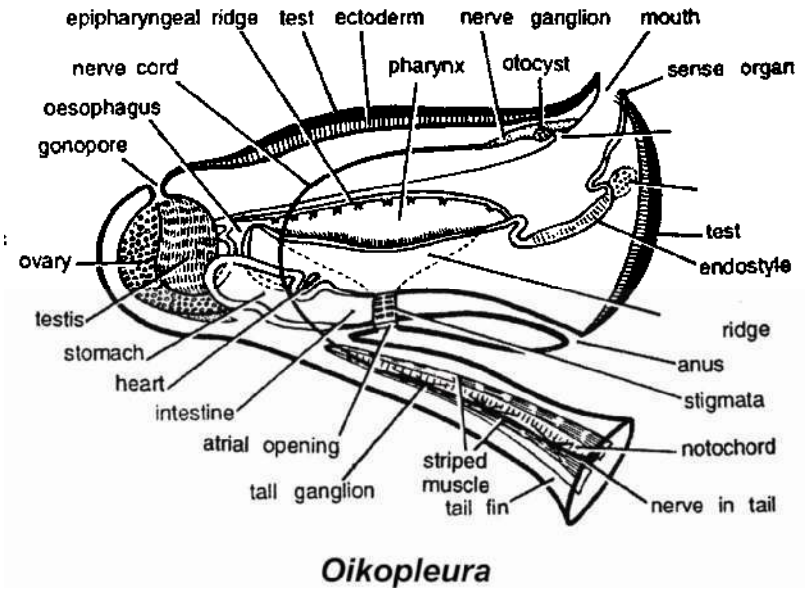
– larve does not metamorphose into adult, but attains sexual maturity and reproduces like an adult. This condition is called **Neoteny** or **Paedogenesis.**

e.g.* : –** ***Oikopleura - Shows pseudomorphism - A gelatinous shellt envelops the animal.

Appendicularia

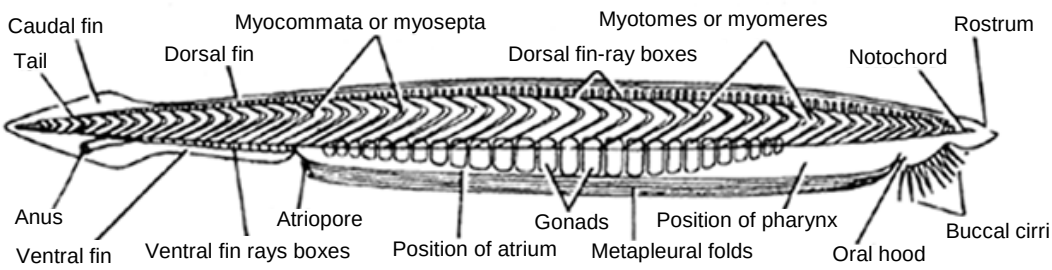


Salpa



Oikopleura

2. CEPHALOCHORDATA :



– Found in shallow **sea water**.
– Animals form burrows in sand and are nocturnal.
– Body is laterally compressed like fish, and is segmented.
– Head is absent. Body is divided into **trunk** and **tail.**

- Paired appendgaes absent. Median fins (Dorsal, ventral and caudal) are presents.
- Alimentary canal **complete**.
- Buccal opening is covered by oral hood from all the four sides.
- Just beneath it, **''Wheel organ''** or "Ciliated organ of Muller" present. This organ helps in the ingestion of food by proudcing circular currents in water.
- **Hatschecks** pit is found on the wall of oral hood which secretes mucus.
- **cillary feeders**, feed on diatoms and microbes. Oral cirri is present.
- Blood vascular system is **closed type** and respiratory pigment **absent.**
- Hepatic portal system present.
- For excretion **protonephredia** are present in the form of **flame cells** or **solenocytes**. **Hatscheck's nepheridium** (single kidney) is present which helps in excretion.
- Dorsal, tubular hollow nerve cord is present.
- Notochord and nerve cord remain extended from posterior end of the body to the anterior end hence named as cephalochordata.
- Pharyngeal gill slits are numerous. Larva and adult both show chordata characters.
- These are **unisexual** animals.
- Fertilization is **external.**
- Development is indirect i.e. larval stage is found.
- Members of this group are the **first complete chordate animals**
  e.g. : - ***Branchiostoma*** or ***Amphioxus*** (Lancelet). Posses 26 pairs of gonads. ***Assymetron***

CRANIATA or EUCHORDATA

- These animals are known as **higher chordates.**
- These animals have **head, Vertebral column, Jaws** and **Cranium.**

SUB – PHYLUM – VERTEBRATA :

- In these animals, notochord is **completely** or partially replaced by **vertebral column.**
  Vertebral column is made up of **many vertebrae.**
- Brain is covered by a protective covering made up of **bones** or **cartilage, called cranium.**
- There is a prominant head and well developed and complicated **brain.**
- Nerve cord **remains enclosed** within the **vertebral column.**
- Single or paired nostrils.
- 2 - 3 semicircular canals is each internal ear.
- Animals are unisexual.
  Sub-phylum Vertebrata is further divided into two division.
  (1) Agnatha
  (2) Gnathostomata

Division I. Agnatha	Division II. Gnathostomata
Without true jaws	True jaws present
Paired appendages absent	Appendages paired (pectoral & pelvic)
Inner ear with 2 semi-circular canals.	Inner ear with 3 semi-circular canals
Notochord persistent in adults	Notochord persists or replaced by vertebrae

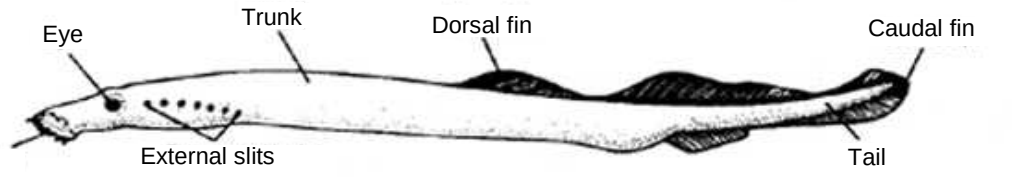
(1) Agnatha (Jawless) :

– Jaws are absent in these animals .
– Notochord persistant.
– Mouth at the anterior end of body, **round, funnel shaped and suctorial.**
– Paired appendages (fins) are absent.
– No exoskeleton.
– Single nostril.
– cold blooded.
– Genital ducts are absent.
– **Two semi - circular** canals are found in **internal** ear.
– One median **pineal eye** is found along with lateral eyes on head.
Group Agnatha is divided into two classes.

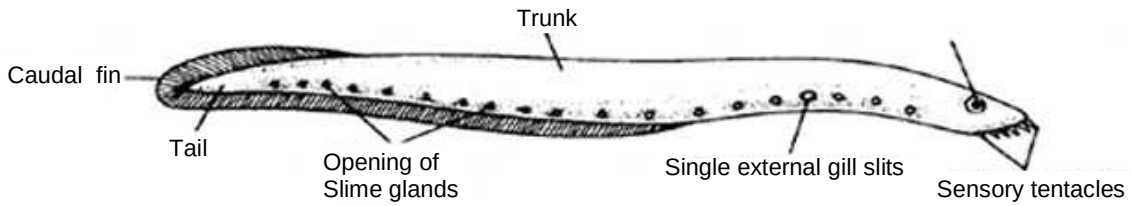
Class [A] - Ostracodermi

– All are extinct. These **were freshwater fishes the first vertebrates.**
– These were shell skinned with exoskeleton of bony plates.
e.g. – Cephalaspis (Primitive vertebrate of Ordovician period)
– Drepanaspis

Class [B] - Cyclostomata :



Petromyzon



Myxine

– Mostly marine, except some fresh water species.
– These are **parasite** as well as **scavanger.**
– Also called as **Jawless fishes (false - fishes).**
– Body long, thin, tubular, tail is flat.
– Skin soft, smooth and scaleless.
– **Mouth** is rounded, sucker like and biting - eating type.
– **Three eyes** are found on the head, one median **pineal eye** and two lateral eyes.
– Only one Nostril **(Monorhynous).**
– Internal ear contains **one** or **two semicircular canals.** Internal ear works as **statoreceptor** only. *i.e.*, Organ of balance.
– Gill clefts are **6** to **15 pairs.**

– Digestive system is without stomach. Intestine has **spiral typhlosole.**
– Notochord and vertebral column both are present. Cranium and Vertebral column is made up of **cartilage.**
– Bones are absent.
– Heart is two - chambered. It is called **Venous - heart.**
– Kidneys are **protonephric** or **mesonephric** type.
– Paired fins absent. Dorsal median and tail fin is present.
– Tail is **protocercal type**. In this type of tail, notochord is extended at the last end of tail and tail fin is divided into two equal dorsal and ventral lobes.
– Animals **unisexual**, fertilization **external**, larval stage absent,
– In Petromyzon - **Ammocoete** larva is present.

⇒ ***Petromyzon* or *Lamprey* :**

– It is a living fossil.
– Ectoparasite (Sanguivorous) on true fishes. Many teeth are found in mouth.
– Shows **Anadromous** migration.
Larva Ammocoete is considered as connecting link between Cephalochordata and Cyclostomata.

⇒ **Myxine or Hag fish : -**

– It has wrinkled lips just like an old woman.
– It usually remain attached with the gills of host.
– It has **Archaenephric kidney** in young ones i.e. which can filter blood and coelomic fluid.

(2) Gnathostomata :

– Mouth is surrounded by true jaws.
– Vertebral column well developed.
– Movement by paired fins or legs.
– Gonads are paired, genital ducts are present.
– 3 Semi circular canals are found in internal ear.
– Pineal eye is absent.
– Animals are unisexual.
– Gills or lungs are meant for respiration.
– Gnathostomata is classified into two super classes on the basis of locomotory organs, respiratory organs, heart and blood vascular system.

Super Class : -

(1) Pisces (2) Tetrapoda

(1) Super class - Pisces

– **"Devonian period"** is called **"Golden period of fishes"**
– Study of fishes **Icthyology**.
– Includes **true fishes**. Fresh water or marine.
– Body is long, boat shaped and streamlined, which is divided into **head, trunk and tail**.
– Neck is absent.

- Slime glands are present on the skin.
- Body is covered by **dermal scales**. But Cat fish, **Torpedo** & **Wallago** are **scale less**.
- Colour in fish is produced by **iridocytes** present in the dermis.
- Paired fins are present for swimming. e.g. Pectoral and pelvic fins are paired.
- Unpaired fins are also found on the body e.g., **mid dorsal fin** and **caudal fin.**
- External nares are one pair. **[Dirhynous condition.]**
- External and middle ears are absent, only internal ear is present in which **three semi - circular canals** are present. Eyes are without lids.
- Respiration by **gills**, gills are **4 to 7 pairs. Naked** or covered by **operculum**.
- **"Air bladder"** is present which helps in swimming as well as in respiration in bony fishes **only**.
- Heart two chambered, known as **"Venous heart",** because it contains only impure blood, which from heart goes to gills for purification, pure blood is then distributed to all parts of body directly from gills, i.e. circultion of blood is **unicircuit**.
- RBC are **nucleated. Sinus venosus, renal** and **hepatic portal** systems are found in circulatory system.
- Endoskeleton is made up of **cartilage** or **bones**.
- Vertebrae in fishes are **amphicoelous.** (centrum is concave at both the surfaces)
- Only one occipital condyle is present, so that skull is **monocondylic type**.
- Cranial nerves are **10 - pairs**.
- **Lateral line system** is present in the body of fishes, which can detect vibrations (Rheoreceptor) and Electric field.
- Kidneys in fishes are **mesonephric** type.
- **Cartilagenous** fishes excrete **urea**, Marine bony fishes excrete **trimethylamine oxide** and fresh water fish excrete **ammonia**. Urinary bladder is absent.
- Fishes are **unisexual**.
- Fertilization is **internal** or **external**.
- Eggs are **mesolecithal** or **megalecithal** type.
- **Extra embryonic membranes** are **absent [anamniota]**.
- Development is direct.
- These are **cold blooded**, poikilothermic animals (Exception - Tuna fish, endothermic).
- Small fishes (Baby fishes) are called **Fry or Hatchling**.
- Fishes show a **seasonal migration**.

[A] **Anadromous migration :** Migration of fishes from marine water to fresh water.
e.g., (1) **Salmon** (2) **Sturgeon** (3) **Hilsa**

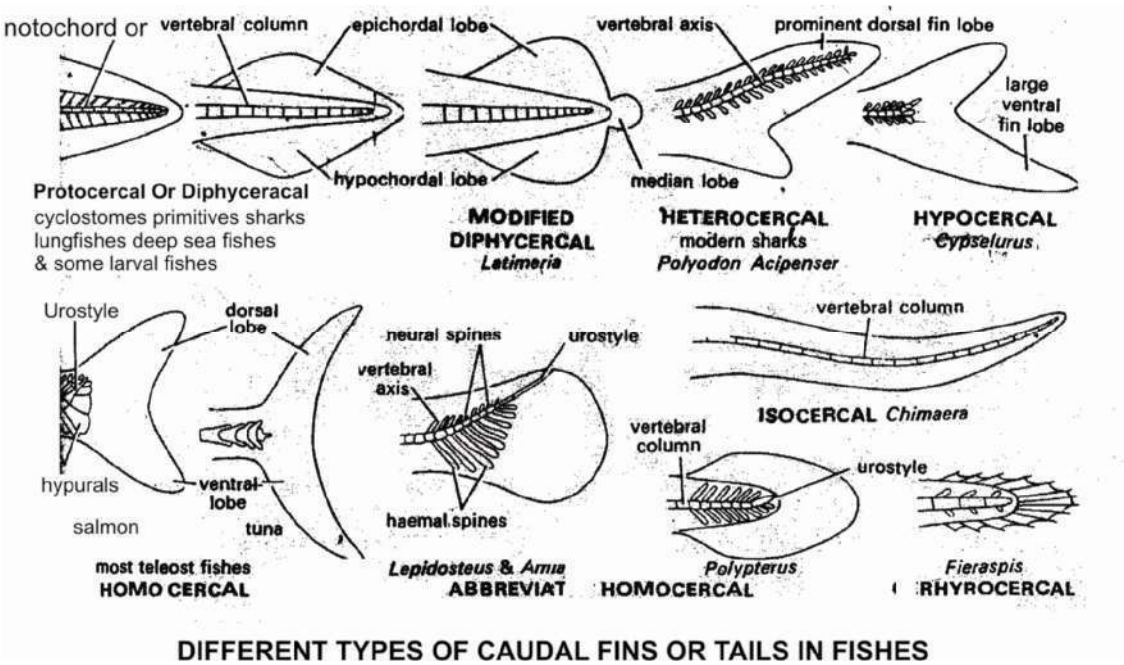
[B] **Catadromous migration :** Migration of fishes from fresh water to marine water. ***e.g., Anguila***

[C] **Potamodromous migration :** Migration of fishes from Fresh water to fresh water

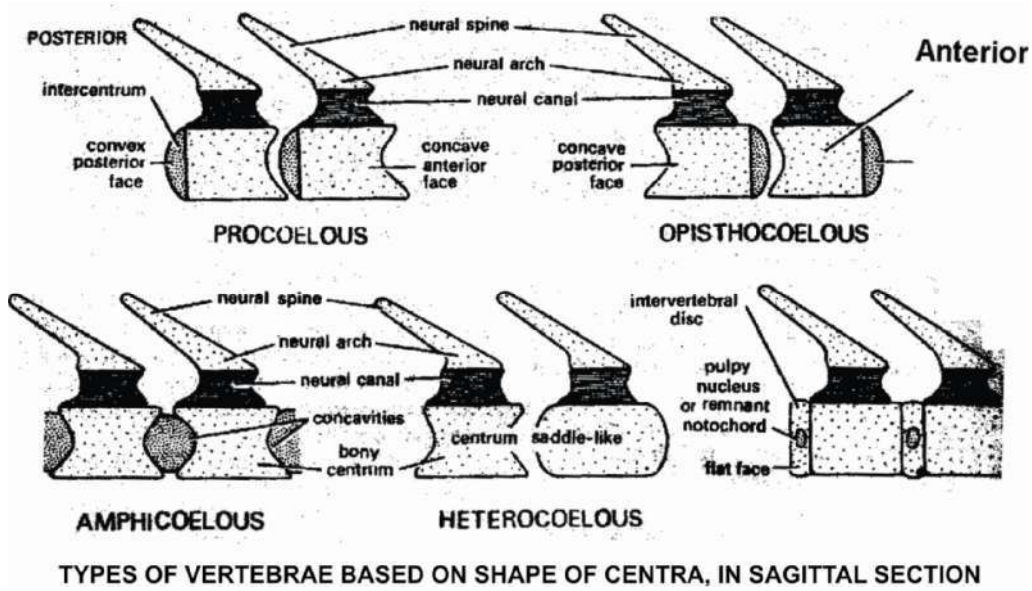
[D] **Oceanodromous migration :** Migration of fishes Marine to Marine water

⇒ **Stenohaline : -** Fish which can tolerate a narrow range of salinity in water.

⇒ **Euryhaline : -** Fish which can tolerate a wide range of salinity in water.



DIFFERENT TYPES OF CAUDAL FINS OR TAILS IN FISHES



TYPES OF VERTEBRAE BASED ON SHAPE OF CENTRA, IN SAGITTAL SECTION

Super Class Pisces has been classified into 3 classes.

Super Class Pisces

Class Placodermi (Extinct)

- Primitive earliest jawed fishes of Palaeozoic.

  Ex. : Placoderms. Climatius, Dinichthys.

Class Chondrichthyes

- Mostly marine and Cartilaginous endoskeleton.

  Ex. : Scoliodon (dogfish), Chimaera (ratfish).

Class Osteichthyes

- Freshwater and marine and bony endoskeleton.

  Ex. : Labeo (rohu), Protopterus (lungfish), Hippocampus (sea horse).

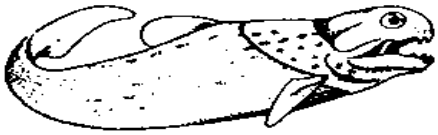
(a) Class - Placodermi :

– In this class, **extinct** fishes (Fossil fish) are included, which use to live from devonian era to permian era. So these were the first fresh water true fishes.

– Their body was covered by **bony plates**, so these are called **"Armoured fishes"**

e.g. : - – **Climatius** – First jawed fish

– **Dinichthyes**



Dinichthyes

(b) Class - Chondrichthyes or Elasmobranchi

– This includes **cartilagenous fishes** i.e. endoskeleton is made up of **cartilage**.

– Fishes are generally **marine**.

– Exoskeleton over the skin is made up of **placoid** scales. These scales are like denticle and are originated from dermis of skin.

– In these fishes, **5 - 7 pairs** of gills are present, which open directly outside the body by gill slits, operculum is normally absent in these fishes, except is **chimaera** where operculum is present.

– Mouth is present at the **ventral surface** of head.

– **Suspensorium** of jaws is **Hylostylic type**.

– Air - bladder or lungs are absent.

– **Spiracles** present.

– A **spiral valve** or **scroll valve** is found in intestine.

– Cloacal aperture is present.

– There is special structure at the dorsal surface of head in these fishes, which is called **"Ampulla of Lorenzini"**, this works as **thermoreceptor.**

– Tail is **heterocercal** type.

– Genital ducts open into cloacal aperture.

– Fertilization is **internal** – male fishes have **"Claspers"** as copulatory organs, which are developed by the inner edges of pelvic fins.

– Fishes are oviparous or viviparous (few have yolk sac placenta).

– **Scoliodon : -** Dog fish - Dog like sense of smell. It is also known as **Indian shark - viviparous**

– **Sphyrna/Zygaena -** Hammer headed shark

– **Stegostoma** - Tiger Fish / Zebra shark

– **Carcharodon -** great white shark

– **Rhinobatus -** Guitar Fish

– ***Pristis* : -** Saw - fish

– ***Trygon* : -** Sting ray - Its dorsal fin has poisonous spines.

– **Torpedo : - Electric ray -** In this fish an electric organ is found which is a modified muscle, it can give shock of about 100 volts. Scales are absent.

– **Rhinodon : -** Whale shark - It is the largest fish. Its length is 13 – 14 meters.

– **Chimaera : -** "Rat fish" or "King of herrings" or Ghost fish. Connecting link between bony & cartilagenous fish. Operculum present. Cartilage fish with operculum is placed under **holocephali** group.

(c) Class - Osteichthyes or Teleostomi

- Includes **Bony fish**. **Endoskeleton** of these fishes is made up of **bones**.
- Found in fresh water as well as marine water.
- **Exoskeleton** is made up of scales, such as cycloid or ctenoid or ganoid type. Placoid scales are absent.
- Respiration by **4 - pairs** of gills. These are covered by **operculum**.
- Mouth is normally terminal or subterminal.
- Suspensorium of Jaw is **autosytylic**.
- Accessory respiratory organ **"air bladders"** is present. This helps in swimming as well as in respiration both.
- Spiracle is absent.
- Scroll valve in intestine is absent.
- Cloaca absent, in place of cloacal aperture **anus** is present.
- No Ampulla of Lorenzini.
- Tail is normally homocercal type but sometimes it may be **diphycercal** type.
- Genital ducts open outside the body through separate apertures.
- Fertilization is **external, claspers** are absent in male fishes.
- Fishes are **oviparous** but may be **ovoviviparous** or **viviparous**.
- ***Labeo*** "Rohu" or "Indian carp" - It is a fresh water fish.
- ***Clarias*** "Cat fish" or **magur**
- **Wallagon** Lachi (scale less)
- ***Catla*** - Catla (Fresh water)
- **Heteropneustis** - Singhi
- **Channa** – Lata Fish
- **Laphius** – Angler Fish
- ***Hippocampus*** - "Sea – horse" or **"Pregnant male" :** - It swims in water in its vertical position. A pouch like structure is present at the abdomen of male fishes known as "Brood - pouch" in this pouch male collects the eggs. Secondary vivipary and parental care is found in Hippocampus.
- **Anabas** - Climbing perch.
- **Sardinella** - Salmon
- **Acipensor** - Sturgeon - Endoskeleton is **cartilaginous.**
- ***Betta*** - Fighting Fish
- **Pterophyllum** - Angel Fish
- ***Exocoetus*** - Flying fish - Its dorsal fin is long, it can fly (glide) over 400 metre with the help of this fin.
- **Anguila** - Eel : - Snake like. migrate to sea for spawning. Young eel (Elver) migrate back to fresh water
- **Solea** - Flat fish
- **Fistularia** - Flute fish
- **Harpodon** - Bombay Duck
- **Amia** - Bow fish
- **Echeneis** (Remora) - Sucker fish. Shows commensalism with shark and whales. Dorsal fin modified into sucker.
- **Mystus** - Singhara
- **Cirrhinia** - Mrigal
- **Latimaria or coelacanth - Living fossil** – It is the **oldest living vertebrate** known till date. Belongs to group **Crossopterygii**.
- **Chenocephalus** - Ice fish only vetebrate without haemoglobin.
- **Opsanus** - Toad fish
- **Synanceja horrida** - Stone fish it is the most poisonous fish.
- **Gambusia** (Top minnow) - Larvivorous fish.

DIPNOI GROUP

- Fishes of dipnoi group are called **Lung-fishe**s or **"Uncle of amphibia"** because lungs helps in respiration.
- Three chambered heart.
- External and internal both the nares are present.
- Their tail is **heterocercal** type, Scale is **cycloid** type.
- These are freshwater fishes.
- **Lepidosiren** : - South American lung fish. Respire though lungs only.
- **Protopterus : -** African lung fish : - It is living fossil fish. Paired lungs are present.
- **Neoceratodus : -** Australian lung fish. Respire by gills only. single lung is present which is used in stressful condition.

Special Points :

- **Shagreen** is dried skin of Cartilaginous fish.
- **Cod liver** oil is rich in Vitamin D, Shark liver oil is rich in Vitamin A.
- **Maltese cross** is found in vertebra .of cartilaginous fishes such as shark.
- **Mermaid's purse** refers to Egg capsule of shark.
- **Isinglass** is a gelatinous product from air bladder of certain fish for making cement, Jelly & for cleaning of wine & beer.
- Smallest fish **Mystichthyes** - Goby fish - Pandaka (8 - 10 mm).
- Algae in aquarium provided oxygen & selter to fishes.
- Catfish is a true fish. It has sensory barbels and is without scales.

COMPARISON OF CHONDRICHTHYES AND OSTEICHTHYES

S.No.	Characteristic	Chondrichthyes (cartilaginous fishes)	Osteichthyes (bony fishes)
1	Habitat	Mostly marine	Both marine and freshwater
2	Shape	Usually dorsoventrally flattened	Usually bilaterally flattened
3	Caudal fin	Heterocercal	Homocercal or diphycercal
4	Pelvic fins	Usually posterior. In male form claspers for transferring sperms into genital tract of female	Usually anterior, posterior Claspers absent
5	Mouth opening	Ventral on head. Large and crescentic	Terminal on head. Variable in shape size
6	Gill openings	Usually 5 pairs of naked gill slits. No operculum	5 pairs of gill-slits covered by a flap of skin called operculum.
7	Spiracles	Usually Ist gill slits become spiracles which open just behind eyes	Spiracles are lacking
8	Cloaca	Between two pelvic fins lies midventrally common cloacal opening for alimentary, urinary and genital products	Cloaca absent. Anus and urinary and genital apertures open separately

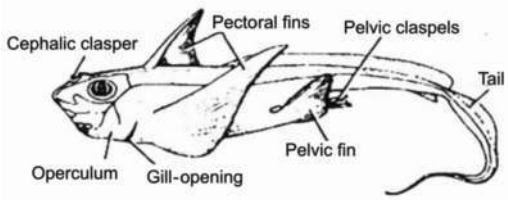
9	Exoskeleton	Separate dermal placoid scales	Overlapping dermal cosmoid, ganoid, cycloid or ctenoid scales
10	Endoskeleton	Wholly cartilaginous	Mostly bony
11	Jaw suspension	Hyostylic	Hyostylic and autostylic
13	Intestine	Short and with an internal fold or **scroll valve** in lumen	Long and without scroll valve
14	Rectal gland	Present	absent
15	Liver	Generally has 2 lobes	Generally has 3 lobes
16	Type of gill	Lamellibranch with long interbranchial septum	Filiform with reduced interbranchial septum
17	Air (swim) bladder	Absent	Usually present
18	Conus arteriosus	Present in heart	Absent
19	Afferent branchial vessels gills	5 pairs from ventral aorta to	Only 4 pairs
20	Efferent branchial vessels	9 pairs	4 pairs
21	Brain	Primitive with larger olfactory lobes & cerebrum and smaller optic lobes and cerebellum	Advanced with smaller olfactory lobes and cerebrum and larger optic lobes and cerebellum
24	Retina	Lacks cones	Cones present
26	Ampullae of Lorenzini	Present	Absent
29	Urinary and genital apertures	United and urinogcnital apertures lead into common cloaca	Separate and open independently to exterior
30	Fertilization	Internal	External in water
31	Eggs	Few, large with much yolk	Numerous, small with less yolk
32	Development	Internal in ovoviviparous types. Externally inside egg cases in oviparous types	Usually external without an egg case

Common Food Fishes Of India

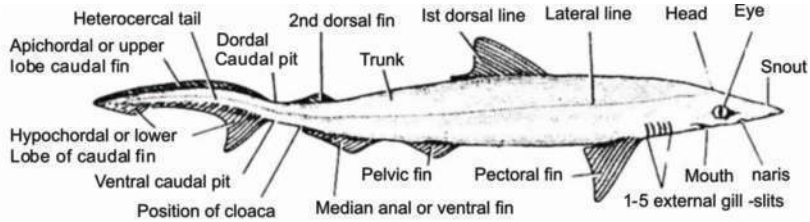
S.No.	Fresh water food fishes	Marine water food fishes
1.	*Lebeo rohita* (Rohu)	*Stromateus* (Pomfret)
2.	*Lebeo calbasu* (Calbasu)	*Harpodon* (Bombay Duck)
3.	*Catla catla* (Katla)	*Sardinella* (Salmon)
4.	*Cirrhina mrigala* (Mrigal)	*Hilsa* (Hilsa)
5.	*Mystus seenghala* (Singhara)	*Anguilla* (Eel)

False Fishes

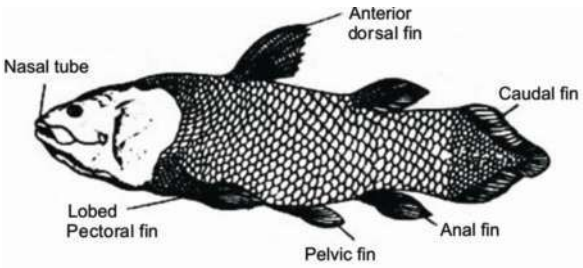
Sr.No.	Common Name	Genus	Phylum
1.	Jellyfish	*Aurelia*	Coelenterata
2.	Silverfish	*Lepisma*	Arthropoda
3.	Crayfish	*Astacus*	Arthropoda
4.	Razorfish/Shellfish	*Solen*	Mollusca
5.	Cuttlefish	*Sepia*	Mollusca
6.	Devilfish	*Octopus*	Mollusca
7.	Starfish	*Asterias*	Echinodermata
8.	Hagfish	*Mysine*	Chordata
9.	Whalefish	*Balaenoptara*	Aquatic mammles



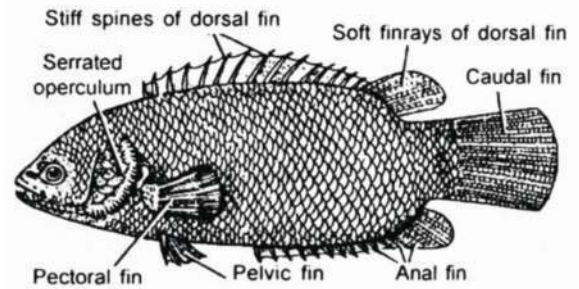
Ratfish or Chimaera



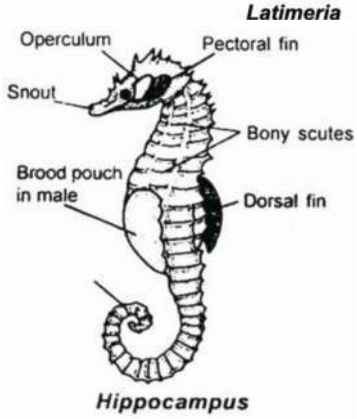
Female Indian dogfish shark (Scoliodon sorrakowash) in lateral view



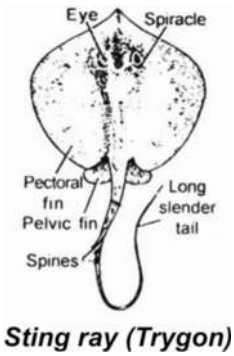
Latimeria



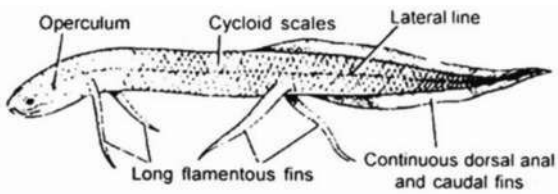
Climbing perch (*Anabas testudineus*)



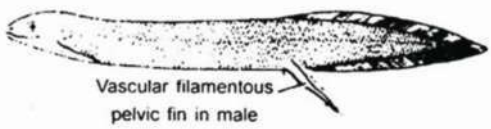
Hippocampus



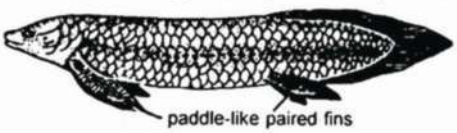
Sting ray (Trygon)



African lungfish *Protopterus*

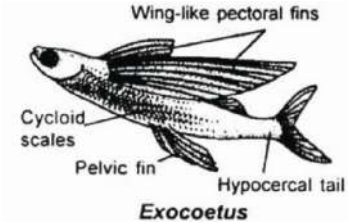


American lungfish *Lepidosiren paradoxa*

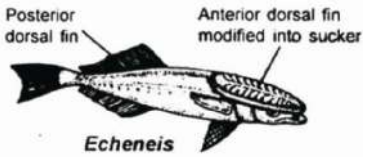


Australian lungfish *Neoceratodus forsteri*

Lung fishes (Dipnoi)



Exocoetus

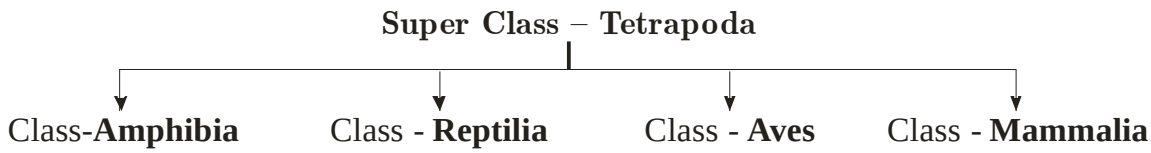


Echeneis

(2) Super Class – Tetrapoda

- Members of this superclass are found in water and on land.
- Locomotion by 2 pairs of **pentadactylous** limbs.
- Gills are present only in embryonic stages. Main respiratory organ in adults is **lung**.
- Exoskeleton is made up of scales, feathers or hair.
- Endoskeleton is made up of **bones**.
- Heart is three or four chambered and **double circulation** is found in them.
- Kidneys are **mesonephric** or **metanephric** type.
- Middle ear is present. **Birds** and **mammals** have external ears also.

Superclass - Tetrapoda is divided into four classes.



(A) Class - Amphibia

- Originated is **Devonian**.
- Carboniferous Age of Amphibians
- Includes vertebrates with dual life - can live in water as well as on land.
- No marine forms.
- These are the first chordate which can live on land but not permanently, these depend on water for their reproduction.
- Their eggs do not have protecting covering to check the evoporation.
- Body is divided into head, trunk and tail. Some amphibians lack tail e.g. frog, toad etc.
- Skin is smooth and mostly **scale less**, but whenever scales are present they are embeded in the skin e.g. **Ichthyophis**.
- Skin is gladndular which keep the skin moist. Members show cutaneous respiration.
- Some poisonous glands are also found in the skin of some animals e.g. **Bufo**.
- Pigment cells are also found as **chromatophore** for colouration. Few amphibians have ability to change colour by expansion and contraction of pigment cells. This phenomenon is known as **Metachrosis**.
- Two pairs of limbs help in swimming in water or moving on land. Forelimbs have four fingers and hind limbs have five fingers.
- Their digits do not have **nails** or **claws** at all.
- Mouth is bigger in size. Upper or both the jaws have similar teeth (Frog - Acrodont). Teeth are **pleurodont, homodont** and **polyphyodont**.
- Suspensorium of jaws is **Autostylic**.
- A well developed and complete alimentary canal along with digestive glands are present in digestive system (Salivary glands are absent in frog.)
- Alimentary canal, urinary bladder and genital ducts open into **cloaca**.
- Respiration by **gills, skin, lungs** or **buccopharyngeal** cavity.
- Two nostrils are found, this condition is called **dirhynous**.
- Heart is three **chambered**, 2 auricles and 1 ventricle (arteriovenous).
- **Sinus venosus** and Truncus **arteriosus** is well developed,
- R.B.Cs are biconvex, oval and **nucleated**.
- In these animals, **renal portal system** and **hepatic portal system** are found.

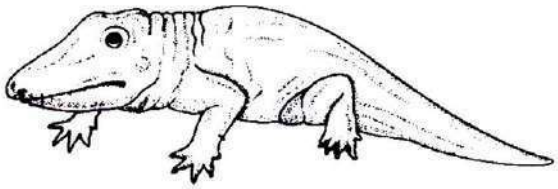
- Endoskeleton is made up of bones, but **cranium** is **cartilagenous**.
- Skull has **two occipital condyles**, **(dicondylic skull).**
- Ribs absent, but may be present in some animals, but **ribs** are fused with **sternum**.
- Vertebrae, are **procoelus** type, in which centrum is **concave** from anterior side and **convex** from posterior side.
- External ear absent, only one ear ossicle **columella** present in middle ear.
- Cranial nerves are **10 – pairs**.
- **Lateral line sensory system** is necessarily found. In any stage of development. In frog it is found only in larval stage.
- Kidneys are paired, **mesonephric** or **opisthonephric** type. Animals are **Ureotelic.**
- But salamanders & larva are **Ammonotellic**.
- These are cold blooded or **poikilotherm**.
- Undergo **hibernation** or **aestivation** to protect themselves from extreme cold and heat and to overcome unfavourable conditions.
- These are unisexual, males lack copulatory organs. These animals return to water from land for reproduction.
- Fertilization is **external** and occur in water.
- These are oviparous, lay their eggs in water. Eggs are **mesolecithal.** Extra embryonic membranes absent, so these are placed under, anamniota group.
- Cleavage in eggs is **holoblastic** and **unequal**.
- Development is **indirect type** ie. **tadpole larva** is found.
- This class is divided into three orders : -

Classification of Class Amphibia

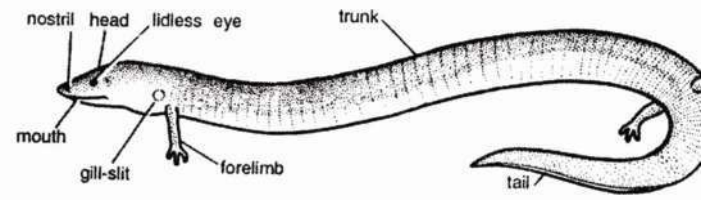
Order-I	**Order-II**	**Order-III**
Gymnophiona or Apoda	**Caudata or Urodela**	**Anura or salientia**
(1) Skin have dermal scales	Skin smooth	Skin smooth
(2) Legs absent	Present	Present
(3) Copulatory organ present	Absent	Absent

Order – I : Gymnophiona or Apoda or Caecilian :

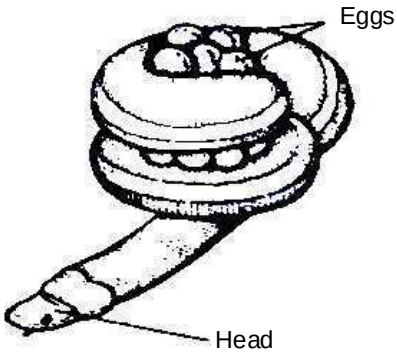
- Commonly called as Blind - worms.
- Body is **worm** like.
- These are **primitive amphibians**, burrowing in nature.
- **Limbless**
- Skin is soft, and moist, with mucous glands, small scales (cycloid) are found embeded in the skin.
- Eyes are covered by opaque skin.
- Middle ear and tympanic membrane absent.
- Protrusible copulatory organ is present in male.
- Fertilization **Internal**.
- Parental care is found.
- Tail is absent.
- ***Ichthyophis (Caecilian)* : -** Blind worm without tounge.
- **Uraeotyphlus : -** Dermal scales are found in the skin.
- **Gymnophis**



Stegocephalia (Amphibian Ancestor)



Amphiuma



Ichthyophis

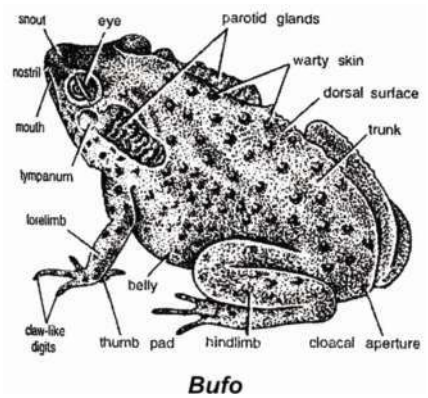
Order - II : Caudata or Urodela :

- Body is distinctly divided into **head trunk** and **tail**. Tail may or may not have caudal fin.
- Normally two pairs of limbs are found which are of **equal** size. Sometimes hind limb is absent.
- **Scaleless** skin.
- Middle ear and tympanic membrane absent.
- External gills are present only in larval stage.
- **Copulatory organ absent** in males. Fertilization **Internal**.
- Vertebrae are numerous, centrum is **amphicoelous** or **opisthocoelous** type.
- Characterstic feature of this order is Neoteny.
- Larva attains sexual maturity without undergoing **Metamorphosis**, and starts reproduction.
- ***Salamandra* : -** It is viviparous. Its larva is called **Axolotl larva.** It sometimes show neoteny. (Longest gestation period - 36 months).
- **Trilotriton** - Indian salamander found in himalayas.
- **Proteus** - Cave - salamander (Blind)
- **Ambystoma** - Tiger salamander **(Axolotl larva)**
- **Triton** - Newt
- **Necturus -** Water dog or mud puppy , Gills in adult also. It shows **permanent neoteny**.
- **Amphiuma -** Congo-eel , Largest RBC is present.
- **Siren -** Mud-eel
- **Cryptobranchus** - Hell Bender : - Largest Amphibian, aquatic

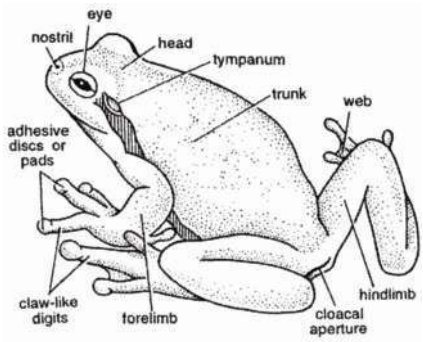
Order - III : Anura or salientia :

- Tail is absent in adult stage.
- All the frogs and toads are included in this order.
- Skin is moist with **mucous**.
- 2 pairs of limbs are found. Fore limbs are short and hind limbs are long. Digits of hind limbs are webbed, which help in swimming.
- Gills are absent in adults.
- Vertebral column small, in which only **5 - 9 vertebrae** are found. Last vertebra is stick like **urostyle**.
- Eyes **with lids, tear** glands present. (Lower lid movable & upper immovable).
- Maxillary teeth are present in the upper jaw (absent in Toad).
- **Middle** ear and **Tympanic membrane present**.

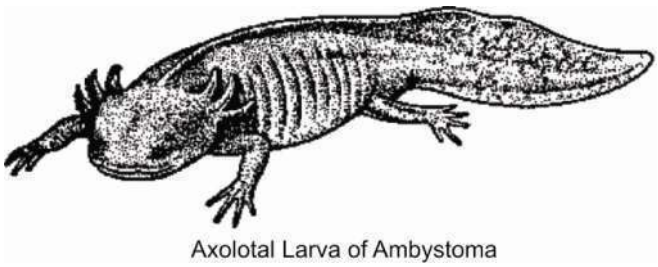
- Egg laying, fertilisation and development is always in **water**.
- Males have well developed **vocal sacs** i.e. power of voice.
- Development **indirect** i.e. **tadpole larva** is found.
- Complete Metamorphosis.
- ***Bufo*** – Common toad (Poison glands are modification of parotid gland.)
- ***Hyla* –** Tree - frog
- ***Rana tigrina*** – Indian bull frog. Mentomeckanial bone is found (Tip of the lower jaw).
- **Rhacophorus** – Flying frog
- **Alytes –** Midwife toad – Parental care is well developed in them. Male toads carry eggs in their limbs.
- **Pipa americana –** Surinam toad – carries eggs, Secondary vivipary. (Tongue absent)
- **Rana goliath –** Largest frog
- **Phyllobates –** Smallest frog (found in Cuba)
- **Discoglossus** or **Bombinator** – Fire bellied toad
- **Xenopus –** African toad

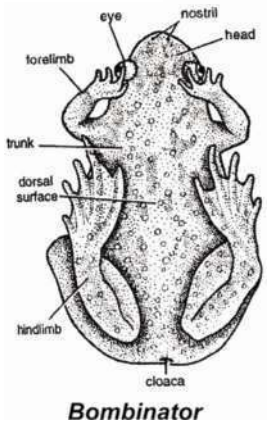


Bufo

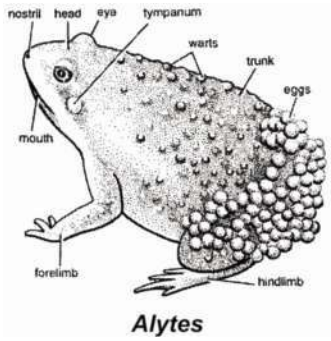


Hyla


Axolotal Larva of Ambystoma



Bombinator

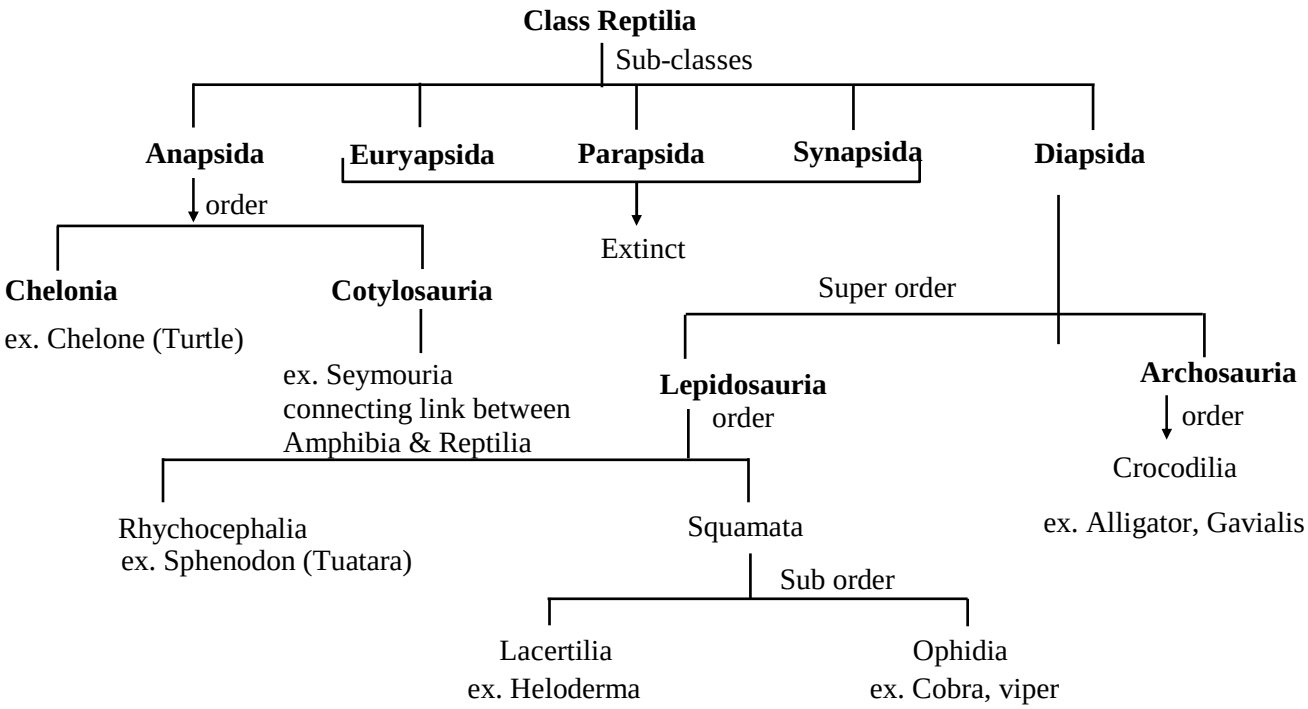


Alytes

(B) Class - Reptilia

- Reptiles were originated during **carboniferous** period of palaeozoic era. Mesozoic era is Golden age of Reptile.
- Study of reptiles is known as **''Herpetology''.**
- Members of this class are the **first successful terrestrial animals.**
- First reptiles are called **Stem reptiles** or **Cotylosaurs.**
- These are **Cold blooded, Poikilothermal animals.** Their body temperature varies according to climate.
- Mostly, terrestrial, but some are aquatic.
- Body is divided into head, neck, trunk and tail.
- Skin is **dry, cornified, rough, nonglandular** (Femoral gland in male lizard).
- Pentadactyle limbs. Each digit has **curved claws.**
- Some **lizards and snakes** do not have limbs e.g. **Ophiosaurus** lizard is a limbless lizard.
- Exoskeleton is made up of horny **epidermal scales** or **bony scales** or **bony plates.**

- A complete alimentary canal is found in these animals, which opens into cloaca.
- Teeth are **acrodont, thecodont, pleurodont** type.
- Tounge is **protrusible.**
- Respiration is by lungs, but members of order **Chelonia** can respire through their cloaca, it is known as **''Cloacal respiration''**
- Heart is incompletely four chambered, 2 complete auricles and two incomplete ventricles. Right and left both systemic arches are present.
- Ventricle of animals of order **Crocodilia** is completely divided into two, i.e. heart is **four chambered** in **Crocodiles.**
- External ear aperture is absent.
- Tympanum represents external ear.
- Tympanum is absent in snakes.
- Sinus venosus is underdeveloped and trunkus arterious is absent. RBC are **oval** and **nucleated.**
- Bony endoskeleton.
- Skull is **monocondylic**
- True well developed sternum is present.
- Centrum are **procoelous** type. **Sternal ribs** are found in reptiles.
- A **chevron bone** is found in caudal vertebrae of these animals.
- One pair of **Metanephric** kidneys help in excretion.
- Members are **uricotelic** for water conservation.
- Brain is well developed **12 - pairs** of cranial nerves are present.
- Lateral line system is absent.
- At the roof of buccal cavity **Jacobson's organ** (olfactory) is present.
- Ureters, genital ducts and alimentary canal open into a **single cloacal aperture.**
- Unisexual animals. Fertilization is **internal.**
  One or two penis (Hemipenis) is found in male as copulatory organ.
- Mostly **oviparous**, but some are viviparous also. Large amount of yolk in their eggs. i.e. eggs are **Megalecithal** & **Telolecithal**, Cleidoic & leathery eggs are present.



- All the four embryonic membranes **amnion, chorion** and **allantois** present in the embryo. **Yolksac** is also attached with embryo. So this class is grouped under **Amniota group.**
- Cleavage is **Discoidal, Meroblastic.**
- Development direct i.e. larva stage is absent.
- Parental care is often marked.
- Class Reptilia is classified on the **basis of presence or absence of temporal fossae in the temporal region of skull and their number**.

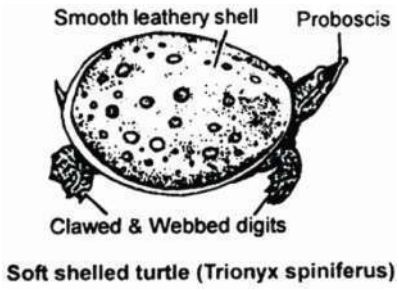
  Class reptilia is divided into following Major Five sub-classes :

  (i) Anapsida (ii) Euryapsida (iii) Parapsida (iv) Synapsida (v) Diapsida

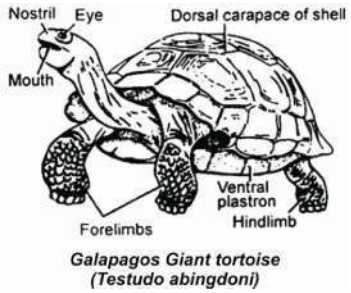
(i) Sub-Class – Anapsida :

Order – Chelonia

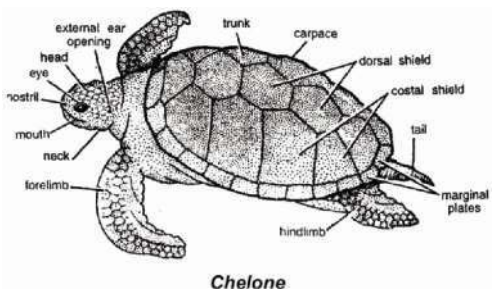
- Temporal fossae are absent in the temporal region of the skull i.e. roof of skull is complete.
- Limbs are strong.
- Body is broad and oval.



Soft shelled turtle (Trionyx spiniferus)



Galapagos Giant tortoise (Testudo abingdoni)



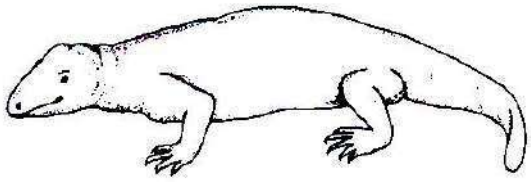
Chelone

- They are terrestrial, marine and fresh water animals.
- This order includes live and extinct both the animals.
- Whole body is covered by firm bony shell.
- Exoskeleton of dorsal region of body is called **carapace** and skeleton of ventral region of body is called **plastron.**
- Horny, **teethless, beak like** jaws are found.
- **Sternum** is absent.

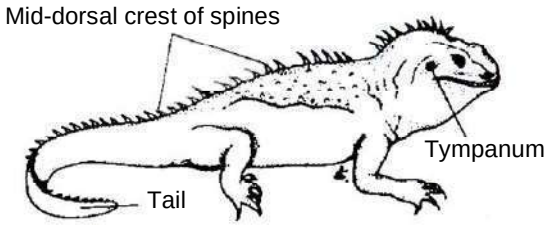
  Bony plate present on the body are called **osteoderms.**
- Clawed digits. Web or membrane of found in between the digit for swimming.
- Scales are found on **neck, limbs** and **tail.**

  All these three organs can be pushed into the **carapace.**
- Thoracic vertebrae and **ribs** are attached with **carapace.**
- Cloacal aperture is vertical and it helps in respiration. (cloacal respiration)
- **Single** copulatory organ is found in male animal.
- Animals are **oviparous.**
- **Testudo** - Land tortoise
- **Trionyx** - Fresh water terrapins (edible)
- **Chelone** - Marine (tortoises) turtles

Order - Cotylosauria



A cotylosaurus Seymouria
(First /Stem reptile)



Sphenodon (Tuatara)

e.g. **Seymouria :** Connecting link between **amphibia & reptilia.**

(ii) Sub-Class – Diapsida :

– One pair superior and one pair inferior temporal fossae are found in the temporal region of skull. Sub-class Diapsida is divided into two super orders.
  - **Lepidosauria**
  - **Archosauria**

Super order Lepidosauria :-

This super order is divided into two orders.

Order - Rhynchocephalia :

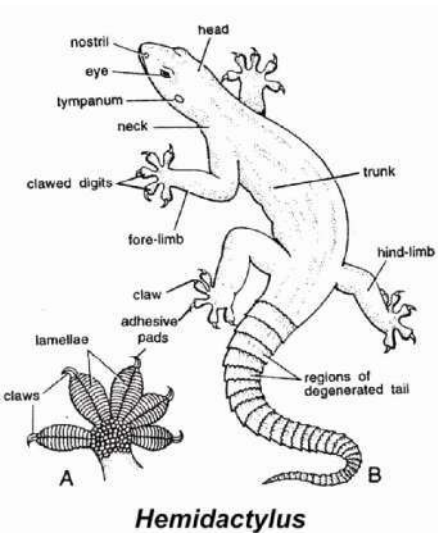
– Most of the species of this order are found in the form of fossils.
– Body is small and lizard like.
– Tail is laterally compressed.
– Limbs are pentadactyl and digits clawed.
– A functional **third eye** or **pineal eye** is found in the head.
– Vertebrae are **amphicoelous** type.
– Teeth are **acrodont** type.
– Penis or copulatory organ is absent in male.
– Long life span living $\simeq$ 100 years

Sphenodon punctatum - Tuatara **(living fossil)** It is found only in **NewZealand.** Only living member.

Order - Squamata :

– Largest number of species of reptiles are found in this order in modern era. All the lizards & snakes are included in this order.
– One or two pairs of temporal fossae are found in temporal region of skull, which disappear after sometimes.
– Limbs clawed.
– Some of the lizards and all snakes are limbless.
– Scales are found on body.
– Vertebrae are procoelus type.
– Teeth are pleurodont, i.e. tooth is situated at lateral side of jaw bone.
– Copulatory organs are paired (hemipenis).
– Order squamata is divided into **two** suborders

Sub-Order (i) Lacertilia ; (ii) Ophidia

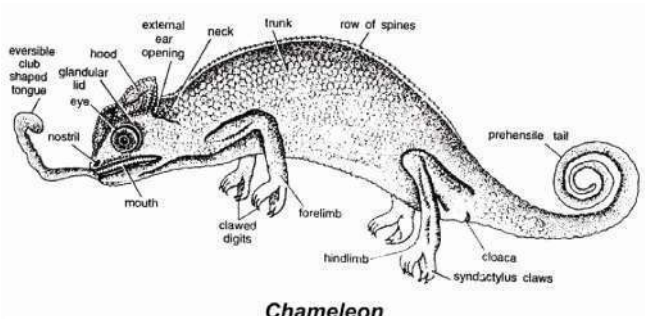


Hemidactylus

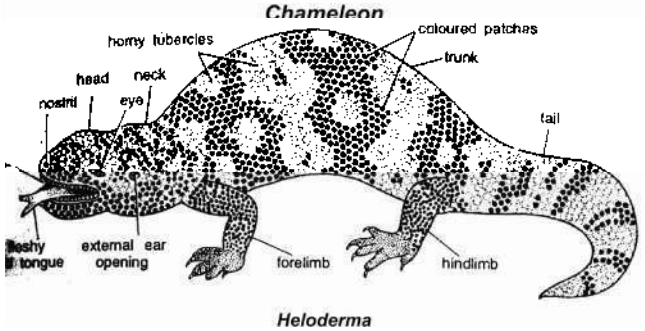
Sub-Order (i) Lacertilia :-

– Normally the members of this suborder is **''Lizards''.**

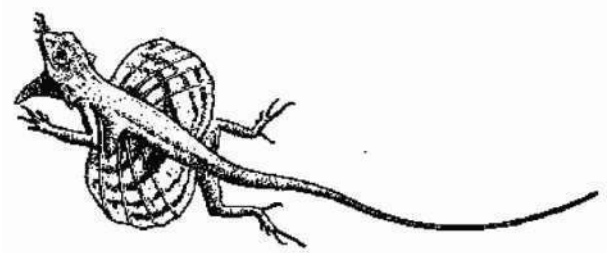
– Study of lizards is called **''Saurology''**
– Girdles and pendactyle clawed limbs are well developed.
– Eyelids are **movable** and **nictitating membrane** is found in eye.
– **Auditory aperture or auditory opening** and **tympanum** is present.
– Autotomy (for breaking of tail) is found in lizards only.
– Urinary bladder is present.
– **Foramen of panizzae** is present in the heart of lizard.
– Both lungs are well developed.
– ***Hemidactylus*** - Common lizard, **wall lizard.** Power of regeneration is well marked.
– ***Calotes*** - Blood sucker, Garden lizard/Girgit. it can change its colour according to environment.
– **Draco** - Flying lizard. Its body skin expands in the form of 2 wings or **patagia.** With the help of these patagia, it can glide from one tree to another tree or its branches. It can not fly.



Chameleon



Heloderma


Draco

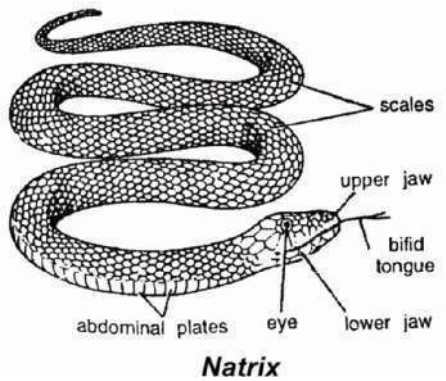
– ***Chameleon*** - Arborial lizard (Viviparous) (Girgit)
– **Varanus** -Goh, Monitor lizard. **Varanus komodoensis** - Ferocious Dragon - **Largest living lizard.**
– **Rhineura** - Limb - less lizard.
– ***Ophiosaurus*** - It is **limbless lizard.** It is also called **glass - snake.**
– **Anguis** - limbless lizard
– **Burkudia** - limbless lizard found in south India.
– **Heloderma** - Gila - monster/Beaded lizard. It is the **only poisonous lizard.**
  Its poison glands are modified sublingual glands (Maxico & USA).
  two sps (H. suspectum, H. horidema).
– **Mobuya** - Viviparous lizard.
– **Phrynosoma** - Horned toad (viviparous)
– **Uromastix** - Sand lizard or Sanda

Sub-Order (ii) Ophidia :-

– Members commonly called **''Snakes''**.
– The study of snakes is called **ophiology** or **serpentology.**
– Body long, thin, smooth and limbless.
– Eyelids are immovable and nictitating membrane in eyes are absent.
– Girdles, sternum and urinary bladder **absent.**
– **Auditory opening** and **tympanum** absent. No middle ear.
– Tongue thin, long and **bifid** and sensitive to odour and vibration.
– Left lung is ill developed.
– Snake poison is proteinaceous and good digesting enzyme.

NON-POISONOUS SNAKES :

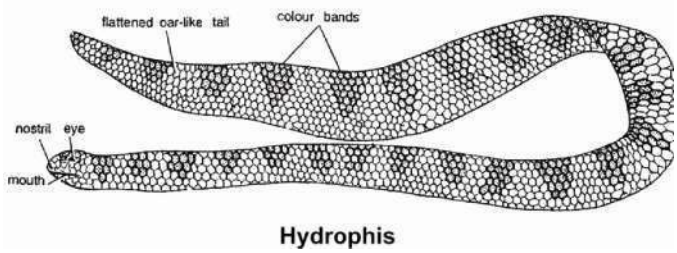
- **Python molurus -** Azgar. It is the **largest snake,** its length is about 25 feet. Rudiments of hind limbs are found on the body. It is non-poisonous snake.
- **Ptyas mucosus - Zamenis** or Rat snake. It is commonly called **Dhaman.** It feeds on rats, so it is also called ‘‘Friend of farmers’’. It is a non-poisonous snake.
- **Eryx Johni - Sand boa.** It is also called **Dumuhi** snake. It is a non-poisonous snake.
- **Typhlops** - Blind snake. Non poisonous.



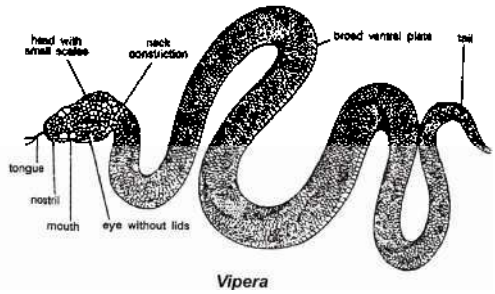
Natrix

POISONOUS SNAKES :

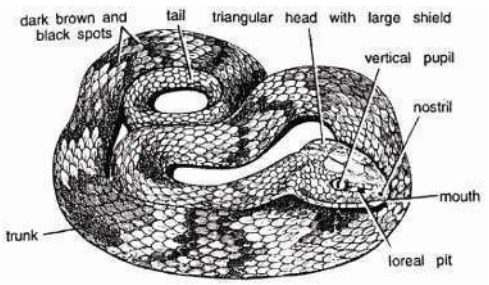
- **Hydrophis -** Marine snake. It is a **deadly poisonous snake.** Its tail is laterally compressed. It is a viviparous snake.
- **Enhydrina** - Sea snake (Poisonous)
- ***Naja* - Indian cobra.** Poisonous snake. Its poison is **neurotoxic** cause paralysis of respiratory muscles.
- **Naja naja or** - King cobra, poisonous snake. It is the largest snake among poisonous snakes **N.hannah** (Head with one or two circular mark).
- ***Bungarus*** - Krait : Poisonous (neurotoxic) snake
- ***Vipera*** - Viper snake : Head is differentiated from body. Poisonous snake (viviparous). Its venom is **haemotoxic/Cardiotoxic Proteolysin is present and damages tissue Loreal pit** is found which is a **thermoreceptor.** Largest viper is Russel viper (V mark on head).
- **Micrurus** - Coral snake.
- **Crotalus** - Rattle snake : It produces a characteristic rattling sound of ‘‘Rate - rate - rate’’, so it is called **rattle snake.** It is poisonous and ovoviviparous snake.



Hydrophis



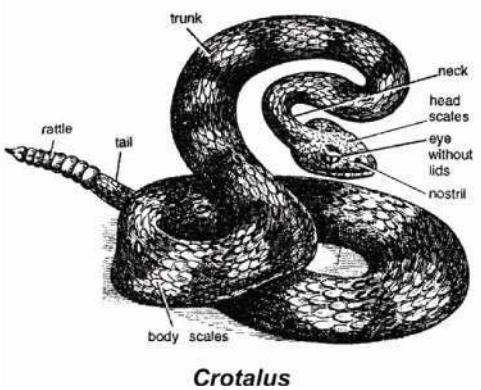
Vipera



Ancistrodon

Characteristic features of poisonous snakes :-

- Small scales are found on head or hood.
- Laterally compressed tail is present in marine snake.
- Ventrally placed scales of the body are broad.
  Two teeth mark is of poisonous snake. (V-shaped - Non posionous)
- Poison glands of poisonous snakes are modified **labial glands.** Probably these glands are homologous to parotid salivary glands of Mammals.
- Poisonous teeth (fangs) are modified maxillary teeth.
- Treatment of poisonous snake bite is done by **Antivenom dose. Antivenom** is produced at



Crotalus

(i) Central Research Institute Kasuali - Shimla
(ii) Hoffkins Institute, Mumbai.
Biggest **Serpentorium** is located in India - **Chennai**

(2) Super order - Archosauria

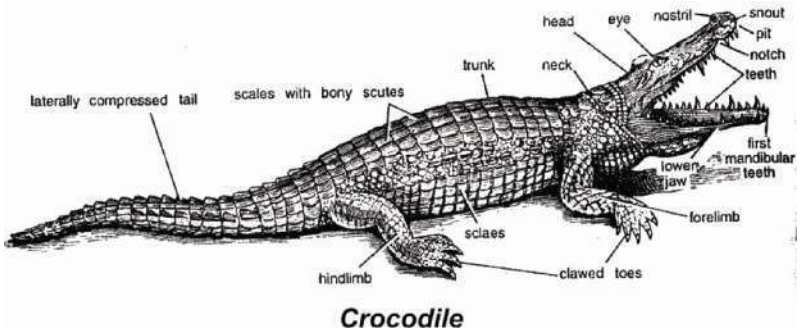
This super order is classified into

(i) Order - Crocodilia

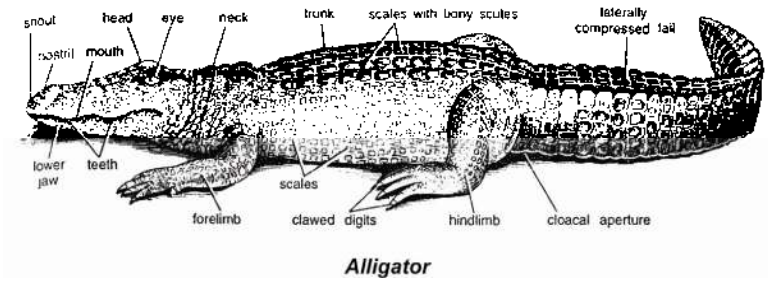
(ii) Order - Saurischia

Order - Crocodilia

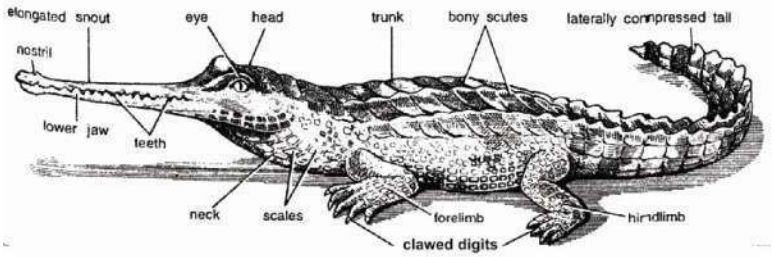
- Crocodiles, Alligator etc. are included in this order.
- Amphibious in nature.
- These are **largest modern reptiles.**
- Skin is covered by lines of **bony scutes.**
- Snout is long. External nares are situated at the distal end of snout and nares have cover also.
- Diaphragm is present in between thorax and abdomen.
- Sternum and abdominal bifid ribs are present.
- Heart is completely four chambered.
- Ventricle is completely divided into two chambers.
- Teeth are thecodont type.
- Urinary bladder **absent.**
- A median erectile grooved penis is present in male animals.
- **Crocodiluss (Crocodile) -** It is only found in Indian subcontinent.
- **Gavialis -** Gharial. Snout very long.
- ***Alligator* -** Maxican crocodile.



Crocodile



Alligator



GAVIAL OR GHARIAL (*Gavialis gangeticus*)

Differences between Crocodile, Alligator and Gavialis

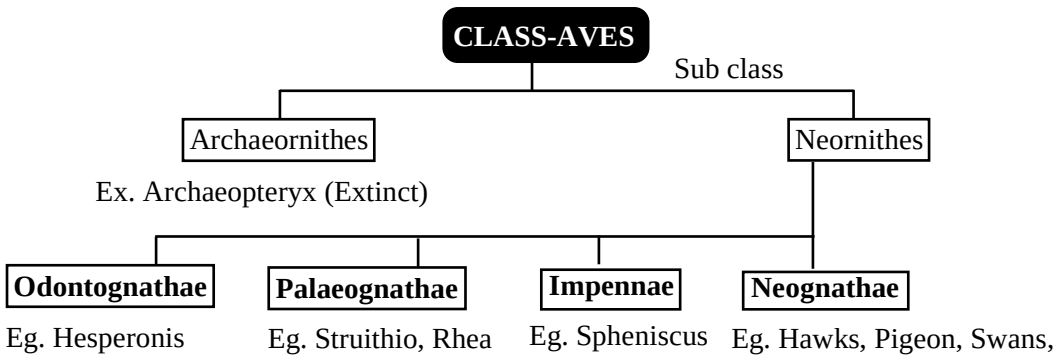
S.No.	Characters	Crocodile	Alligator	Gavialis (Gharial)
1.	Distribution	Asia, Central America, Africa, Malaya, Indonesia and North Australia.	North America, China	India. It is also found in Myanmar (Burma) Pakistan and Nepal
2.	Habits	More aggressive,dangerous to man	Less aggressive, attack when provoked.	Can eat only fish because of narrow throuat.
3.	Snout	Moderately long and pointed	Short and broad	Very long
4.	Teeth	Unequal	Very unequal	Almost equal
5.	Hump	Such structure does not develop.	Such structure does not develop.	During breeding a hollow hump (ghara-like) develops on the snout of the male. Hence it is commonly called **gharial**.

6.	Body Length	8 metres	3 metres	6 metres
7.	Colour	Olive green with black spots of bands.	Steel grey	Dark olive green
8.	Fourth mandibular tooth	Fits into a maxillary groove and visible externally.	Fits into a pit and not visible externally.	—

(C) Class – Aves :

- Originated at the end of **Jurassic period** of Mesozoic era & advancement took place in **cretaceous**
- Study of birds is known as **''Ornithology''**
- **Dr. Salim Ali** was the great ornithologist of India and known as **''Birdman of India''**
- Study of bird's egg is known as **Oology.**
- Study of bird's Nest is known as **Nidology.**
- Birds are glorified reptiles stated by **Huxley.**
- Arrangement of wings on the body of bird is known as **Pterylosis.**
- Body is boat shaped. It is divided into **head, neck, trunk** and **tail.** Neck is **long** and **flexible.**
- A cover of soft feathers **(derivative of stratum corneum)** is present all over the body, that is called **''plumage''**
- Scales are found only on **hind limbs.**
- Birds are **warm blooded** or **Homeothermic** or **endothermic animals** i.e. Body temperature remains almost constant.
- Skin is dry and without glands. But oil glands or **Preen glands** are found on tail or **Uropygium.** These glands secrete oil, which makes feathers soft and water proof.
- Two pairs of limbs are present. Birds are feathered bipeds.
- Forelimbs (with three digits) are modified into wings, which help in flying.
- Four clawed digits are found on hind limbs. these are best adapted for perching, for walking on land, or for swimming in water.
- **Oesophagus** is modified into **Crop** for quick food ingestion and storage and **Gizzard** for crushing the food which is swallowed unmasticated. **Pigeon milk** is secreted by **both sexes** (Crop product).
- Gall bladder is absent.
- A three chambered **cloaca** is present in the birds.
- Teeth are absent in jaws. Jaws are modified into horny beak. Beak is toothless. An epidermal horny sheath is present on beak, which is called **Ramphotheca.**
- Spongy lungs are present for respiration. Air sacs are also found attached to lungs forming accessory resp. organs these help in flying.
- Sound producing organ at the junction of trachea and bronchi of birds is called **syrinx.**
- Heart is four **chambered.**
- Hepatic portal system is well developed in birds, but renal portal system is vestigeal developed. Sinus venosus absent. Only Right aortic arch persist.
- R.B.Cs are **nucleated,** small and oval. No. of RBC/mm^3 is max. in among animals.
- Endoskeleton is **bony.** These bones are hollow, air is filled, and are called **pneumatic bones.** These make the body light in weight and help in flying.
- **Skull monocondylic.**
- Centrum of the vertebra is **heterocoelous. (**Saddle - Shaped**)**
- Some vertebrae of the posterior body portion join together to form **synsacrum**
- Last four caudal vertebrae fuse to form **pygostyle.**

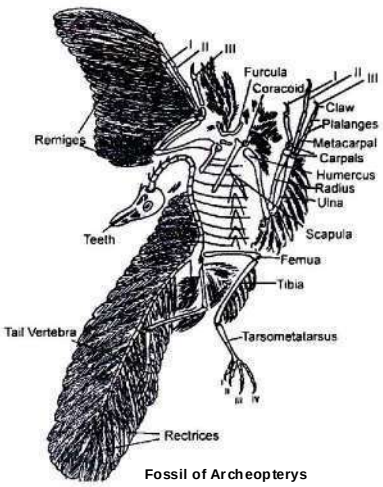
- Sternum is large. Swollen basal part of sternum is called **''Keel''** This keel offers a joint plane for **flight muscles.**
  Keel is highly developed in flying birds.
- Ribs of birds are **bifid** and **uncinate processes** are present in ribs.
- Exoskeleton is in the form of soft **feathers** all over the body (except hind limbs)
- **Foramen of triosseus** is found in their pectoral girdle.
- Two bones, **clavicle** and **interclavicle** fuse to form **V - shaped furcula or wish bone** or **Merry thought bone.** Act as a spring between two girdles .
  Furcula is **absent** in flight less birds.
- Kidneys **metanephric** (Trilobbed). Ureters open into **cloaca.**
  Members are always **Uricotelic.**
  Uric acid is a semisolid substance. Excreta of marine birds is known as **guano.**
- Most of the birds do not have **urinary bladder.**
- Brain is large, smooth, highly developed. Cerebellum is well developed for aerial mode of life.
- Cranial nerves are **12 - Pairs.**
- The skin around the nostrils is sensory in birds, that is called **''Cere''.**
- **Eyes** are large and well developed which are surrounded by rings made up of bony plates known as **Sclerotic ossicles.**
- Eyes are large and **nictitating membrane** is present. Vision is **monocular.**
- A specific comb like structure **Pecten** is found in the eyes of all birds except kiwi's eyes. Pecten helps in Acomodation of eye and provides nutrition to eye balls . It also control pressure of liquid present in eye. **Acute** and **Telescopic vision** of birds is due to pecten.
- External ears are present but ear pinnae are absent. **Columella bone** (Stapes) (one ossicle) is found in middle ear. Cochlea (not coiled) is present in internal ear.
- Olfactory organs are less - developed.
- Birds are **monodelphic** i.e. only left ovary and left oviduct is functional in females.
- Birds are **unisexual. Sexual dimorphism** is well marked. Copulatory organ absent in males.
- Fertilization is **internal, oviparous.** Eggs are **large, megalecithal, telolecithal** and **cleidoic.** Shell is perforated. Cleavage is **meroblastic** and **discoidal.**
- Embryonic development is **direct.** Birds are included under group amniota.
- **Parental care** is well marked. Young one without feather is known as **Nidiculous** and with feather is known as **Nidifugous.**



Subclass - Archaeornithes

- Primitive **''Reptile like birds''** are included in this subclass, which belong to Jurassic period. All the members have becomes extinct.

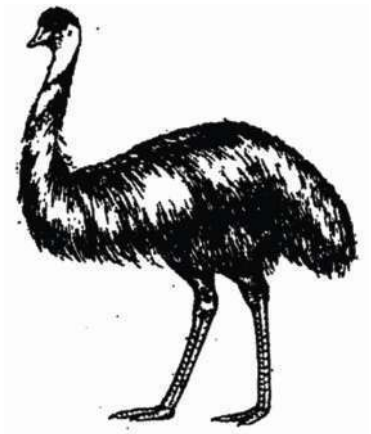
– Wings are ill developed, i.e. capacity of flying was very less.
– **Pygostyle** was **absent.**
– **Keel** on sternum was **absent.**
– There were present 3 - 3 clawed digits of forelimb at the free edges of wings.
– **Uncinate processes** on ribs were **absent.**
– Teeth were present in the jaws of skull.
– All the members of this subclass are the **connecting links** between **reptiles** and **birds.**
– **Archaeopteryx lithographica - Lizard bird.** (Extinct in Cretaceous period) Its fossil was discovered by Andreas wagner in 1861 from Bavaria (Germany).
– **Archaeornis**



Fossil of Archeopterys

Sub class - Neornithes

– This includes living as well as **extinct** birds of post jurassic period.
– Wings are well developed which are used in flying (except some birds)
– Last few vertebrae fuse to form **pygostyle.**
– Sternum is bigger and with keel.
– Digits of forelimbs are fused and claws absent.
– Thoracic ribs are having uncinate processes.
– Except some species (which are extinct) rest of the birds are toothless.
– In living members of this subclass, vertebrae are **heterocoelous.**
– Last few vertebrae joins to form pygostyle.
– This subclass is classified under four super orders.


Australian Emu
(Dromaitus novaehollandiae)

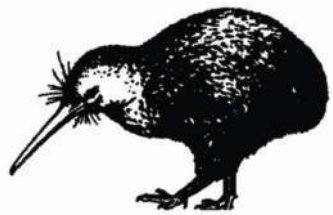
Super order - Odontognathae :-

– These extinct birds were having teeth.
– Pygostyle was absent.
– Keel in sternum is absent
– **Hesperornis** (Flightless marine bird)
Icthyornis (Flightless marine bird)

Super order - Palaeognathae or Ratitae

– It includes large and massive birds, which are flightless in nature.
These are able to run fast. Wings are reduced / rudimentary / vestigeal or absent.
– Caudal vertebrae are free and **pygostyle** is absent.
– Sternum is **raft like** which lacks **Keel.**
– Uncinate processes on ribs, **Oil glands** or **preen glands** and sound producing organ syrinx is absent.
– ***Struthio*** **-** African ostrich or Camel-bird - It is the **largest living bird** of modern period. Polygamous, male incubate the eggs (Largest egg). In this bird **urinary bladder** and **penis** is present.
– **Rhea -** South american ostrich :- It also has **urinary - bladder** and **penis.**

- **Apteryx -** Kiwi - It is National bird of New zealand. It has hair like feathers all over its body. It is smallest flightless bird.
- **Dromaeus -** Emu - It is a monogamous bird in which only males look after their young ones and eggs.
- **Aepyornis** - Elephant bird
- **Casuarius** - Cassowary (found in New Guinea/Australia)



Large grey Kiwi
(Aptery haasti)

Super order - Impennae

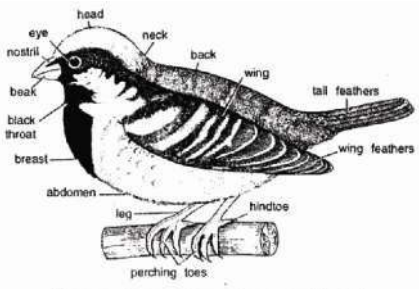
- All are **aquatic birds**
- **forelimbs** are modified into **flippers**
- Limbs are webbed.
- **Teeth** are **absent**
- **Sternum** without **keel.**
- **Spheniscus** -Penguin - It is also called **''sea bird of Antarctica''** (Emperor Penguin)
- **Aptenodytes** -Penguin

Aftrical Ostrich
(Struthio camelus)

Super order - Neognathae or Carinatae

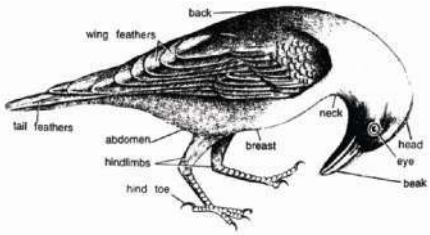
- This super order includes **flight birds** of modern era. Wings are well developed
- **Pygostyle** is present
- **Keel** in sternum is highly developed.
- Its crop glands secrete pigeon milk
- Uncintate processes at ribs are well marked.
- Oil glands or preenglands are found.
- **Toothless** beak
- Sound producing **syrinx** is present.
- ***Pavo – cristatus*** - Peacock - It is the national bird of India.
- ***Psittacula krameri*** - Indian parrot. (upper jaw movable - Psittaciformes)
- ***Columba livia*** - Blue rock pigeon its crop glandssecrete pigeon milk (columbiformes)
- **Streptopelia** - Dove
- **Passer domesticus** - Sparrow - It shows commonsalism with man.
- ***Corvus splendens*** - Crow
- **Molpaster** - Bulbul
- **Cygnus** - Swan - Aquatic bird having webbed limbs
- **Bubo bubo** - Bubo or owl or ''III of oman''
- **Cuckoo** - It lays its eggs in the nest of other birds (Crow)
- **Eudynamis** - Indian Koel (Nest - Parasitism)
- **Anas** - Duck
- **Phoenicopterus** - Flemingo
- **Alcedo** - King fisher
- **Raphus didus** - Dodo (Mauritian extinct bird in 17th centuary)

Colomba livia

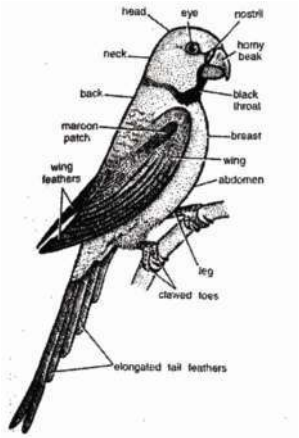


Passer domesticus (sparrow) male

– **Dinopium** - Wood pecker - Kathphorva
– **Diomedea** - **Albatross -** Marine bird with **largest wings** in flying birds.
– **Milvus** - Kite (Predatory birds)
– **Falcon** - Falcon (Predatory birds)
– **Neophron** - Vulture (Scavenger bird)
– **Choriotis-nigriceps** - Great Indian bustard. It is also called Gondavan. It is the **state bird of Rajasthan.** (local name - Godavan)
– **Helena** - Humming bird - It is also called sunbird. It feeds on nector of flowers it is the smallest bird. It is found in cuba. It can fly in forward and backward both the directions. It can fly like helicoptor. Its size is about 3 to 4 cm
– **Ploceous** - Weaver bird (Baya)
– **Micropodus** - Pitohiudicthous/pathua - It is the only poisonous bird, which is found in Newguinea.
– **Swift spine tailed** - Fastest flying bird, it is found in **Japan.**
– **Poor bill** - Bird which shows sleeping stage and undergoes hibernation. **Migratory Birds**
(Phenolosy = Study or bird migration)
– **Pluvialis dominica**- It is an American bird which migrates from south to north and from north to south.
– **Scolopax eusticoa** - It migrates from hill area to planes.
– **Himalyan partiges** - It can fly over 6000 miles
Sterna parasisaea - Champion bird - Arctic to Antarctic and back.



Corvus splendis



Psittacula euparia (parrot)

Dendrocopus mahrattensis (wood pecker)

Feathers

There are different types of feather namely

(1) **Quill** (flight feather) consists of (a) **Remiges -** feather of wings (b) **Retrices -** feather of tail

(2) **Coverts -** small just like quill for filling gap on wings & tail.

(3) **Contours -** small feather to cover the body

(4) **Filoplums -** Beneath the contours

(5) **Down feather -** Cover the body of newly hatched bird. (Filoplume and Down feather make body surface as heat - resistant.)

Differences between Ratitae and Carinatae

S.No.	Character	Super order–III Palaeognathae or Ratitae	SuperorderIV Neognathae or Carinatae
1	Distribution	Restricted, discontinuous. Not found in India	Cosmopolitan, found all over the world
2	Habitat	Terrestrial	Arboreal, terrestrial or aquatic
3	Locomotion	Flightless running birds	Flying birds
4	Size		Usually large-sized
5	Wings	Vestigial or absent	Well developed
6	Legs	Large cursorial	Variously adapted
7	Feathers	Without interlocking mechanism Barbs free	Barbs interlocked due to barbules and barbicels
11	Downfeathers	Absent	Present
12	Horny sheath of beak or marnphotheca	Divided in several pieces	Undivided
13	Oil gland	Usually absent	Present
14	Skull sutures	Remain distinct for a long time	Disappear very early
15	Type of skull	Dromaeognathous or palaeognathous	Neognathous, never dromaeognathous
16	Vomer	Large, broad, interpolated between palatines	Small, narrow, allows palatines to meet
17	Palatines	Short, do not articulate with rostrum	Long, articulate with parasphenoidal rostrum
18	Pterygoids	Immovable	Movable
19	Basipterygoid processes	Well-developed	Small or absent
20	Pygostyle	Small or absent	Well developed
21	Sternum	Plat, raft-like due to vestigial or no keel	Well-developed mid-ventral keel
22	Uncinate processes	Vestigial or absent	Present
23	Coracoid and scapula	Comparatively small, and fused at an obtuse angle	Comparatively large, not fused but meet' at an acute angle
24	Clavicles	Small or absent, no furcula	Both clavicles and interclavicle fused to form a V -shaped furcula
25	Ilium and ischium	Usually remain free posteriorly	Become fused posteriorly
26	Pelvic symphyses	Pubic in ostrich, ischiatic in rhea	Public and ischiatic symphyses absent
27	Limb bones	Not pneumatic	Pneumatic
28	Pectoral muscles	Poorly developed	Well developed
29	Caecum	Large	Small
30	Syrinx	Usually absent.	Present

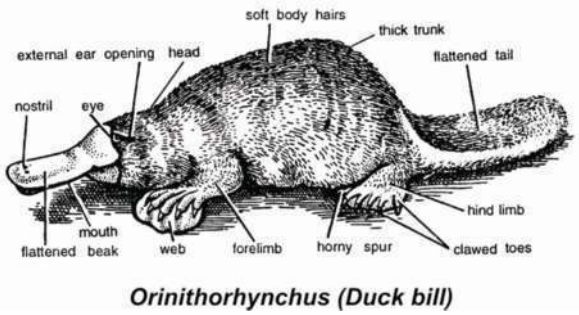
31	Air sacs	Poorly developed	Well developed
32	Penis in male	Present	Absent
33	Clitoris in female	Present	Absent
34	Eggs	Shell thick, hard. Pore canal branched	Shell thin, fragile, Pore canal unbranched
35	Newly hatched young	Precocial, not dependent on parents	Altricial, helpless dependent on parents

Types of Feet in Birds			**Types of Beaks in Birds**		
Sr.No.	**Type**	**Example**	**Sr.No.**	**Type**	**Example**
1.	Perching	Sparrow	1.	Seed eating	Sparrow
2.	Raptorial	Owl	2.	Cutting	Crow
3.	Scratching	Fowl	3.	Fruit eating	Parrot
4.	Swimming	Duck	4.	Insect eating	Hoopoe
5.	Running or cursorial	Ostrich	5.	Fish eating	Kingfisher
6.	Climbing and clinging	Woodpecker	6.	Flower probing	Humming bird
7.	Wading	Jacana and Heron	7.	Spatulate	Spoonbill
			8.	Water and mud straining	Duck
			9.	Tearing and piercing	Eagle and owl

(D) Class – Mammalia

- Evolved in **Triassic period** of Mesozoic era.
- **Coenozoic** era is **golden era of mammals.**
- Study of mammals is known as **Mammology.**
- The members of this class are **cosmopolitan,** Homeiothermal, Endothermic.
- Skin of mammals is thick, water proof, glandular
- Epidermal hairs are present. These act as thermo resistant layer and helps in maintaining internal body temperature. In aquatic mammals hairs are lost and homeothermic condition is maintained by layer of sub-cantaneous fat.
- Mainly two types of glands are found in skin - sweat and sebaceous glands.
- Sweat glands release sweat and helps in regulating body temperature. It is excretory in nature also.
- Sebaceous glands release only secretion and keep the skin and hairs water-proof.
- Body is divided into **head, neck, trunk** and **tail.**
- A horizontal, **diaphragm** is present in the body cavity of all the members of this class without any exception.
  This diaphragm is present in between thorax and abdomen.
  Diaphragm helps in **respiration, defaecation, micturition** and **parturition.**
- So many types of glands are present in the skin as **sweat glands, oil glands** or **sebaceous glands** and **mammary glands.**
- **Mammary glands** are modified sweat glands found in females for baby feeding and on the basis of this, the class mammalia was so named.
- Other skin derivatives such as **nails**, **claws** or **hoof** or horns are found, which provide protection.

- Two pairs of limbs are present in trunk. Limbs are **pentadactyle** which help in swimming, walking running etc. Hind limbs are absent in Cetacea and Sirenia.
- Alimentary canal is **complete**, Anus and urinogenital apertures are separate. Cloaca is absent except in sub class - Prototheria.
- Teeth are **Thecodont, Heterodont, diphyodont**.
- Jaw suspension is **Craniostylic type**
- Lower jaw is made up of dentary bone.
- Paired pulmonary resp. by paired lungs enclosed in pleural cavity.
- **Larynx** or sound organ is found in the trachea for the production of sound.
- Heart **four chambered.** Double circulatory system is present. No sinus venosus. Only **left aortic**/systemic.
- RBCs small, circular and **enucleated**. Family **Camilidae-Lama** and **Camel** which has **nucleated** RBCs.
- Endoskeleton is bony, skull is **dicondylic.**
- Vertebrae are **acoelous** or **amphiplatyan type** i.e. centrum is flat at both the sides. **Epiphysis** is present on either side of centrum & long bones.
- Neck is having **7 cervical vertebrae :** (**Bradypus/Sloth** has **9 or 10** cervical vertebrae and **Sea - cow/Mantees** has **6** cervical vertebrae.)
- Ribs are **bifid.**
- Paired **Metanephric** kidneys located in abdominal cavity.
- These animals are **ureotelic.**
- Brain is comparatively large and highly developed.
- **Cerebrum** and **Cerebellum** are very complex in structure and highly developed.
- **Corpus - callosum.** (Absent in Monotermes & Marsupial) connects both the cerebral hemispheres of brain
- 4 Solid optic lobes collectively known as **corpora quadrigemina** are present.
- 12 - **pairs** of cranial nerves.
- External ear is present in the form of ear pinna and auditory meatus (canal)
- **Malleus, Incus** and **stapes** are the three ear ossicles in middle ear.
- **Cochlea** of internal ear is spirally coiled. 3 pairs of semi circular canals are present.
- Unisexual animals. Testes of males are situated (out side the body) in the **scrotal sacs.** A distinct penis is present in males for copulation.
- Ovaries are found in females
- Fertilization is **internal** and it takes place in **fallopian tubes.**
- Development internal occurs in uterus. Extra embryonic membranes amnion, chorion, allantois and yolk sac are found in embryos **(Amniota).**
- Eggs are **alecithal** or **microlecithal** & **homolecithel** except eggs of prototherians **megalecithal.**
- Placenta is present, so these animals are also called placental animals.
  Placenta helps in the **nutrition, respiration** and **excretion** of embryo
- Mostly mammals are viviparous. Some mammals are oviparous [Prototherians], some mammals are ovoviviparous [Metatherians]
- Parental care is well marked in mammals.
- Living mammals are classified into three subclasses.



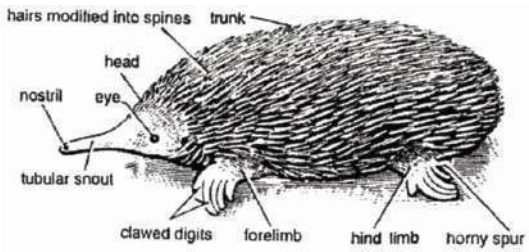
Orinithorhynchus (Duck bill)

Subclass :- Prototheria

- Primitive egg laying mammals are included.
- Eggs are large, yolky and shelled. (**Megalecitha**l)
- Mammary glands are **without nipples.**

– **Gynaecomastism** is found in these animals i.e. male and female both feed their child. Mammary glands are functional in males and females both.
– **Cloaca** is present.
– **Testes** are abdominal
– Pinnae are absent and cochlea is less coiled.
– **Corpus - callosum** is **absent** in brain.
– A toothless horny beak is found in adult animals, but teeth are present in child hood.
– These are partially homeothermic animals.
– Members of this subclass are found in **Australia, New Guinea** and **Tasmania.**

Only one order is included in this subclass.



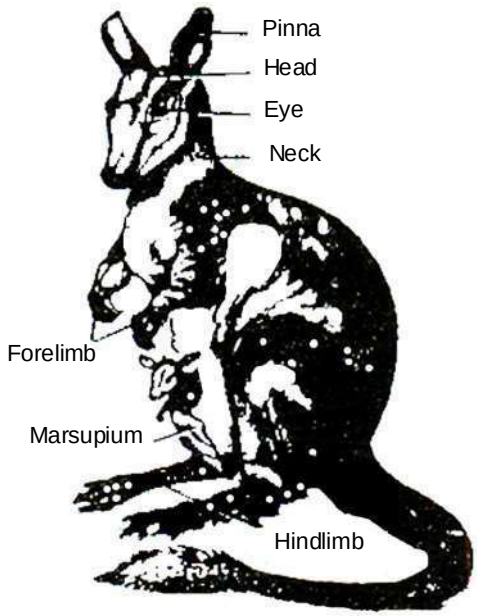
Echidna (Spiny anteater)

Order - Monotremata

Connective links between **reptiles** and **mammals.**

e.g.

– ***Ornithorhynchus*** *or* ***Duck billed platypus*** **- poison glands** are found in **male platypus.**
– **Tachyglossus** or **Echidna** or **spiny anteater.**



Kangaroo

Sub-class Metatheria or Marsupials

– An abdominal pouch called **marsupium** is found in these animals, in which immature young ones are developed till maturity.
– Mammary glands are present and **nipples** are also found on these mammary glands, these are situated in **marsupium.**
– **Two vagina, two clitoris** and **two uteri** are present in a **female** animal and bifid penis present in male.
– **Yolk sac,** placenta are found.
– Cochlea is more coiled in internal ear.
– Teeth are present in adult animals, which are **monophyodont** and **heterodont** type.
– **Corpus callosum** is also **absent.**

Only one order is included in this sub-class

Order - Marsupialia

Animals are **ovoviviparous**

– ***Macropus*** **-** Kangaroo - Found in Australia only. Saltatorial locomotion (Tail to use as body balance)
– **Didelphys** - Opossum - Found in North America. Shortest gastation period (12-13 days).
– **Dasyurus -** Tiger cat.

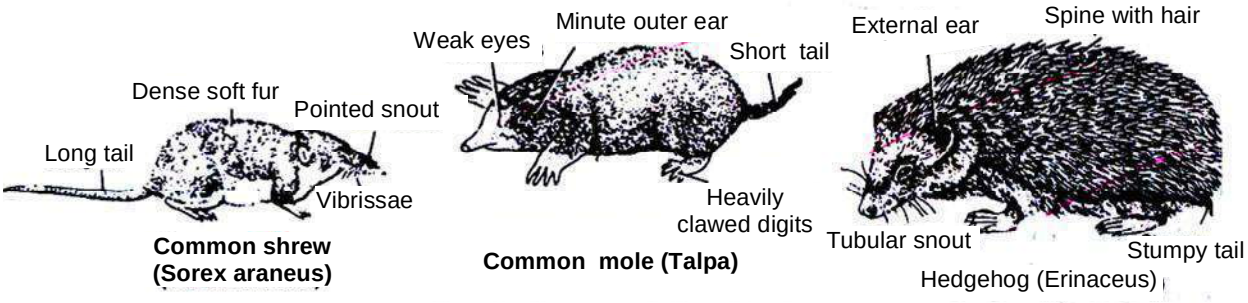
Sub-class - Eutheria

– These are **true mammals.** that give birth to a mature child. A true placenta is found, which is **Allanto-chorionic** type.
– Cochlea is highly coiled.
– Nipples are well developed in mammary glands.
– Uterus and vagina are **single** i.e. only one uterus and only one vagina are present in a female. Penis simple.
– **Corpus callosum** is found in brain.
– Completely **endothermic** animals.

Sub-class **Eutheria** is divided into **16 orders :-**

Order : Insectivora -

– These are burrowing nocturnal and insectivorous animals.



Insect eating mammals (Insectivora)

Erinaceous - Jhau - Chuha/Hedge Hog
Serox - Shrews : smallest mammals size is about 3 - inches : Chhachhunder
Talpa - Mole

Order : Dermoptera/Flying lemurs

Gliding mammals with patagium

– These are furit eaters (frugivorous)
– Only two existing sps. present.

Galeopithecus - Flying lemur

Order : Chiroptera

– In this group bats are included which can fly in air. These are true **flying mammals.**
– Skin between forelimbs and hindlimbs is expanded in the form of **patagium,** it work as wing, which helps in flying.
– Testes are abdominal.
– **Ecolocation** (Radar system) sensory system is found which helps in flying.

***Pteropus* -** Flying fox, It is a fruit eater animal.

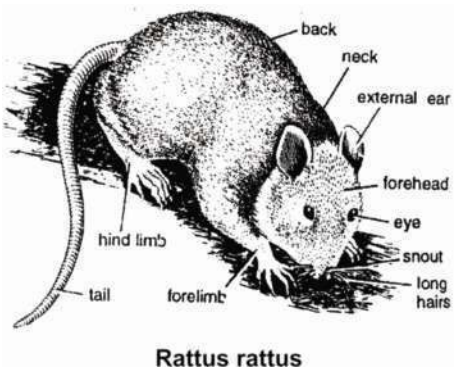
Vespertilo - Insectivorous bat, it is also called filtter mice.

Desmodus - Vampire bat, it is a **sanguivorous** animal

Order : Rodentia

– It is the biggest order in mammals
– These are small, terrestrial, herbivore or omnivore animals.
– Incisor teeth grow continuously in these animals and canines are absent, empty space of canine is called **diastema.**

Funambulus - Squirrel
Rattus rattus - Rat
Hystrix - Porcupine = Sehi = Body hair are modified into quills.
Cavia - Guinea Pig
Dipodomys - Kangaroo rat - Desert rat (Never drink water)
Beavers - Aquatic Rodents

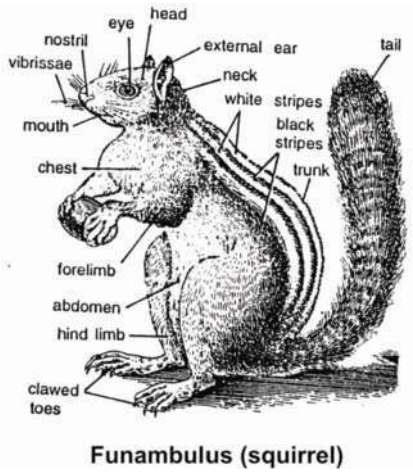


Rattus rattus

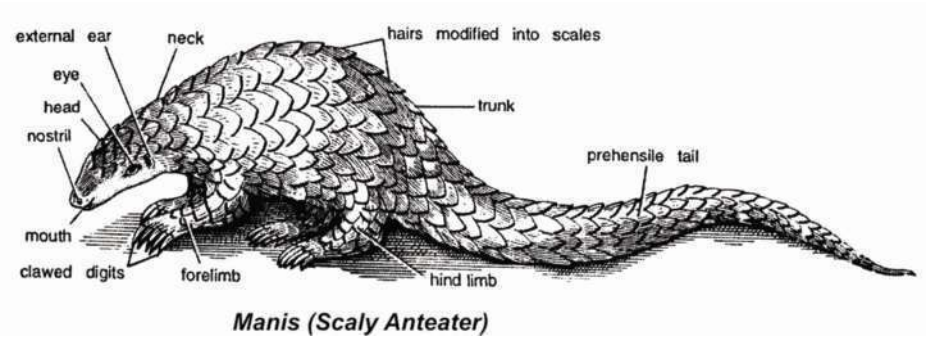
Order : Edentata (Ant - eaters)

- **Insectivorous** animals.
- Tongue of these animals is long, thin and sticky.
- Digits are clawed.
- Teeth ill developed or absent.
- It is the only mammal, which has **exoskeleton** of **bonyplates** and **horny scales.**

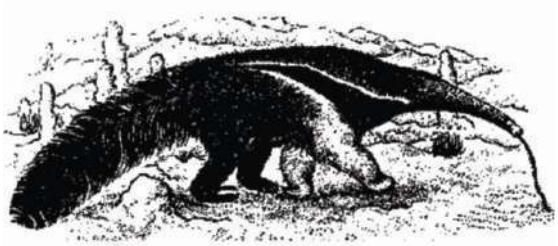
Myrmecophaga	-	Giant ant eater.
Dasypus or **Armadillo**	-	It shows **polyembryony** (4 - 8 embryoes)
Bradypus	-	Slowest animal

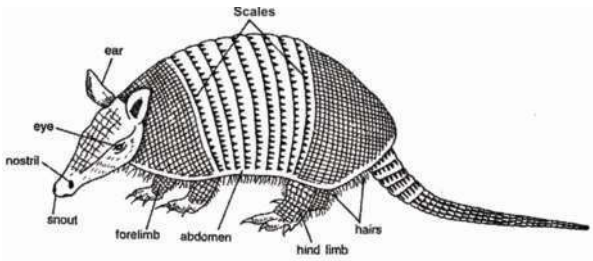


Funambulus (squirrel)



Manis (Scaly Anteater)


Great ant-eater, myrmecophaga



Dasypus

Order : Pholidota - (Scaly ant - eater)

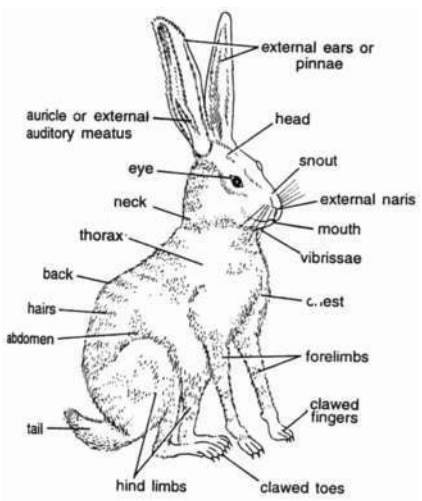
- Teeth are absent. Tongue is long.

  Manis/Pangolin - Scaly ant eater

Order : Lagomorpha

- Rodent like mammals
- Complete herbivore
- Canines absent, **diastema** is present

Oryctolagus	-	Rabbit
Lepus	-	Hare
Ochotona	-	Pika (Tail less)



Lepus (Hare)

Order : Carnivora

- Canines well developed.
- Strong and carnivorous animals.
- Upper **last premolar** and lower first molar are Specialized for tearing the flesh these are called **carnassial teeth.**

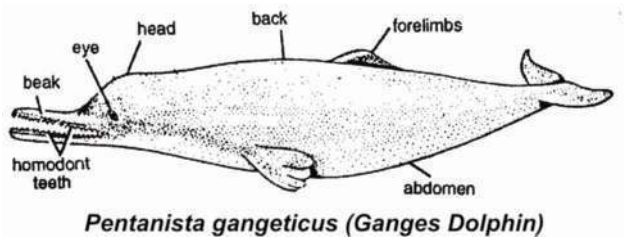
– **Digitigrade** locomotion.
– Terrestrial carnovorous animals are called **Fissipedia** & Marine carnivores are called **Pinnipedia.**

Giant Panda, Ailuropoda

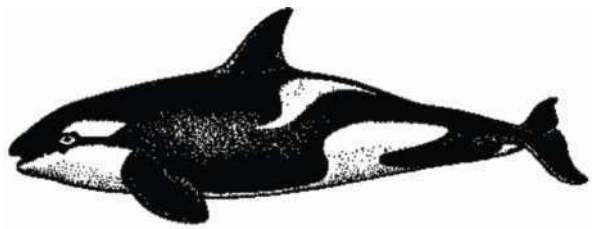
Canis familiaris	-	Domestic dog.
Felis domesticus	-	Domestic cat.
Panthera leo persica	-	Lion - Lions in India are found only in **Gir forests** of Kathiawar of Gujrat state.
Panthera pardus	-	Tendua - Panther.
Panthera tigris	-	Tiger - It is the **National animal** of India.
Acinonyx	-	Cheetah - It is the **extinct** animal of **India.**
Vulpes - bengalnensis	-	Fox.
Zalopus	-	Sea lion.
Phoca	-	Seal.
Odobenus	-	Walrus
Herpestes	-	Mangoose.
Ursus	-	Bear.
Canis lupus	-	Wolf

Order : Cetacea

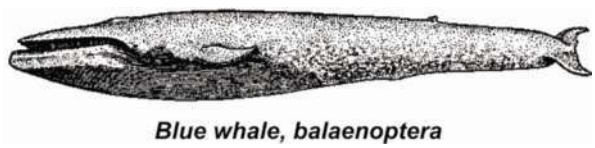
– These animals are fish like marine mammals
– **Hind limbs** absent.
– **Hairs** & **Pinnae** are absent.
– Abdominal testes.
– Females have nipples.
– A thick heat resistance layer of adipose tissue is present just beneath the skin, that is called **blubber.**



Pentanista gangeticus (Ganges Dolphin)

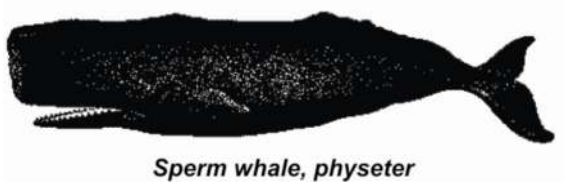

Killer, orctinus

Balaenoptera musculus - Blue whale - Found in **Antarctic ocean.** A Horny sheet called **Baleen** Plate (for filtration) is found in upper jaw instead of teeth. Milk is squirited to through of baby by the muscle contraction of mother. **Retea mirabilis** is found in thoracic region which helps in **respiration** in under water.


Blue whale, balaenoptera

Phocaena porpoise	-	Small whale
Orcinus	-	Killer whale.
Caparea	-	Pigmy whale.
Physeter	-	Sperm whale

From its intestine **Ambergris** is secreted which is used in making perfumes.


Sperm whale, physeter

Platanista gangetica	-	Dolphin - It is found in Ganga river.
Delphinus	-	Common Dolfin

Order : Sirenia

– Herbivorous aquatic animals
– Hind limbs absent.
– Pinnae absent.
– A **transverse fin** on tail.
– Big **tusk** in male.

Rhytina - Sea cow.
Trichechus - Manatee
Halicore - Dugong

Order : Tubulidentata

– Tubular mouth, Tounge Slender & Protrusible.

Orycteropus - Aardvark - It is found in Africa

Order : Proboscidia

– Includes **largest** and **heaviest** modern **terrestrial** animals.
– **Upper incisors** long, tubular form **tusks.** Canine absent.
– Molar teeth are **lophodont** type.
– Hair less, Testis found in abdomen.

Elephas - Indian elephant
Loxodonta - African elephant, it is **largest living land animal.**

Order : Hyracoidea

– Small herbivore animals like rabbit
– **Plantigrade** animals

Hyrax - It is found in Asia and Africa.

Order : Artiodactyla

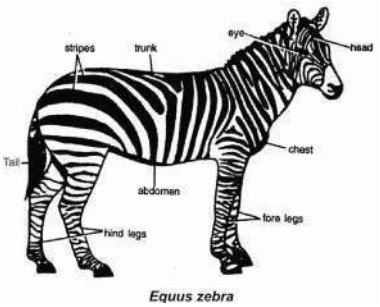
– Stomach is four chambered, (ruminant stomach) it helps these animals in **rumination** (Cud-chewing). All animals are Ruminant except pig and Hippopotamus (Nonruminant). **Eventoed ungulate** animals.

Bos indicus - Cow
Bubalus bubalus - Buffalow
Camelus - Camel [RBC nucleated]
Sus - Pig
Capra - Goat
Ovis - Sheep
Bos mutus/ - Yak
Cervus - Dear
Camelo paradelis - Girrafe
Moschus moschiferus - Musk dear (Smallest RBC)

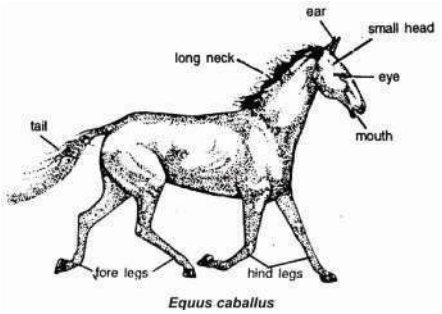
Order : Perissodactyla

– Limbs long, which have 1 or 3 digits with hooves. These are fast runners.
– Odd toed animals

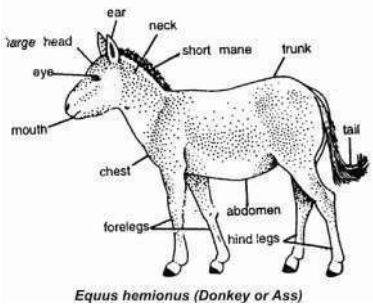
Equus caballus - Horse
Equus asinus - Donkey
Equus hemionus - Indian Donkey
Equus zebra - Zebra
Rhinoceros unicornis - Rhino - Single horn Genda. It is found in Kaziranga National Park Jorhat, Assam Rhino posses keratin hornoversnout.



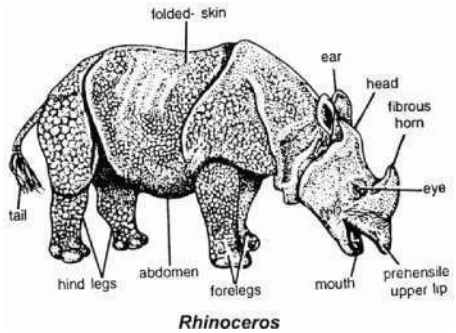
Equus zebra



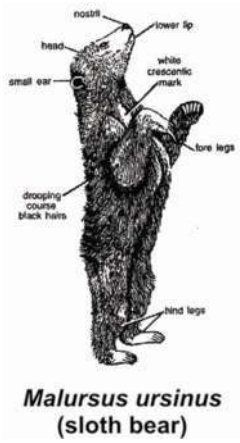
Equus caballus



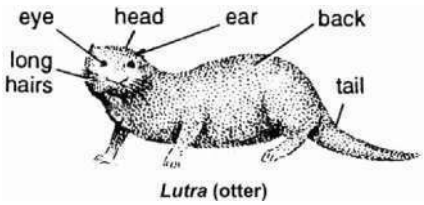
Equus hemionus (Donkey or Ass)



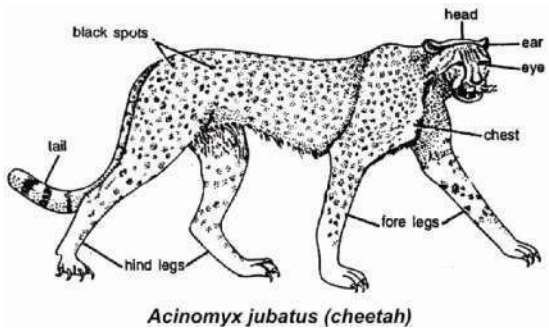
Rhinoceros



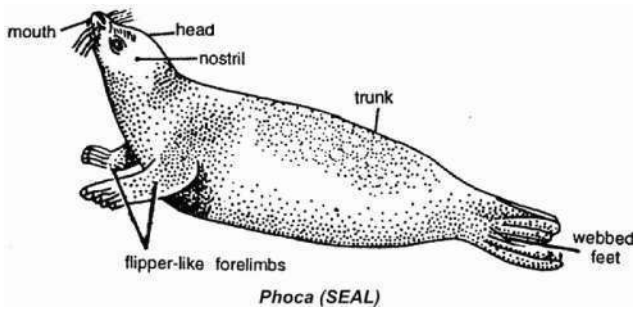
Malursus ursinus
(sloth bear)



Lutra (otter)



Acinomyx jubatus (cheetah)



Phoca (SEAL)

Order : Primates

– Most developed mammals. Plantigrade, large and highly convoluted cerebral hemispheres. It includes most intelligence animals e.g. man, monkeys, lemur, apes, gibbons, gorilla chimpangee.

(a) Prosimians

– **Nycticebus** - Lemur
– **Loris** - Loris (tail less)
– **Tarsius** - Tarsier

(b) Simians

– **Macaca mulalta** - Rhesus monkey
– **Semnopithecus** - Baboon

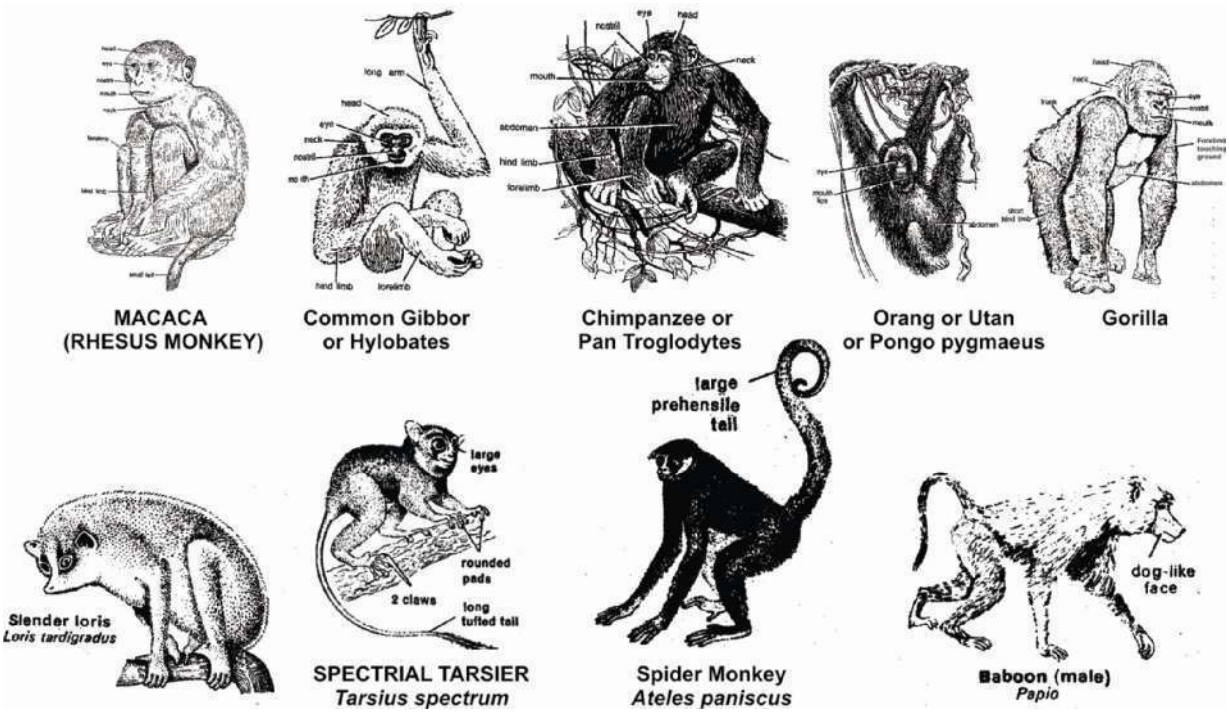
} (Monkey of old world catarrhini)

– **Atles** - Spider monkey (Prehensile tail) } Monkey of modern world. (Platrrhini)

– **Hylobates** - Gibbon - smallest ape. (found in India)
Only ape found india-Hoolock gibben

– **Gorila** - Largest ape.
– **Pan chimpanzee** - Most intelligent in apes
– **Oranguttan** - Man of forest (found in Indonesia)
– **Homo sapiens** - Man

} Ape



DIFFERENCE BETWEEN PROTOTHERIA, METATHERIA & EUTHERIA

S.No.	Prototheria	Metatheria	Eutheria
1	Most primitive and oviparous mammals.	Viviparous animals but young one born immature	Viviparous which give birth to mature younger one.
2	No care of egg but young ones are nourished by parents	Immature embryo young ones are carried in marsupium pouch	Young ones are looked after by mother but marsupium parents absent
3	Placenta is absent	Yolk sac placenta is present	True allantochorion placenta
4	Eggs are large; yolky and shelled	Eggs are small; yolkless Without shell	Eggs are small; yolkless and without shell
5	Meroblastic cleavage	Holoblastic cleavage	Holoblastic cleavage
6	Mammary glands without nipples	Mammary gland present in marsupium with teats	Mammary glands with well developed teats (nipples)
7	Pinna is absent	Pinna present	Pinna present
8	Teeth only in young ones i.e. Monophyodont.	Teeth only in adult stage i.e. monophyodont young ones	Teeth arises twice i.e. diphyodont.
9	Cloaca present	Cloacal aperture absent	Cloaca is absent
10	Testis abdominal	Testis extra abdominal lie in front of penis	Testis extra abdominal lie behind penis.
11	A mammalian penis absent	Penis is present sometimes bifid	Penis well developed
12	The two oviduct remain distinct and no differentiation in uteri and vagina	There are two uteri and two vagina but remain distinct/seperate	A single uterus & two vagina fuse to form single vagina
13	Uterus open into urinary bladder	Ureters open into the urinary bladder	Ureters open into urinary bladder

14	Corpus callosum absent	Corpus callosum absent/poor	Corpus callosum present
15	Cerebrum and cerebellum less developed	Poorly developed	Cerebrum and cerebellum are well develoed
16	Internal ear with less coiled	Cochelea is coiled	Cochelea is more coiled
18	Tympanic bulla absent	Tympanic bulla formed of alisphenoid	Tympanic bulla formed of periotec
19	Epiphysis absent	Epiphysis present between the vertebrae	Epiphysis present between the Vertebrae long bones
21	T. shaped interclavical	Inter clavical absent	Inter clavical absent

COMPARISON BETWEEN LEMUROIDEA, TARSIOIDEA AND ANTHROPOIDEA

S. No.	Characters	Suborder 1 Lemuroldea (Llemures, ghost)	Suborder 2 Tarsloldea (Gr., tarsus, first foot)	Suborder 3 Arthropoidea (Gr. anthropos man)
1	Status	Primitive or lowest	Slightly advanced	Most advanced,
2	Distribution	Madagascar, Africa, Southeastern Asia.	Philippines and adjacent islands.	World wide
3	Habits and habitat	Arboreal, mostly nocturnal omnivorous, solitary	mainly insectivorous.	Arboreal, nocturnal, solitary, Atboreal or tene gregarious,
4	Snout	Usually elongated	Shortened	Short-faced.
5	Eyes and vision	Usually lateral. Vision poor	Large protruding forward eyes. Vision good.	Forward with great power of vision (stereoscopic)
6	Tail	Long, nonprehensile, Sometimes lacking	Long, tufted, non-prehensile	Usually prehensile when present
7	Digits	Second toe with claw, others with flat nails.	2 toes with claws, 3 with nails. Tips of all digits bear rounded pads	All digits with nails
8	Dental formula	$\frac{2.1.3.3}{2.1.3.3} = 36$	$\frac{2.1.3.3}{1.1.3.3} = 34$	$\frac{2.1.2.3}{2.1.2.3} = 32$
9	Orbit	Confluent with temporal fossa.	Communicates by a wide fissure with temporal fossa.	Separated from temporal fossa by a bone
10	Cerebellum	Not covered by cerebrum	Not covered.	Covered by highly developed cerebrum.
11	Uterus	Duplex	Bicornuate	Simplex
12	Clitoris	Traversed by urethra.	Traversed by urethra	Not traversed
13	Placenta	Diffused and non deciduate	Metadiscoidal and deciduate	Metadiscoidal and haemochorial.
14	Examples	Tree shrew *(Tupaia) Aye-Aye (Cheiromys = Daubentonia), lemurs (Lemur), loris (Loris)*	Only single genus with 3 species Spectral tarsier (Tarsius spectrum).	New World and Old World Mookeys, apes and man

COMPARISON BETWEEN PLATYRRHINA AND CATARRHINA

S.N.	Characters	Infraorder Platyrrhlna (New world monkeys)	Infraorder'Catarrhlna (Old World monkeys, apes, man)
1	Distribution	Central and South America.	Africa and Asia.
2	Habitat	Mainly arboreal	Arboreal or terrestrial
3	Size	Relatively small	Relatively large
4	Nose	Nose flat. Internal septum broad, Nostrils widely separated and directed sideward	Nose raised, Internasal septum narrow. Nostrils close together and face downwards.
5	Cheek pouches	Absent	Present except in apes.
6	Tail	Long, usually prehensile	When present, not prehensile.
7	Ischial callosities	Ischial callosities on buttocks absent	Callosities on buttocks present
8	Bony auditory meatus	Poorly developed	Well developed
9	Tympanic bulla	Well developed	Poorly developed.
10	Dental formula	Premolors 3.	Premolars 2.
11	Sigmoid flexure	Poorly developed	Well developed
12	Placenta	Not secondary discoidal	Secondary discoidal
13	Offsprings	Usually more than one	Usually one
14	Examples	Spider monkey *(Ateles)*, howling mookey (Aloutta), capuchin (Cebus), mannoset (Callithrix).	Rhesus monkey *(Macaca)*, langur (Presbytis = Semnopithecus), gibbon (Hylobates), baboon (Papio), orang-utan, (Pango = Simia), chimpanzee (Pan = Anthropilhecus) , gorilla (Gorilla), Human (Homo sapiens).

SUMMARY OF ANIMAL CLASSIFICATION – CHORDATA

PHYLUM CHORDATA

Dignostic Characters

1. Notochord.
2. Dorsal Hollow Central Nervous System.
3. Pharyangeal Gill Slits.
4. Tail.

Sub-Phylum 1. Urochordata (Gr. Uros = tail + chordata = notochord). This sub-phylum is also called **Tunicata** because the adult body is enclosed within a leathery test of tunic formed of a cellulose-like organic substance termed **Tunicin.** The notochord is only present in the tail of the larva (hence named urochordata) and disappears in the adult. The dorsal tubular nerve cord is found in the larva. It is replaced by a dorsal ganglion in the adult. The larva (tadpole) undergoes **retrogressive metamorphosis,** i.e., chage from better devolped larva to less developed adult, e.g., Herdmania (Sea Squirt), Doliolum, Salpa, Botryllus (colonial urochordate). Molgula, pyrosoma-colonial urochorate. Pyrosoma is known for its powerful light with which is shines.

SUb-Phylum 2. Cephalochordata or Aeraniata. (Gr. cephalos = head + chordata = notochord) The notochord persists throughout life. The tail is present throughout life, e.g., Branchiostoma (= Amphioxus). Amphioxus has both ends pointede like hence it is commonly called **lancelet .**

SUb-Phylum 3. Vertebrata or Craniata- These are advance chordates that have cranium (Brain Box) around brain. Notochord is only present in the embryonic stae. it replaced by vertebral column (back bone) in the adult forms. **Paired appendages** are never more than two pairs. There is very high degree of cephalization (formation of head). The epidermis consists of may layers of cell. Epidermis may bear an exoskeleton of scales, feathers of hair. Heart is ventrally situated and there is present hepatic portal system. In many vertebrates renal portal system and pituitary portal system are also present. There is closed circulatory system consisting of blood corpuscles. Red blood corpuscles contain haemoglobin. Nervous system consists of central nervous system (brain and spinal cord), peripheral nerous system (cranial and spinal nerves) and autonomic nervous system(sympathetic and parasympathtic nervous systems). Subphylum vertebrata is divided into two sections : Agnatha and Gnathostomata.

Agnatha (The Jawless Vertebrates). They are most primitive of all craniates. The mouth does not possess jaws hence named agnatha. Notochord persists throughout life. Vertebral column is represented only by small imperfect neural archs over the notochord. They do not have exoskeleton and paired appendages. They have single nostril, Internal ear have one or two semi-circular canals. They are cold blooded. Agnatha has a single class named cyclostomata.

CLASS CYCLOSTOMATA – The Circular mouthed fishes (Gr. cyklos = circular ; stome = mouth)

General Characters – The mouth is circular is circular and Jawless. They are also called jawless fishes. Body is cell like but tail is compressed. Skin is soft and is without scales. Head and brain are poorly developed. Unpaired fins are present. Paired fins and associated girdles are absent. Endoskeleton is cartilaginous. Kindneys are mesonephric. Respiratiory organs are gills.

Heart is two chambered (one auricle and one ventricle) Lateral line sense organs are present. Fertilization is external. Life history may include a larval stage. They are mostly parasites on some fishes. Lamprey attaches itself to some fishes and sucks blood from them. In some places they aggect fish production e.g., petromyzon (lamprey), Myxine (Hag fish).

Gnathostomata (The Jawed Vertebrates). It includes advanced vertebrates. Embryonic notochord is usually replaced in adult by a vertebral column. Paired fins or limbs are present. Mouth has jaws hence it is named gnathostomata. Paired nostrils are present. Internal ear has three semicircular canals. ***Gnathostomata*** is divided into two super classes : **Pisces and Tetrapoda** .

Super class 1 Pisces. It includes true fishes. All are aquatic body bears fins. Repiration occurs typically by gills. They are cold blooded, Each eye has a well developed nictitating membrane. Super class Pisces is divided into three classes.

Class1.Placodermi. It includes the earliest fossil fishes which in lived fresh water. Body had an external protective armour of bony scales or plates. Primitive jaws with teeth were present. Skeleton was bony. Fins were mostly formed of large spines, e.g., *Climatius*.

Class 2. Chondrichthyes. This class includes cartilaginous fish, e.g., Scoliodon, Torpedo, Chimaera.

Class 3. Osteichthyes. It includes bony fish, e.g.m Labeo, Hippocampus, etc.

Tetrapoda is divided into four classes : **Amphibia, Reptillia, Aves and mammalia.**

Class Chondrichthyes- The Cartilaginous Fishes (Gk. chondros = cartilage; ichthys = fish)

General Characters-

The fishes of this class bear catilaginous endoskeleton. They are cold blooded (ectothermic). The exoskeleton consists of **placoid scales**, which are dermal in origin. Except in the Chimaeras, the gills are not covered by an operculum (gill cover). Jaws are well developed. Mouth is entrally placed. A spiral valve called scroll valve is usually present in the intestine. The digestive tract leads into the cloaca. External nares are present on the ventral side of the head. The internal nares are lacking. Paired fins are broad. The caudal fin is mostly **heterocercal.** Heart is two chambered (one auricle and one ventricle). Heart has a well developed sinus venosus and conus arteriosus. There is well developed renal portal system. Urea is chief nitrogenous waste. The brian bears large olfactory lobel and a large cerebellum. There are 10 pairs of cranial nerves. Laternal line system is well deveolped . Lung or air bladder is absent in these fishes. They haved cloaca. Male usually has claspers which are used in copulation. The fertilization is internal. They are oviparous or ovivivipparous (produce eggs which hatch out in mother's uterus).

Class Osteichthyes–The Bony Fishes (Gk. Osten = bone; ichthys = fish)

General Characters- The endoskelton is cartilaginous in the embryonic stage, but in he adult forms more or less it is replaced by bones. They are ectothermic (cold blooded). Caudal fin usually **homocercal.** The exoskeleton, if present comprises cycloid, ctenoid or gonoid scales. Scales are mesodermal in External nares lie on the dorsal surface of the snout. In lung fishes internal nares are also present. A swim bladder is usally present. It faciliatates floating and may function as a respiratory organ. Gills a covered by an operculum. The heart is 2-chambered and has sinus venosus and conus arteriosus. Lung fishes have three chambered heart. (Two auricles and one ventricle). They have well developed renal portal system. Kindneys are mesonepheric. Ammonia is chief nitrogenous waste. There are present 10 pairs of cranial nerves. The brain relatively small olfactory lobes and cerebellum. Lateral line system is well developed.

Common Food Fishes of India-Fresh Water Food Fishes- Labeo rohita (Rohu), Labeo calbasu (Calbasu, Catla catla (Catla), Cirrihina marigala (Mrigal), Mystus seenghala (Singhara), Wallago attu (Malhi), Notopterus chitala (Chital), Ophiocephalus striatus (Daula), Cyprinus carpio (Common Carp) **Marine Water Food Fishes-** Stromateus (Pomfret), Harpodon (Bombay Duck), Sardinella (Salmon), Hilsa (Hilsa), Anguilla (Eel)

CLASS AMPHIBIA – The Vertebrates with Dual - life (Gk. Amphi = Two or both; bois = life)

General Characters- They are the first cold blooded vertebrates from evolution point of view which came to the land. They are amphibious in nature, viz, they can live on and as well as in water. They are mostly found in warm countries. They are ectothermic (cold blooded). They are usually without scales, but if present they are hide beneath the skin (e.g., **Caecilians**)/ Paired fins are absent. Unpaired fins may be present. Two pairs of limbs are used for locomotion. The gills are present at least in the larval stage; some adult forms also carry also carry them in addition to lunge (e.g. Necturus). Skull is diccondylic, i.e., with two occipital condyles for articulation with vertebral column. The heart is three chambered, having two auricles and one ventricel. In the heart, there are present sinus venosus and truncus arteriosus. Both hepatic portal and renal portal systems are well developed. Kindneys are mesonephric.Urinary bladder is present in frog. Larvae and tailed amphibians (e.g., Salamanders) are ammonotelic. Frogs and toads are ureotelic. Ear consistrs of internal and middle ear. Tympanum (outer membrane) covers the middle ear. Ten pairs of cranial nerves are present. Lateral line system is found during their development. They return to water for breeding. Lacks copulatory organs. The metamorphosis is usually present. A Fish like stage, the tadpole is present. They occur only in fresh water and moist land. Amphibians are not found in sea water. Living amphibians are divided into three orders.

Order 1. Apoda (Gymnophiona or Caecilia)- Limbless, Scales present, e.g., Uraeoty- Phlus, Ichthyophis. They are called "blind worm'' or caecillians.

Order 2. Urodela (Caudata). Tail present, e.g., Necturus (Mud puppy), Amphiuma (Congo-eel), Salmandra (Salamander), Trilotriton (Indian Salamander) , Proteus (Blind Salamander), Siren (Mudeel) Ambystoma tigrinum (Tiger Salamander), Triturus (European large crested Newt).

Order 3. Anura (Salientia)- Without tail, e.g., Rana(Common frog), Rhacoporus (flying frog), Bufo (Common toad), Hyla (Tree frog), Alytes (Midwife frog), Xenopus (African toad), Pipa (Surinam toad).

Many frogs and toads show **parental care.** The female surinam toad (Pipa) carries the tadpoles in special pitas in its back till the tadpoles ae ready to hatch. Ichthyophis.

CLASS REPTILIA – The creeping vertebrates(L.Reptare = to creep)

General Characters- Resptiles are the creeping and burrowing cold blooded vertebrates bearing epidermal scales. They are ectothermic (cold-blooded) and are found mostly in the warmer parts of the world. They are few in colder parts. Skull is **monocondylic,** i.e., with single occipital condyle. Except in snakes, there are two pairs of pentadactyl limbs, each with 5 digits bearing claws-tetrapodus pentadactyl type. Heart consists of two auricles and a partyl system is less developed. Kindneys are **metanephric.**Urinary bladder may be present. Crocodiles are ammonotelic. Turtles and alligators are ureotelic. Lizards and snakes are uricotelic. Twelve pairs of cranial nerves are present. Snales do not possess ears. The laternal line system is altogether absent. Tortoises feed almost entirely on vegetation. Some turtles are flesh eaters. All other reptiles are carnivorous/insectivorous. A typical cloaca is present.

Living Reptiles are divide as follows; **Subclass1.Anapsida** : Skull has a soild bony roof; notemporal vacuities. It includes only single living **order chelonia** e.g., Chelone (turtle), Testudo (Tortoise), Trionyx (Terrapin)–soft shelled turtle of Indian rivers. **Sub class 2. Diapsida :** Skull has two temporal vacuities. It includes three living orders. **Order1 Rhynchocephalia e.g.,** Sphenodon (Tuatara)–a living fossil, **order 2 Squamata.** It includes two suborder: **suborder 1. Lacertillia (Sauria)** e.g., Lizards. Sub order 2. Ophidia e.g., snakes. **Order 3. Crocodilia** e.g., Crocodsiles, Alligators, Gavialis ("Gharial").

CLASS AVES- The Birds (L.Avis = Bird)

General Characters- Birds are bipedal feathere and warm blooded (endothermal, Sternothermal or homoiothermal) Animal. Their fore-limbs are modified into **wings.** The hind-limbs are adapted for perchin, walking or swimming, etc., and usually bear four, sometimes three and rarely two toes. Except **uropygial gland** (oil gland) , on the tail, no skin gland is present. Ostrich and parrot lack oil gland. The upper and lower jaws are modified into beak, which lacks teeth. Beaks are adapted to many ways of feeding; seed-crushiung, fruit-scooping, flesh-tearing, nector-spining, wood-chiselling and so on. The alimentary canal has additional chambers, the crop and gizzard. The crop stores and softens the food, however, the gizzard helps in crushing and churning the food. There is a **cloacal aperture.** Gall bladder is absent in some seed-eating birds (graminivorous) such as pigeons. The lungs are spongy and in elastic. Air sacs are connected with the lungs. The larynx does not act as a voice box. Voice is produced by a special organ, **the syrinx.** The heart is four-chambered Sinus venosus is absent. Renal protal system is very much reduced. ed blood corpuscles are nucleated, oval and biconvex. The kidneys are **metanephric** which drain the nitrogenous waste matter (chiefly uric acid) into cloaca through the uraters. Urinary bladder is absent except **Rhea americana** (American Rhea- also called "South American Ostrich". This is the only bird that has urinary bladder). Brain is better developed than that of reptiles, of which cerebrum, cerebellum and optic lobes are quite large. Birds has 12 pairs of cranial nerves. Birds have a keen, sense of sight. Sense of smell is usually poor developed. Ear openings are present. Each ear consists of three parts : external, middle and inernal.

The bones are **Pneumatic**, viz, they have air cavities to reduce weight. There is no bone marrow. The skull is **dylic** i.e., with one occipital condyle. Cervical (neck) vertebrae are from 11 to 25. Sternum is usually large and with a median keel for the attachment of flight muscles. Female has usually well developed single left ovary and oviduct are present. they are vestigial (nonfunctional). **Sexual dimorphism** is found in many birds. Fertilization is internal. All birds are oviparous. Eggs are large with much yolk and hard calcareous shell. Eggs are incubated at the body temperature by the parents. Four **embryonic membranes** (e.g., chorion, amnion, allantois and yolk sac) are formed. The birds are the most beautiful among the animals. They show courtship, nest building, parental care, migration and territorial behaviour. Class Aves is divided into two subclasses :

Subclass I Archaeornithes. Extinct, toothed beak, tail long lizard like e.g., Archaeopteryx.

SubclassII. Anas (Duck), Columba (Pigeon), Gallus (Fowl), Tyto (Owl), Milvus (Kite), Pavo(Peacock, House sparrow). Darwin Finchess–Dodo was pigeon-like bird which became extinct during 17th century in mauritius.

CLASS MAMMALIA–The Mammals(L. Mamma = Breast)

General Characters- these animals are warm blooded, hairy and have mammary or milk producing glands. They are the only animals which nourish their young ones with milk. Oil glands (sebaceous glands) and sweat glands (sudoriferous glands) are present in the skin. Teeth are of different types (beterodoot) and are embedded in the subjects of jaws (thecodont). These are developed twice during the life-time of the a Jumal (dipbyodoot), milk and permanent teeth. Teeth occur in both the jaws. Except a few, mammals possess seven cervical (neck) vertebrae. They possess a muscular diaphragm dividing trunk into thorax and abdomen. The heart is four chambered. sinus venosus is absent. The red blood corpuscles are without nucleus, Renal portal system is absent. The brain has large cerebrum and connects the two cerebral hemispheres internally. 12 pairs of cranial nerves are present.

Each ear consists of three parts external, middle and internal. Pinna is a part of external ear. Middle ear has 3 bony ear ossicles (malleous-hammer shaped, incus-anvil **shaped and stapes-** stirrup shaped). Internal ear has organ of *Corti-actual hearing organ. The kindneys are **metanephric** type, the cloaca is absent except in monotremes (egg laying mammals). Main excretory matter is urea. Ureters open into the urinary bladder. A copulating organ (penis) is always present. Fertilization is internal. Except egg laying mammals they are viviparous. There are [present four embryonic membranes : chorion, amnion, allantois and yolk sac. Except egg laying mammals a well developed is present.

Classification- Living mammals are divided into two sub-classes

1. **Sub-class Protoheria-** Prototherians are considered to be the most primitive mammals which are only restricted in Australia and its neighbouring islands (Tasmania, New Guinea). They lay eggs containing ample amount of yolk. They have cloaca. Subclass Prototheria includes **one order Monotremata** e.g., Orinithorhynchus (Duck billed paltypus), Echidna (spiny ant eater).
2. **Sub-class Theria-** They produce young ones. subclass theria is divided into two infraclasses; Metatheria and Eutheria.

I. Infra Class Metatheria- Now they are found mainly in Australia, New Guinea and South America. Females have a marsupium or brood-pouch for rearing the young ones. Infra-class metatheria includes in order Marsupialia. Mammals of this order are called marsupials or pouched mammals, e.g., Macropus (Kangaroo), Didelphis (Opossum) and Phascolarctos (Koala).

II. Infra-calss Eutheria- They are, provided with true placenta, hence called placental mammals. The embryos are retained in the uterus (womb) till an advanced stage. Some of the principal orders of placental mammals are briefly described here.

1. **Order Insectivora.** (L. insectum = insect, vorare = to eat). These are insect eating mammals and are most primitive palcental mammals. Testes are abdominal. The water shrew is the thiniest mammal which is large as a human thumb e.g., shrews, moles and hedgehogs.
2. **Order Dermoptera** (Gr. derm = skin, pteron-wing) A hairy skin fold called patagium extends like a parachute from neck to tail for gliding. All the four limbs are similar. These are nocturnal and arboreal (tree living) forms feeding upon leaves and fruits e.g., Flying foxes (larger than bats), vampire bats. These are small bats that suck blood of mammals such, as cattle and horses. They also attack man. These bats also spread certain diseases.
3. **Order Chiroptera.** (Gk. Cheiros = hand, potron = wing) They are aerial mammals. The forelimbs are modified into wings. The vampire bats feed on the blood, of man and mammals. Bats can echo-locate and capture flying insects in th dark e.g., Bats and Flying foxes (larger than bats), vampire bats. These are small bats that suck blood of mammals such, as cattle and horses. They also attack man. These bats also spread certain diseases.
4. **Order Edentata** (L. Edentaus = toothless). They are toothiess of with poorly developed molars. This order includes th armadillos and sloths of .South America.
5. **Order Pholidota.** (Gk. *Pholis* = a horny scale). The body of these mammals is covered with overlapping horny scales with sparse hair in between. Teeth are absent e.g., Mains (scalyant eater or pangolin).
6. **Order Promates** (L. *Primus* = of the first rank). Primates have highly developed brain. The living primates includs prosimians (meaning before monkeys) and simians. The prosimians include lemurs, lorises and tarsiers. The simians include monkeys, apes and man.
7. **Order Rodentia.** (L. *rodo = gnaw).* They have one pair if sharp chisel-like incisors in each jaw. The Canines are absent, leaving a toothless space, the diastema, in the jaw e.g., rats, mice, beavers, squirrels, guinea-pigs and procupines.
8. **Order Lagomorpha.** (L. *Logos* = hare , morphe = form). They have two pairs of incisors in the upper jaw and one pair of incisors in the lower jaw e.g., rabbits and hares.
9. **Order Cetacea.** (L. *Cetus* = whale). They have fish-like body, well adapted for aquatic life. They have fin-like fore limbs, but no hind limbs. Testes are abdiminal. the skin has thick layer of fat called blubber serving as reserve food, an insulator for reducing the specific gravity. Pinnae are reduced of absent. Hair are only on lips. They do not have sweat and oil glands e.g., Whales, Dolphins and porpoises. Blue whale is the largest living animal. Whales normally lack pelvic girdle and hind limbs. The Green land whales, however, possess vestiges of pelvic girdles and bones of hind limbs inside the body.
10. **Order Carnivora.** (L. Caro =Flesh, vorare = to eat.) They are flesh eating mammals. These animals have sharp pointed canines, strong jaws and well developed claws e.g., dog, cat, wolf, jackal, fox, cheetah, lion, tiger, hyaena, mongoose, bear, panda, otter, seal, walrus, sea lion. Cheetah is the fastest runner. It can cover a distance of 120 Km in one hour.
11. **Order Proboscidea.** (Gk. *Pro* = in front, boskein = They have a long muscular proboscis or trunk. The trunk is formed by nose and upper lip. They also have long tusks which are modified incisor. Canines are absent. They are tusks e.g., Manatee, Seacow.

12. **Order Proboscidea.** (Gk. Siren = sea nymph). They are herbivorous aquatic mammals with fin-like forelimbs and no hind limbs. They do not have hair and external ears. They have thick blubber. Testes are abdominal. The males have tusks e.g., Manatee, Seacws.

13. **Order Perissodactyla** (Gk. *Perissos* = odd, dactylos = toes). They are herbivorous odd toed hoofed mammals. It means they are unglates (L. ungula = hoof) or hoofed which have an odd number or toes **(lor3).** True horns with a bony core are never present. The stomach is of non-ruminating type (these are not cud chewing animals) e.g., horses, asses, mule, zebra, tapirs and rhinoceros.

14. **Order Artiodactyla** (Gk. artios = even, dactylos = digit). They are herbivorous even toed hoofed mammals. It means they are ungulates (hoofed) which have even number of toes (2 or 4). True horns of antlers are present in many animals of this order. Many even toed hoofed mammals like cow and camal are ruminants or cud-chewing. The four chambered stomach of cow is capable of digest ; 1g cellulose of plant materials by micro-organisms present in the rumen (first part of their stomach) e.g., cows, buffaloes, sheep, goats, deer, antelopes, camels, giraffes, pigs, and hippopotamus.

SPECIAL POINTS

FISHES- *Gambusia fish was introduced into several tropical regions to control malaria.

*** Hilsa** is the only India fish that migrates from the seas to the river for breeding. It migrates from the Bay of Bengal to the Ganges, Brahmaputra, Godavari and Krishna. Dr. Hora studied the migratio of Hilsa. *Copulartory organs of sharks are known as claspers.

***Largest Fish**- The whale shark, upto 18m long, weight over 40 tonnes. **Smallest fish-** Pygmy goby, up to 11 mm long, weight 4-5 mg. **Fastest fish-** Sail fish, about 109 km/h.

*** Ichthyology-** The study of fishes. ***pisiculture-** Cultivation of fishes. * **Devonian Period-** "Age of fishes"

Most** primitive fish (fossil) : Climatius.* Most beautiful fish in the sea : **Zebra fish Most poisonous fish : **Stone fish.**

Catadromous fishes live in fresh water and go down to sea for breeding e.g., Anguilla (European eel). When fishes migrate from the rivers to the sea. It is called catadromous **migration.**

Pomfret it the most widely eaten fishin India. It was introduced in India by foreigners.

***Types of Scales in Fishes: 1. Placoid Scales.** A placoid scale has a disc-like basia plate. In basic structure, a placoid structure resembles a tooth. These scales are found in cartilaginous fishes. e.g, Scolidon.2. **Ganoid Scales.** Ganoid scales are heavy and have an outer layer of hard inorganic enamel like material called **ganoine** . These scales are found in primitive bony fishes. e.g., Polypterus, Acipencer **3. Cycloid Scales.** These scales have circular ridges. The cycloid (smooth) scales are found in higher bony fishes. e.g., Carps, lung fisher. **4. Ctenoid Scales.** These scales also have circular ridger but have more of less serrated free edge. Thus they are comb-like. Ctenoid scales are found in higher bony fishes e.g. perch.

Stenohaline Fishes. They have only a narrow range of salinity tolerance and hence remain restricted to either fresh or salt water. ***Euryhaline Fishes.** They migrate between fresh water, estuarine and thus have a wide salinity tolerance.

***Dipnoi** (Gr. di = two, + pneoe = breathing (Gr. di = Two + pneoe = breathing)-means double breathers as they respire through gills as well as lungs. Dipnoi is a group of bony fishes which includes fungs fiehs.

***Weberian Ossicles.** These are named after the name of their discoverer **(Weber 1820,)**. In certain fishes (e.g., Labeo). A chain of four small bones (Claustrum, Scaphium, Intercalarium and tripus) connects the air bladder and internal on either side. They are considered helpful in the temperature e.g. Mashser (Tor Tor)

AMPHIBIANA-*Largest amphibians. Japanese Giant Salamander which grows to a length of 1.6 cm Smallest amphibian. One of the South American arrow poison frogs which meaures upto 1.3 cm.

***Axolotls** are larvae of a certain type of salamander. They are unsual in that many axolotls remain larveae all their lives but are still able to breed. When the larva develops gonads and reproduces as in axolotl) (larva). It is called **Neotony.**

***Blind worms** (limbless amphibians) are unusual amphibians as only one species lives in water. All the others burrow underground and are rarely seen on the surface. Many do not even need water to bread.

*Amphibians originated in **Devonian Period. *Carbonians Period-** "Age of Amphibians".

*The **Arrow Poison frogs** secrete a powerful poison from their skin which can cause death. These frogs are only found in central and South America.

*Poisonous forgs often **advertise the danger** with bright **yellow, orange, red and black patterns.** So that they can be easily avoided.

***Most poisonous Frog. Golden dart poison** frog from South America is the most poisonous frog. One adult frog contains enough poison to kill 2200 people.

*Salamanders are better adapted to life on land than newels. Salamander lives are similar to those of newts, except that they usually live in warmer areas and do not need to bibernate.

Necturus (Mud puppy), Proteus (Blind Salamander), Siren (Mud eel) and Axolotl larve have external gills.

REPTILES-* reptiles without urinary bladder -snakes, crocodiles, alligators.

* The oldest living animals in any Indian Zoo is the Aldabra giant tortoise. It has been living in the Alipore Zoo in Calcutta since. It is 1.3 metre long.

Herpetology** -Study of reptiles. ***Ophiology-** Study of sankes.Largest Lizard**. Komodo dragon.

***Saurology–** Study of lizards. ***Mesozoic Era**– Also called "Age of Retpiles. "*Rattle snake's tail emits a frightening sound which scares away the enemy. *The king cobra of India is the only snake in the world that builds a nest.* Forked tongue of snakes simple gives a "stereo" Senseof smell to them. They have an organ called **Jacobson's orgen** within their tht helps them to detct odours.

Most Poisonous Snake**- Hydrophis (Sea snake)* Longest Poisonous Snake-** King cobra*Fangs of a poisonous snake are maxillary teeth. ****Largest Snake.** Python/Anaconda, may grow upto 10 m in length. **Smallest Snake.**Thread snake, less than 12 cm inlength.****Largest Living Reptiles** (i) python, (ii) Crocodile(iii) Komodo dragon.

***Seymouria.** It was one such ancestral reptile which probably started laying eggs on land in the **Permian period.** It was a lizard like sluggish creatur. It was a "connecting link" between amphibians and reptiles. Its amphibian characters were short and stubby limbs, and lateral line system. The reptilian characters were-lizard like body, typical pentadactyle limb, modification of first two cervical vertebrae into atlas and axis. Dr. T.E. White made a detailed study of seymouria.

***Lycaenous.** It was a mammal -like reptile. This fossil was discovered from the late **Permian period.** In South Africa. It is considered a "connecting link" between reptiles and mammals.

Pterosauria (= Pterodactyl). They are extinct reptiles which were light built. Their fore limbs evolved into membranous wings. Rhamphorhynchus of late **Jurassic period** was primitive pterosaur with one metre wing span, a long balancing tail and toothed jaws.

*Anguish (European glass snake-limbless-lizard), Chameleon pumilus, vipera russelli-(the Russell's Viper), Hydrophis (Sec snake), -All are viviparous.

BIRDS-* Archaeopteryx (fossil) is one of the earliest birds. The first fossil of Archaeopteryx was found in Germany in 1861. It has the characters of both reptiles and birds. *The largest bird is **Ostrich.** *Dove is the emblem of the sign of peace. *The humming birds is the only bird which can fly backward as well as forward.***** Colombia has the world's richest diversity of birds. The bird Dodo became extinct because of its fearlessness.* **Ornithology-** study of birds. ***Nidology-** study of nests of birds. ****Oology-** study It eggs of birds.

* **MAMMALS-** The Indian one-horned Rhinoceros is the second largest land animal of-India. * Highest 1.Q in man- 210 in Korean boy 4 years.* Project Tiger was started, on April , 1973. Kailash Sankhala was the founding Director of project tiger.

* **Mammals : Largest -** Blue whale, up to 33 m in length and weighs 100-120 tones (heavies recorded about 180 tones). Smallest- Shrew, body length of less than 4.5 cm and weights about 2g. The hog-nosed bat of Thailand is about, the same weight. Longest Liver-Human being. Most primitive-spiny ant eater, Duck billed platypus.

* **Apes : Largest-** Gorilla, Smallest -Gibbon.

* **Monkeys : Largest-** Mandrill. Smallest-Pygmy marmosed.

* **Giant panda** is one of the rarest animals in the world. Pandas rarely breed in captivity. Giant pandas live only in high mountains of China.

Holocene Epoch-** "Age of Man". * Ancon Sheep-** short legged sheep which originated by mutations in a single generation. **Largest land animals.** African elephant. *Fastest growth-Blue whale.

* Aquatic mammals such as whale, Siberians and seals lack pinna. Platypus also does not have pinna.

* **Mammals without 7 cervical vertebrae.** 2-toed sloth (Choloepus) with 6 cervical vertebrae, 3-toed sloth (Bradypus) with 9, ant bear (Tamandua) with 8 and Manatee (Tiochechus) with 6. Manatea is like sea cow.

* **Koala Bear** lives without water on Eucalyptus leaves. The water in the leaves perhaps meets its requirement of water.

* The first living being sent into space was dog called **"Laika."** Kangaroo rat never drinks water in its entire life.

* Asiatic wild as is flowed in Rann of Kutch. Gujrat.* Origin of Mammals- **Triassic Period.*** Origin of manpiocene Epoch.

* **Pashmina woll** is obtained from the mountain goat. This animal is found in Ladakb and Tibet.

* **The white Tiger**. All white tigers in the world are the progeny of a white male tiger which was capturted in 1951 from the forest by the Maharaja of Rewa, Madhya Pradesh, and reared as, "Mohan" at Govindgarh Palace.

* Primate Population in Assam is falling. The study was carried out at Borajln Reserve Forest. There five Types of primates (except amn) in the state- the slow loris, the Assamese macaque (monkey) the Capped langur and the **Hoolock gibbon** (ape).*** Sambar stag** is the largest deer of India.

* **Hangul** (Kashmiri stag, red deer) is the world famous red deer. It is one of the endangered species red deer, found in Dachigam National Park situated about 25 km from Srinagar.*** Land of white Elephant -** Thailand.

DIFFERENCE BETWEEN THREE GROUPS OF MAMMALS

S.NO.	PROTOTHERIA	METATHERIA	EUTHERIA
1	Oviparous	Viviparous	Viviparous
2	No pinna	Pinna present	Pinna usually present
3	No nipples (mammae)	Nipples abdominal	Nipples abdominal thoracic
4	No marsupial pouch	Marsupial pouch often present.	No marsupial pouch
5	Digestive and urinogenital tracts open into a cloaca. Cloaca opens outside through cloacal aperture.	Anus and Urinogenital aperture open into a shallow cloaca surrounded by a common sphincter	Digestive and urinogenital tracts open out by separate apertures
6	Corpus callosum is feebly developed or absent	Corpus callosum is feebly developed or absent.	Cropus callosum is well developed. It connects two cerebral hemispheres of the brain internally.
7	Testes abdominal, No Scrotum.	Scrotum in front of penis.	Scrotum behind penis
8	No placenta.	Placenta is less developed	Placenta is well developed

* African Fish Eagle is called the Voice of Africa because of its familliar yelping call. * Shrews (mammals) have the highest metabolic rate. Humming birds rank along with them in having the highest metabolism of any warm-blooded vertebrate.

* Famous Inidan Orthinologist- Dr. Salim Ali.* **Certain humming** birds becomes cold blooded at night their Poikilothermal (warm blooded) behaviour is due to their very small size. The birds is so small and loses heat so quickly that it cannot maintain its temperature at a constant level over night. At night its metabolic rate falls. just before day break the humming birds' body spontaneously returns to its normal temperature and high consumption of oxygen certain humming birds also hibernate. The Kiwi of New Zealand has an usually acute sense of smell. The Kiwi has the most sensitive beak of any bird. It can detect worms in the ground, thus, Kiwi is the only bird known to use the sense of smell for smell for finding food on the ground.

* Origin of toothed birds - **Jurassic Period.* Origin of Reptiles** was in Carboniferous period.

* Kalka deo Ghana National Park, Bharatpur , Rajasthan and Chilka Lake Bird Sanctuary, Balagaon, Orissa are famous for birds.* A comb-like structure, the **pectin**, objects from the blind spot into the vitreous humour, The pecten is present in the eye of all the birds except Kiwi (Apteryx). **Pecten** is also found in some reptiles (e.g., Uromastix) but it is absent in mammals. The actua of pecten is not understood but possibily it aids in the nutrition of the eyeball or in accommodation.

Four Evolutionary Lines of Placental Mammals-

1. **Insectivorous Line-** It includes the primitive including placental mammals the groups arising from it such as bats and primates.
2. **Rodents and Rabbits-** Both group have no canines. The incisors are adpoted for gnawing.
3. **Whales, Dolphins and Porpoises-** They are aquatic placental mammals and have flipper like forelimbs and lack hind limbs.
4. **Elephants, Carnivores and Ungulates-** Elephants have padded-feet and no hooves. The elephant's trunk is an elongated nose and the tusks are modified incisors. Carnivores are flesh eating. The ungligate are hoofed herbivorous mammals.

COMPERISION AMONG VARIOUS CLASSES OF VERTEBRATA

Features	**Fishes**	**Amphibians**	**Reptiles**	**Aves**	**Mammals**
Habits	Aquatic, mainly carnivorous, cold blooded, active swimmers	Aquatic and terrestrial both, carnivorous, cold blooded	Terrestrial mainly, cold blooded, Mainly carnivorous	Terrestrial, warm blooded, carnivorous and herbivorous	Terrestrial, warm blooded, omnivorous carnivorous and herbivorous
Main habitat	Water	Water and land	Mainly land	Land	Land
Skin	Skin moist, with many mucous glands and embedded dermal scales. (Epidermal scales are absent)	Moist, soft, slippery, glandular and sticky. (Dermal and epidermal scales are absent)	Rough, dry with many epidermal scales. Skin is covered by dermal scutes and plates in snakes, crocodiles and tortoises.	Dry, covered by horny feathers. Epidermal scales are present on legs, feet and base of beak.	Rough, dry, cornified. Skin is the thickest. Skin bears dermal hairs
Occipital condyles in skull	Dicondylic	Dicondylic	Monocondylic	Monocondylic	Dicondylic
Vertebrae	Amphicoelous	Amphicoelous, Procoelous	Procoelous	Heterocoelous	Amphiplatyan (Acoelous)
Jaw' suspansorium	Amphistylic or hyostylic	Autostylic	Autostylic	Autostylic	Craniostylic
Teeth	Teeth are modified placoid scales in cartilaginous fishes.	Homodont, acrodont and polyphyodont	Homodont and pleurodont. Absent in tortoises	Absent	Heterodont, diphyodont and thecodont

Respiratory organs	Gills	Gills in larva but lungs and skin in adult	Lungs	Lungs	Lungs
Cloaca	Present	Present	Present	Present	Absent (Present in prototherians)
Heart	2 chambered	Three chambered	Three chambered (imperfectly four chambered in crocodiles)	Four chambered	Four chambered
Cranial nerves	10 pairs	10 pairs	12 pairs	12 pairs	12 pairs
Thermal nature	Poikilothermic	Poikilothermic	Poikilothermic	Homeothermic	Homeothermic
Kidneys	Mesonephric	Mesonephric	Metanephric	Metanephric	Metanephric
Scrotal sac in male	Absent	Absent	Absent	Absent	Present
Mammary glands	Absent	Absent	Absent	Absent	Present
Fertilisation	Usually internal	Usually external .	Internal	Internal	Internal
Development	Usually direct	Direct or indirect	Direct	Direct	Direct

Classification Chart

Class Mammalia

Subclasses

Prototheria (Egg-laying mammals)

- Primitive mammals which **lay eggs**.
- Digestive tract and urinogenital duct open to the exterior by single aperture.
- Newly hatched animals are nourished on mother's milk.
- External pinnae absent, Testes abdominal, cloacal opening present.
- Confined to Australia and its neighbouring islands.

Order

Monotremata

- **Cloacla** opening present.
- *E.gs.* Platypus (*Ornithorhyncus*), spiny ant eater (*Echidna*)

Theria (Viviparous)

- **Viviparous,** both extinct and living.
- Digestive tract and urinogenital duct open by separate aperture to the exterior.
- Their young develops in the uterus, extra abdominal testes, cloacal is usually absent.

Infraclasses

Metatheria
(Pouched mammals or marsupials)

- Placenta is simple and small
- Young ones are born prematurely
- Corpus callosum is absent
- The females have a pouch or marsupium for keeping and nourishing the young ones

Order

Marsupialia

- Vagina and uterus are double.
- *E.gs.*, Kangaroo, (*Macropus*), koala, opossum (*Didelphis*)

Eutheria

- **Placental mammals** with well developed placenta
- Cerebrum has corpus callosum
- Teeth thecodont, diphyodont and heterodont, cloaca absent but anus is present.

Order (16)

Insectivora

- Primitive placental mammals with abdominal testes.
- Sharp teeth, prolonged snout plantigrade feet with claws
- *E.gs.*, Mole (*Talpa murina*) Shrew (*Sorex*) Hedgehog (*Paraechinus*)

Chiroptera

- Patagium (skin fold) for flying
- Nocturnal arboreal
- Have ecoapparatus
- *E.gs.*, small bat (*Scot-ophillus*), large bat or flying fox (*Pteropus*), Vampire bat (*Desmodus*)

Dermoptera

- A hair skin fold patagium extended from neck to tail used for gliding,
- *E.gs.*, flying lemur (*Galaeopithecus*)

Edentata

- Teeth are few or absent.
- Testes are abdominal.
- Tongue is long and protrusible
- *E.gs.*, armadillo (*Dasypus*), sloth (*Bradypus tridoctylus*)

Primates

- Highly developed brain
- Long limbs
- Large convoluted cerebral hemispheres
- Forwardly directed eyes, binocular vision
- *E.gs.*, lemur, tarsiers, monkey, man

Lagomorpha

- Upper jaw contains two pairs of incisors while lower jaw has one pair of them.
- Pinnae are large
- Diatema occur
- *E.gs.*, Rabbit (*Oryctolagus*), hare (*Lepus*)

Rodentia

- Sharp chisel like incisors.
- Diastema occur.
- *E.gs.*, Rat (*Rattus*) Mouse, (*Mus musculus*) *Funambulus* (squirrel) Beaver (Castor *fiber*) Porcupine (*Hystrix indica*)

Pholidota

- Upper surface is covered with strong horny scales.
- Tongue is long worm-like, protrusible and sticky.
- *E.gs.*, manis (*Pangolin*)

Proboscidea

- Nose and upper lip are jointly prolonged to form prehensile proboscis.
- Canines and premolars are absent.
- Upper incisors enlarge to form **tusks** in elephants.
- Testes are abdominal
- They are the **largest land animals**
- *E.gs.*, Elephant (*Elephas maximus*)

Sirenia

- Herbivorous, aquatic mammals with fin like forelimbs and no hindlimbs.
- They do not have hair and external ears.
- Testes are abdominal
- The male have tusks
- 6 cervical vertebrae
- *E.gs.*, Dugong (*Halicore*), *Rhytina* (sea-cow), *Manthus* (Manatee)

Artiodactyla

- Even toed unguligrade mammals generally with hooves.
- Stomach may or may not be ruminant
- True horns occur in some forms.
- *E.gs.*, Hippopotamus, Spotted deer (*Carvus*), Camel (*Camelus*), Giraffe (*Giraffa*), Ox (*Bos indicus*), Buffalo (*Bos bubalus*), Sheep (*Ovis*), Goat (*Capra*), Pig (*Sus*), Musk deer (*Moschus*)

Perissodactyla

- Odd toed hoofed mammals
- Herbivorous
- Canines are reduced
- True horns are never present
- *E.gs.*, Horse (*Equus*) Africal Zebra (*Equus zebra*) *Tapirus* (Tapir) Ass (*Eqqus asinus*) *Rhinoceros unicornis*

Hyracoidea

- Cheek teeth lophodont
- *E.gs.*, conies (*Hyrax*)

Tubulidentata

- No incisors or canines
- *E.gs.*, Cape anteater (*Orycteropus*)

Cetacea

- Aquatic mammal
- Hair occur only in embryo and snout of the adult
- The skin does not bear any gland.
- Blubber is present
- *E.gs.*, Whale, Dolphin, Porpoise

Carnivora

- Large canines, powerful jaws and claws
- Mammae are abdominal
- Testes descend into scrotal sac
- *E.gs.*, Lion (*Panthera leo*), Tigre (*Panthera tigris*), Panther (*Panthera pardus*), Cat (*Felis domestica*), Wolf (*Canis lupus*), Dog (*Canis familiaris*), Hyaena (*Hyaena*), Jackal (*Canis aureus*), Fox (*Vulpes bengalensis*), Mongoose (*Herpestes edwardsi*), Walrus (*Odobenus*), Seal (*Phoca*)

EXERCISE – 1

PROTOCHODATA

Q.1 Tunicin is similar to
(1) Cellulose (2) Chitin
(3) Cuticle (4) Scleroprotein

Q.2 Retrogressive metamorphosis is found in
(1) Hemichordata (2) Urochordata
(3) Cephalochordata (4) cyclostomata

Q.3 Excretory organs of **Amphioxus** are
(1) Nephridia
(2) Pronephric kidney (Protonephridia)
(3) Mesonephric kidney
(4) metanephridic kidney

Q.4 In which one of the following group, brain box is absent
(1) Cyclostomata (2) Pisces
(3) Amphibia (4) Protochordata

Q.5 Which one of the following is a chordate but not a vertebrate
(1) Scoliodon (2) Salamender
(3) Amphioxus (4) Snake

Q.6 Why the Herdmania is considered as degenerated chordate
(1) Due to absence of kidney
(2) Due to absence of head
(3) Due to absence of brain box
(4) Due to all above character

Q.7 Excretory organ of **Herdmania** is
(1) Protonephridia (2) Supra neural gland
(3) Solenocytes (4) Metanephridia

Q.8 The larval form of Urochordates is called
(1) Tornaria (2) Tadpole
(3) Veliger (4) Pluteus

Q.9 Chordates possess
(1) Dorsal nerve cord placed below gut
(2) Single hollow nerve cord placed dorsal to gut
(3) Double ventral nerve cord
(4) Single solid & ventral nerve cord

Q.10 The distingushing feature of all chordates is
(1) A ventrally placed nerve cord
(2) A water vascular system
(3) A chitinous exoskeleton
(4) Notochord

Q.11 **Salpa** & **Doliolum** belong to : -
(1) Hemichordata (2) Cephalochordata
(3) Urochordata (4) Protochordata

Q.12 Chordates are distinguished from non chordates by the presence of : -
(1) Brain
(2) Dorsal tubular hollow nerve cord
(3) Ventral nerve cord
(4) Dorsal solid nerve cord

Q.13 Which of the following animal belongs to Urochordata : -
(1) Herdmania (2) Balanoglossus
(3) Amphioxus (4) Petromyzon

Q.14 Which of the following animal is devoid of notochord and nerve cord in its adult stage -
(1) Herdmania (Ascidian)
(2) Branchiostoma (amphioxus)
(3) Assymetron
(4) All of the above

Q.15 Which of the following character is shared by all chordates at some stage of life -
(1) Notochord
(2) Dorsdal tubular nerve cord
(3) Pharyngeal gill slits
(4) All of the above

Q.16 Prochordates lack : -
(1) Cranium & vertebral column
(2) Jaws & vertebral column
(3) Paired appendages
(4) All of the above

Q.17 Notochord is extended up to head and is retained thoughout life in : -
(1) Branchiostoma (2) Herdmania
(3) Balanoglossus (4) Frog

Q.18 The adult tunicates show : -
(1) All the chordate characters
(2) No chordate characters
(3) Some of the chordate characters
(4) Only dorsal nerve cord

Q.19 Which of the following urochordate animal is called indian "Sea squirt" : -
(1) Herdmania (2) Branchiostoma
(3) Balanoglossus (4) Saccoglossus

Q.20 Basically all chordates are metamerically segmented animals this statement is : -
(1) Completely false
(2) Applicable to some chordates only
(3) Applicable to all chordates, because at some stage of their development they show some sort of serial repetition of body parts
(4) True for all chordates, as they show this phenomenon throughout life

Q.21 Which of the following is not an essential chordate character : -
(1) Notochord
(2) Vertebral column
(3) Pharynegeal gill slits
(4) Dorsal hollow nerve cord

Q.22 The cephalochordates : -
(1) Are exclusively marine in habitat
(2) Retain the three primary chordate characters throughout the life
(3) Ciliary feeders
(4) All of the above

Q.23 The lateral line sensory system is best developed in : -
(1) **Scoliodon** only (2) **Labeo** only
(3) All elasmobranch and teleostei fishes
(4) Aquatic reptiles

Q.24 The gill – slits of chordates occur in : -
(1) Buccal cavity of aquatic animals
(2) Pharynx of all land vertebrates
(3) Pharynx of all chordates embryos and pharynx of aquatic adult chordates
(4) Pharynx of all aquatic and land vertebrates in adults as well as in their embryos

Q.25 Protochordates are : -
(1) Mucous feeders
(2) water current feeders
(3) Ciliary feeders
(4) Predators

Q.26 The Ascidian tadpole larva undergoes : -
(1) Progressive metamorphosis
(2) Retrogressive metamorphosis
(3) Partial metamorphosis
(4) Complete metamorphosis

Q.27 Find out main difference between urochordata and cephalochordates : -
(1) Position of endostyle & dorsal lamina
(2) Perforated pharynx
(3) Length of notochord
(4) All of the above

Q.28 Biolumnicent chordate is : -
(1) Pyrosoma (2) Doliolum
(3) Salpa (4) Botryllus

Q.29 Body of most of urochordates is covered by : -
(1) Mantle (2) Shell
(3) Dermal (4) Test or tunicine

Q.30 The other name of Notochord is : -
(1) Chorda dorsalis (2) Vertebral column
(3) Endostyle (4) Myotome

Q.31 Phylum chordata was established by : -
(1) Hyman (2) Huxley
(3) Balfour (4) Rommer

Q.32 Tunicine is the basic material of : -
(1) Skin of echinoderms
(2) Test of urochordates
(3) Shell of mollusca
(4) All the above

Q.33 Urochordates animals show : -
(1) Neoteny
(2) Retrogressive metamorphosis
(3) Paedogensis
(4) All the above

Q.34 Ascidians are commonly knows as : -
(1) Acoelomates (2) Tunicates
(3) Denticulates (4) None

Q.35 "Vanadium" is found in blood of : -
(1) Amphioxus
(2) Tunicates
(3) Myxine
(4) Tadpole larva of frog

Q.36 In **Amphioxus** excretion take place by : -
(1) Nephridia (2) Protonephridium
(3) Myotomes (4) Kidney

Q.37 Cranium is absent in : -
(1) Protochordata (2) Vertebrata
(3) Craniata (4) All the above

Q.38 Stomochord (Buccal diverticulum) is present in-
(1) Amphioxus (2) Herdmania
(3) Balanoglossus (4) None

Q.39 "Wheel organ" is found in : -
(1) Herdmania (2) Amphioxus
(3) Balanoglossus (4) All the above

Q.40 Ciliated organ of Muller is : -
(1) Velum (2) Wheel organ
(3) Branchial sac (4) None of these

Q.41 Hatscheck" nephridium is present in : -
(1) Herdmania (2) Amphiouxus
(3) Ciona (4) All of the above

Q.42 "Sea – squirt" is common name of : -
(1) Balanoglossus (2) Herdmania
(3) Amphioxus (4) None

Q.43 In **Amphioxus** notochord is present only in :
(1) In embryo (2) In adult
(3) Both (4) None of these

Q.44 Protochordates are not vertebrates as : -
(1) Notochord absent
(2) Vertebral column absent
(3) Nerve cord absent
(4) None of the above

Q.45 Mode of feeding in Cephalochordates is : -
(1) Ciliary (2) Tentacular
(3) Flagellar (4) None

Q.46 "Lancelet" is : -
(1) Amphioxus (2) Balanoglossus
(3) Herdmania (4) Salpa

Q.47 One of the following is bisexual : -
(1) Herdmania (2) Amphioxus
(3) Branchiostoma (4) Assymetron

Q.48 Which of the following animals is called "Typical chordate" : -
(1) Herdmania (2) Amphioxus
(3) Balanoglossus (4) Salpa

Q.49 Doliolum belongs to subphylum : -
(1) Hemichordata (2) Cephalochordata
(3) Urochordata (4) All of the above

Q.50 **Pyrosoma** is the member of class : -
(1) Thaliacea (2) Larvacea
(3) Ascidiacea (4) All the above

Q.51 Which of the following animal is sessile : -
(1) Balanoglossus (2) Herdmania
(3) Amphioxus (4) Petromyzon

Q.52 Notochord is restricted in tail of : -
(1) All chordates (2) Hemichordates
(3) Urochordates (4) Cephalochordates

Q.53 Which of the following animals are the members of Cephlochordata -
(1) Rhabdopleura and Amphioxus
(2) Branchiostoma & Assymetron
(3) Petromyzon & Myxine
(4) Ciona and Apendicularia

Q.54 Percentage of Chordates animal : -
(1) 3 - 5% (2) 20 - 35%
(3) 70 - 80% (4) 90 - 95%

Q.55 Kidneys of protochordates are : -
(1) Protonephric (2) Mesonephirc
(3) Metanephic (4) Holonephirc

Q.56 Excretory organs of Urochordates : -
(1) Neural gand (2) Pyloric gland
(3) Nephrocytes (4) All of the above

Q.57 Tunicin is secreted by : -
(1) Ectodermal cells
(2) Mesodermal cells
(3) Endodermal cells
(4) Cells of arterial cavity

PISCES

Q.58 By which structure origin of gills-slits is considered
(1) from pharynx (2) from intestine
(3) from duodenum (4) from Trachea

Q.59 Fishes found mainly in marine water are
(1) Placodermi (2) Chondrichthyes
(3) Dipnoi (4) Osteichthyes

Q.60 Example of living-fossil fish
(1) Latimeria (2) Lepidosteus
(3) Acipenser (4) Protopterus

Q.61 Operculum absent around gill-slits in
(1) Dipnoi (2) Osteichthyes
(3) Chondrichthyes (4) Holocaphali

Q.62 Kidney of pisces for excretion-
(1) Holonephric (2) Protonephric
(3) Mesonephric (4) Metanephric

Q.63 Hag fish is
(1) Entospherus (2) Myxine
(3) Ichthyomygon (4) Hippocampus

Q.64 Common name of chimaera
(1) Rat fish (2) Ghost fish
(3) King of herring (4) All of above

Q.65 Sucker fish found on a shark is example of-
(1) Symbiosis (2) Predation
(3) Parasitism (4) Commensalism

Q.66 Branch of science deals with study of shark & rays
(1) Tromatology (2) Saurology
(3) Torpedology (4) Ichthyology

Q.67 Pharyngeal gill slits are found in
(1) Cuttlefish (2) Crayfish
(3) Dogfish (4) Octopus

Q.68 Peculiarity of heart of fishes-
(1) It does no have blood
(2) It contains pue blood
(3) It contains impure and pure blood
(4) It contains only impure blood

Q.69 Lamprey belongs to-
(1) Osteichthyes (2) Chondrichthyes
(3) Cyclostomata (4) Chordates

Q.70 Study of fishes is called as -
(1) Ethology (2) Ethnology
(3) Ichthyology (4) Ichthinology

Q.71 Venous heart is found in -
(1) All fishes
(2) Only teleosts
(3) Fishes & Birds
(4) Reptiles & Amphibians.

Q.72 Cartilagenous fishes lack -
(1) Scales (2) Gill slits
(3) Pelvic girdle (4) Operculum

Q.73 Which fish is viviparous -
(1) Dog fish (2) Anabas
(3) Catla (4) Heteropneustis

Q.74 The fish which swims vertically & has tooth-less tubular mouth-
(1) Hippocampus (2) Latermaria
(3) Protopterus (4) Anguilla

Q.75 Which of the following is called as flying fish-
(1) Clarias (2) Exocoetus
(3) Anabas (4) All

Q.76 Other name of Anabas fish is -
(1) Sucker fish (2) Electric ray
(3) Climbing perch (4) Lizard

Q.77 Class of pisces with sexual dimorphism-
(1) Only shark (2) Elasmobranchii
(3) Teleosti (4) None

Q.78 Fish in which male is very reduced & remain permanently attached to the female-
(1) Amia (2) Acipensor
(3) Lophius (4) Hippocampus

Q.79 One of the following is a larva of petromyzon-
(1) Ascidian larva (2) Tadpole larva
(3) Axolotle larva (4) Ammocoet

Q.80 A fish which dies if kept submerged in water for long time-
(1) Clarias (2) Anguilla
(3) Flat fish (4) Anabas

Q.81 Migration of fishes from sea water to river is-
(1) Anadromous (2) Catadromous
(3) Migration (4) Locomotion

AMPHIBIA

Q.82 Diaphragm is not found in-
(1) Rabbit (2) Man
(3) Bat (4) Frog

Q.83 What is not found in the amphibian skin-
(1) Epidermis (2) Mucous glands
(3) Scales (4) Chromatophores

Q.84 During hibernation frog respires through-
(1) Gills and lungs (2) Gills
(3) Moist skin (4) Lungs

Q.85 Which exhibits permanent neoteny-
(1) Siren (2) Necturus
(3) Proteus (4) All

Q.86 One of the following is an arboreal amphibian-
(1) Rana (2) Bufo
(3) Rhacophorous (4) Pipa

Q.87 Group of limb-less amphibians is-
(1) Gymnophiona (2) Anura
(3) Urodela (4) None

Q.88 One of the following is not an amphibian -
(1) Cricket frog (2) Bell toad
(3) Horned toad (4) None

Q.89 Following is a true terrestrial animal -
(1) Frog (2) Tortoise
(3) Salamander (4) Toad

Q.90 Flying frog is a common name of-
(1) Rhacophorus (2) Hyla
(3) Alytese (4) Pipa

Q.91 Respiratory organ of tadpole -
(1) Gill (2) Skin
(3) Both 1 & 2 (4) None

Q.92 Amphibians are not found in/on -
(1) Land (2) Fresh water
(3) Land & water (4) Sea

Q.93 Except one of the following rest are amphibians
(1) Mud eel (2) Mud puppy
(3) Newt (4) Horned toad

Q.94 Internal fertilization is not found in -
(1) Amphibia (2) Osteichthyse
(3) Nereis (4) All

Q.95 Arboreal frog is -
(1) Pipa (2) Hyla
(3) Bufo (4) Alytes

Q.96 Toad without tongue is -
(1) Pipa (2) Lithodont
(3) Siren (4) Necturus

Q.97 Animal having length about 2 feet. exhibits neoteny & 3 pairs of external gills is -
(1) Ichthyophis (2) Siren
(3) Rana goliath (4) None

REPTILIA

Q.98 Which of the following group is example of non-poisonous snakes
(1) Dendrophis, Hydrophis, Dryofish, Eryx
(2) Naja, Dendrophis, Crotalus and Viper
(3) Eryx, Lycodon, Typhlops, Torpedonotus
(4) Crotalus, Bungarus, Eryx and Viper

Q.99 Lizard which resemble the snake
(1) Hydrophis (2) Ophiosaurus
(3) Iguana (4) Varanus

Q.100 Snakes devoid of limbs because
(1) Limbs lost during burrow formation
(2) Limbs were absent in ancestor of snakes
(3) Limbs lost or reduced during evolution
(4) Snakes never had limbs

Q.101 Number of cranial nerves in Reptiles
(1) 20 pair (2) 12 pair
(3) 10 pair (4) 8 pair

Q.102 Paddle like limbs are found in
(1) Sea-snake (2) Tortoise
(3) Magur (4) Turtle

Q.103 Autotomy found in some snakes it is
(1) Attack for bite
(2) Digest of its own body parts in starvation
(3) Voluntry separation of body parts for protection
(4) Anaerobic respiration

Q.104 Cause of death during snake bite-
(1) Failure of nerves
(2) Destruction of R.B.C.s
(3) Permanent contraction of muscles
(4) Both (1) and (2)

Q.105 Snake belongs to class-
(1) Lacertilia (2) Reptilia
(3) Amphibia (4) Annelida

Q.106 Which animal belongs to order Chelonia-
(1) Aligator (2) Turtle
(3) Snake (4) Lizard

Q.107 Only poisnous lizard is -
(1) Draco (2) Heloderma
(3) Varanus (4) Ophiosaurus

Q.108 Structure found in the middle ear of reptiles analogous to ear ossicles is -
(1) Columella auris (2) Stapes
(3) Incus (4) None

Q.109 Which snake is oviparous -
(1) Cobra (2) Viper
(3) Both (4) None

Q.110 Which of the following animal belong to chelonia -
(1) Trionyx (2) Chelone
(3) Testudo (4) All

Q.111 A reptile which has completely 4- chambered heart-
(1) Crocodile (2) Snakes & lizards
(3) Sphenodon (4) Turtal

Q.112 Fangs of poisnous snakes are modification of
(1) Canines (2) Incisors
(3) Maxillary teeth (4) Vomerine teeth

Q.113 Technical name of snake is -
(1) Serpent (2) Cobra
(3) Opalina (4) Ophidia

Q.114 Poison glands of snakes are modified -
(1) Mucous glands (2) Parotid glands
(3) Sub-lingual glands
(4) Infra-orbital glands

Q.115 Lizard with spiny tail is -
(1) Phrynosoma (2) Heloderma
(3) Uromastix (4) Chelone

Q.116 Snake venum is -
(1) Haemotoxic (2) Neurotoxic
(3) 1 & 2 (4) None

Q.117 One of the following is a marine chelone -
(1) Terrapins (2) Tortoise
(3) Terrapins & Tortoise
(4) Turtle

Q.118 Lizard-like & living fossil sphenodon belongs to-
(1) Rhyncocephalia (2) Squamata
(3) Chelonia (4) Crocodelia

AVES

Q.119 Flightless & fast running birds are included in
(1) Neoganathae (2) Palaeognathae
(3) Impennae (4) Odontognathae

Q.120 Centrum of birds vertebrae is
(1) Amphiplatyon (2) Procoelous
(3) Heterocoelous (4) Amphicoelous

Q.121 Wings of birds are modified from
(1) Fore limb (2) Hind limb
(3) Skin (4) Pectoral muscles

Q.122 Indian ornithologist known as" Bird men of India-
(1) Jakir Ali (2) Dr. Salim Ali
(3) Dr. Salim Ahmed (4) Mani Shanker

Q.123 In pigeon secretion of milk by both male & female by which of the following gland
(1) Salivary gland (2) Crop-gland
(3) Gizzard gland (4) Oesophageal gland

Q.124 Which of these birds builds its nest outside India
(1) Cuckoo (2) Wagtail
(3) Red-vented bulbul (4) Crow

Q.125 Air sacs of birds
(1) Keep body warm
(2) Reduce body weight
(3) Facilitate blood circulation
(4) Maintain body temperature

Q.126 Kiwi is found in-
(1) India (2) West Indies
(3) Newzealand (4) South America

Q.127 Ostrich is found in-
(1) Australia (2) Africa and Arabia
(3) North America (4) South America

Q.128 Which bird can not fly-
(1) Stork (2) Emu
(3) Duck (4) Peacock

Q.129 Birds have bones-
(1) Elastic (2) Solid and strong
(3) Pneumatic (4) Non-elastic

Q.130 Which animal has become extinct rather recently-
(1) Mammoth (2) Dodo
(3) Dinosaur (4) Pterodactyl

Q.131 Which bird makes nest outside India-
(1) Cuckoo (2) Wegtail
(3) Crow (4) Bulbul

Q.132 Which bird sucks nectar of flowers-
(1) Red crested Bulbul
(2) Sunbird
(3) Myna (4) Parrot

Q.133 Birds fly from place to place, this movement is termed-
(1) Cursorial (2) Scansorial
(3) Digitigrade (4) Volant

MAMMALIA

Q.134 Corpus collosum in Brain is absent in which of the following mammals
(1) Eutheria (2) Metatheria
(3) Prototheria (4) Both 2 and 3

Q.135 In India "Panther Leo found in"
(1) Corbet national park
(2) Kaziranga sanctuaries
(3) Gir – forest
(4) Kanha national park

Q.136 By which characteristics whale included in class Mammalia
(1) Gills wings & viviparity
(2) Viviparity, hairy skin, Diaphragm
(3) Vertebral column, Lungs, 4 chambered heart
(4) Lungs, 4 chambered heart & Metanephric kidney

Q.137 Which group of characters of whale justify its inclusion in the class mammalia
(1) Lungs, 4-chambered heart & kidneys
(2) Vertebral column, lungs and 4-chambered heart
(3) Hair skin, mammary glands and viviparity
(4) Gills, fins and viviparity

Q.138 Which one is a diagnostic feature of mammals-
(1) Dome-shaped diaphragm
(2) External ears
(3) Cervical vertebrae
(4) Coelom

Q.139 Marsupials are-
(1) Viviparous (2) Oviparous
(3) Ovo-viviparous (4) Omni-vorous

Q.140 Non-nucleated erythrocytes are found in-
(1) Fishes (2) Tadpole
(3) Birds (4) Mammals

Q.141 Which characters are found only in mammals-
(1) Pinna, teeth
(2) Hair, oviparous
(3) Mammary glands, teeth
(4) Hair, mammay glands

Q.142 In all mammals-
(1) Pinna are found
(2) Mother gives birth to young ones
(3) Seven cervical vertebral are found
(4) Four canine teeth are found

Q.143 Marsupials are found in-
(1) Asia (2) Australia
(3) America (4) Africa

Q.144 Mule is a product of-
(1) Male & female ass
(2) Male & female horse
(3) Male ass & mare (4) Cow & Ox

Q.145 Bat can fly in night because-
(1) It has strong sense of sight
(2) Strong sense of smell
(3) It can hear high velocity sound waves
(4) It can produce high velocity sound waves and perseive them

Q.146 Seal is-

(1) Fish

(2) Carnivorous mammal

(3) Herbivorous mammal

(4) Amphibian

Q.147 Ganges Dolphins are-

(1) Reptiles (2) Mammals

(3) Fishes (4) Invertebrates

Q.148 Respirotory organs of whale are-

(1) Book lungs (2) Lungs

(3) Gills (4) Skin

Q.149 Flying fox is-

(1) Fox (2) Bat

(3) Reptile (4) Bird

Q.150 Prototheria have evolved from-

(1) Metathiria (2) Reptiles

(3) Snakes (4) Birds

Q.151 Cloacal aperture is found in-

(1) Prototheria (2) Polychacta

(3) Primates (4) Protozoa

Q.152 Whale is a mammal because-

(1) Lungs, four chambered heart

(2) Vertebral column, lungs four chambered heart

(3) Hair, mammary glands, viviparous

(4) Viviparous, gills, fins

Q.153 External ear is found in-

(1) Reptiles (2) Mammals

(3) Amphibians (4) Fishes

Q.154 The purpose of warm bloodedness in mammals is-

(1) Maximum evaporation from body surface

(2) Increase metabolic rate

(3) Keep body temperature constant inspite of change in climatic temperature

(4) Continuous production of energy for physiology

Q.155 The class of vertebrate which includes bat-

(1) Eutheria (2) Chiroptera

(3) Metatheria (4) Mammalia

Q.156 In India lion these days is found in-

(1) The forests of Madhya Pradesh

(2) Gir forests of Gujarat

(3) Gim Corbet National Park

(4) Nilgiri forests

Q.157 Which animal has radar system to locate the objects in the darkness-

(1) Mammal (2) Bat

(3) Birds (4) Insects

Q.158 Whale is a mammal because-

(1) Lays eggs

(2) Heart has 4 chambers

(3) Aquatic

(4) Diaphragm is found between thorax and abdominal cavity

Q.159 Kangaroo is-

(1) Eutherian (2) Metatherian

(3) Prototherian (4) Primate

Q.160 Spinyant eater is-

(1) Indian bird (2) Australian mammal

(3) Australian bird (4) Australian reptile

Q.161 The high frequency sound waves produced by the bat, after striking the object are reflected to the animal, this fact proves that-

(1) Sound waves after being produced by bat are scattered in all the directions

(2) Scattered in all the directions after striking the object

(3) Object absorbs them

(4) They travel in straight line

Q.162 Monotremata group includes-

(1) Animals with cloacal aperture

(2) Protozoan with one flagellum

(3) Fishes with one gill

(4) Insect with on spiracle

Q.163 Centrum of mammalian vertebra is-

(1) Heterocoelous (2) Amphicoelous

(3) Acoelous (4) Platycoelous

GENERAL

Q.164 Body organization in Chordates-
(1) Tissue organ (2) organ system
(3) Cell tissue (4) Cellular

Q.165 In which of the following animal coelom is divided into three parts
(1) Saccoglossus (2) Balanoglossus
(3) Cephalodiscus (4) All of the above

Q.166 Which of of the animal remain in larval stage for 7 years
(1) Ammocoete larva (2) Bipinnaria larva
(3) Axolotl larva (4) Tornaria larva

Q.167 Foetal membrane around egg are found in
(1) Mammalia (2) Reptilia
(3) Aves (4) All of above

Q.168 Exoskeleton absent in which of the following animals
(1) Amphibian (2) Reptiles
(3) Aves (4) Mammals

Q.169 Urinary bladder absent in
(1) Prototheria (2) Snakes
(3) Aves (4) All of above

Q.170 Members included in cetacea
(1) Pteropus, Rhinolophus & Whale
(2) Whale, Dolphin & Porpoise
(3) Mink, Seal & Canis
(4) Galeopithecus & Lamur

Q.171 Common character among birds & mammals is
(1) Bipedal locomotion
(2) External ear
(3) Hair on body
(4) Four chambered heart

Q.172 Bat & Birds both are flying but by which character bat differ from birds
(1) Small brain
(2) Wings
(3) Diaphragm
(4) Four chambered heart

Q.173 Largest animal of world belongs to class-
(1) Reptile (2) Aves
(3) Mammalia (4) Mollusca

Q.174 Which of the following is a matching pair
(1) Stream lined body Aquatic Adaptation
(2) Excessive sweating - Desert Adaptation
(3) Parasitism - Inter specific relation
(4) Uricotelism - Aquatic adaptation

Q.175 Where the flamingo breeds
(1) Rann of Kutch (2) Chilka lake
(3) Sambhar lake (4) Mansarower lake

Q.176 Five kingdom classification was proposed by
(1) Linnaeus (2) Whittekar
(3) Aristotle (4) Hymen

Q.177 "Binomial nomenclature" means that every organism has
(1) Two names, one scientific and one popular
(2) One name proposed by two scientists
(3) One scientific name having first generic and a second specific name
(4) Two names, one denoting latinized name of the place and the other of the person who determined it

Q.178 Eumetazoa reproduce asexually by-
(1) Spore-formation (2) Pseudopodia
(3) Budding (4) Encystment

Q.179 Branch of Biology related to classification is
(1) Taxidermy (2) Anatomy
(3) Taxonomy (4) Phyllotaxy

Q.180 An endoskeleton is found in
(1) Earthworm (2) Cockroach
(3) Scorpion (4) Snake

Q.181 Alimentary canal is absent in animals of the class
(1) Apoda (2) Gastropoda
(3) Cestoda (4) Arachnida

Q.182 A common cloacal chamber is found in
(1) All mammals (2) Eutherians
(3) Marsupials (4) Prototherians

Q.183 Which of the following is most unmatching group
(1) Cockroach, king-crab, spider, silverfish
(2) Whale, bat, lizard, sea horse
(3) Starfish, sea urchin, sea cucumber
(4) Crayfish, cuttlefish, sawfish, hagfish

Q.184 A postanal tail is absent in
(1) Rabbit (2) Lizard
(3) Earthworm (4) Snake

Q.185 Animals floating passively at water surface are called
(1) Nektonic (2) Neritic
(3) Planktonic (4) pelagic

Q.186 Who propounded binomial system of nomenclature-
(1) Carolus Linnaeus (2) Gregor Mendel
(3) Pasteur (4) Darwin

Q.187 Radial sysmmetry is best seen in-
(1) Mollusca (2) Sponge
(3) Star fish (4) Fishes

Q.188 Inter-breeding animals are members of the same-
(1) Order (2) Species
(3) Genus (4) Family

Q.189 Moulting is not found in the development of-
(1) Polychaete (2) Snake
(3) Insect (4) All of them

Q.190 One celled animals and plants have been kept in-
(1) Monera (2) Protista
(3) Protozoa (4) Parazoa

Q.191 Animals living on the surface of sea water are called-
(1) Lotic (2) Pelagic
(3) Benthic (4) Lentic

Q.192 Which animal would not survive, if there were no ponds of water-
(1) Fasciola (2) Ascaris
(3) Entamoeba (4) Taenia

Q.193 Sometimes different scientists give different names of the same species, in such a situation-
(1) All these names are cancelled and a new name is put forward.
(2) People are free to choose any name.
(3) First name is considered right.
(4) Last name is considered right.

Q.194 Which is the matching set-
(1) Hydra, jellyfish, leech
(2) Whale, otter, cockroach
(3) Oyster, cuttle fish, octopus
(4) Ascaris, scorpion, spider

Q.195 Which is a species-
(1) Carnivora (2) Canis
(3) Canis femiliaris (4) Mammalia

Q.196 Which structures are found atleast in some stage of all chordates-
(1) Mammary glands, gill clefts, hair
(2) Notochord, scales, dorsal tubular nerve cord
(3) Notochord, vertebral column, gill slits
(4) Notochord, pharyngeal gill slits, dorsal tubular nerve cord

Q.197 Which set or animals are found together-
(1) Zebra and Giraffe (2) Lion and Zebra
(3) Kangaroo and Ostrich
(4) Camel and Elephant

Q.198 Shark, lizard and python are-
(1) Poisonous (2) Scaly
(3) Oviparous (4) Terrestrial

Q.199 Sessile (attached) animals are marine because-
(1) For protection from terrestrial animals
(2) Protection against bacteria
(3) They can produce water current to obtain food and oxygen
(4) Can enjoy water life

Q.200 Other than mammals which group is also warm blooded-
(1) Fishes (2) Amphibians
(3) Reptiles (4) Birds

Q.201 Exoskeleton is absent in-
(1) Frog (2) Mammals
(3) Reptiles (4) Fishes

Q.202 Scales are found in-
(1) Fishes (2) Reptiles
(3) Aves (4) All of these

Q.203 Endoskeleton is found in-
(1) Cockroach (2) Snake
(3) Scorpion (4) Earthworm

Q.204 The embryo is surrounded with amnion in-
(1) Toad (2) Fish
(3) Lizard (4) Cockroach

Q.205 A new species is formed when-
(1) Because of new genic populations organism with new traits are born
(2) Exchange of parts between homologous chromosomes takes place
(3) Changes in the genotype in population leads to sexual isolation
(4) The exchange of parts of chromosomes during gametogenesis leads to the formation of new genotype

Q.206 Body is unsegmental in-
(1) Earth-worm
(2) Glow-worm & scorpion
(3) Ascaris & hook-worm
(4) Tape-worm

Q.207 Which is viviparous-
(1) Turtle (2) Running birds
(3) Rabbit & whale (4) Bony fish

Q.208 Hair are not found in adult whale, its body temperature is regulated by-
(1) Sweat glands (2) Blubber
(3) Blood circulation (4) Water

Q.209 Thorax is not found in-
(1) Squirrel (2) Whale
(3) Centipede (4) Cockroach

Q.210 Metamorphosis does not occur in-
(1) Cnidaria (2) Polychaete
(3) Earth-worm (4) All of them

Q.211 Ventral nerve cord is found in-
(1) Cockroach (2) Hydra
(3) Frog (4) Amoeba

Q.212 Which is a cold blooded animal-
(1) Buffalo (2) Man
(3) Snake (4) Duck

Q.213 In which character vertebrates differ from invertebrates-
(1) Coelom (2) Tail
(3) Dorsal tubular nerve cord
(4) Brain

Q.214 Which set belongs to the same phylum-
(1) Scorpion, cockroach, earth-worm
(2) Cockroach, leech, prawn
(3) Prawn, earthworm, leech
(4) Scorpion, prawn, cockroach

Q.215 Insectivorous animals are-
(1) Some times harmful to prey
(2) Always harmful to prey
(3) Neither harmful nor useful to prey
(4) Useful to prey

Q.216 All worms are-
(1) Radially symmetrical
(2) Asymmetrical
(3) Triploblastic (4) Diploblastic

Q.217 Wasp, gilamonster, centepede, scorpion and honey bee are-
(1) Terrestrial (2) Viviparous
(3) Social (4) Poisonous

Q.218 Animals living at the bottom of the sea do not come on surface of water because-
(1) Water pressure is low on surface of water
(2) They have to swim against gravity of earth
(3) Larger animals will eat them up
(4) They do not have swimming organs

Q.219 Best aquarium is located at-
(1) Madras (2) Trivendrum
(3) Calcutta (4) Bombay

Q.220 Pigment metal found in animals with colourless blood-
(1) Copper (2) Iron
(3) Magnesium (4) Cobalt

Q.221 Animals which give birth to young ones are called-
(1) Viviparous (2) Coelomate
(3) Amphibian (4) Triploblastic

Q.222 Group Amniota includes-
(1) Birds and mammals
(2) Birds and reptiles
(3) Mammals and reptiles
(4) Reptiles, birds and mammals

Q.223 Which group includes monoecious animals-
(1) Leech, tape worm, Hydra
(2) Ascaris, Pheretima Hydra
(3) Leech, man, Hydra
(4) Star fish, toad, tapeworm

Q.224 Group of radially symmetrical animals-
(1) Echinodermata
(2) Cnidaria
(3) Cnidaria and echinodermata
(4) Sponges

Q.225 Animals active at day time are called-
(1) Nocturnal (2) Herbivore
(3) Diurnal (4) Insectivore

Q.226 Ambergis is the secretion from stomach and is used in the manufacture of perfume and other cosmetics, it is produced in-
(1) Techyglossus–Echidna
(2) Musk deer
(3) Physetter–sperm whale
(4) Kangaroo–Macropies

Q.227 Parthenogenesis is commonly found in-
(1) Ants, bees, wasps
(2) Ascaris, earthworm, liverfluke
(3) Frogs, fishes, foxes
(4) Starfish, jelly fish, cuttle fish

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	2	4	3	4	2	2	2	4	3	2	1	1	4	4	1	3	1	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	4	3	3	3	2	1	1	4	1	3	2	2	2	2	2	1	3	2	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	2	3	2	1	1	1	2	3	1	2	3	2	1	1	4	2	1	2	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	3	2	4	3	3	3	4	3	3	1	4	1	1	2	3	2	3	4	4
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	4	3	3	4	3	1	3	2	1	1	4	4	4	2	1	2	3	2	3
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	4	3	4	2	2	2	1	1	4	1	3	1	2	3	3	4	1	2	3
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	2	2	2	2	3	2	2	3	2	2	2	4	4	3	2	3	1	1	4
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	4	3	2	3	4	2	2	2	2	2	1	3	2	2	4	2	2	4	2	2
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	4	1	4	2	2	1	4	1	4	2	4	3	3	1	2	2	3	1	3	4
Ques.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
Ans.	3	4	4	3	3	1	3	2	1	2	2	1	3	3	2	4	1	2	3	4
Ques.	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
Ans.	1	4	2	3	3	3	3	2	2	4	1	3	3	4	2	3	4	2	4	3
Ques.	221	222	223	224	225	226	227													
Ans.	1	4	1	3	3	3	1													

EXERCISE – 2

CHORDATA

Q.1 Which of the following animals is not a vertebrate
(1) Oryctolagus (2) Eurotyphlis
(3) Sparrow (4) Amphioxus

Q.2 Weberian ossicles are found in
(1) Frogs (2) Snakes
(3) Fishes (4) Birds

Q.3 The animal who possesses notochord throughout life is
(1) Fish (2) Amphioxus
(3) Bird (4) Snake

Q.4 In which of the following groups the members are exclusively marine
(1) Aquatic vertebrates
(2) Tetrapoda
(3) Pisces (4) Protochordata

Q.5 Branchiostoma belongs to
(1) Urochordata (2) Hemichordata
(3) Cephalochordata (4) Protochordata

Q.6 Which of the following group of characters is present in all chordates in some or other stage in their life
(1) Mammary glands, hair and gill slits
(2) Notochord, gill slits and dorsal tubular nervous system
(3) Notochord, scales and dorsal tubular nervous system
(4) Gill slits, vertebral column and notochord

Q.7 Agnatha includes
(1) Hag fishes (2) Fishes
(3) Jelly fishes (4) Flying fishes

Q.8 Notochord is restricted to tail region only in
(1) Hemichordata (2) Cephalochordata
(3) Tunicata (4) None of these

Q.9 Cyclostomes are
(1) Monoecious
(2) Dioecious
(3) Monoecious-and dioecious both
(4) Hermaphrodite

Q.10 Whose skin colour does not change
(1) Chameleon (2) Horse
(3) Garden lizard (4) Two of the above

Q.11 One character is given wrongly for phylum chordata mark it
(1) Presence of notochord
(2) Presence of vertebral column
(3) Paired gill slits connected with the exterior
(4) A central nervous system dorsal to digestive canal

Q.12 Which of the following are first Gnathostomes
(1) Fish (2) Amphibians
(3) Aves (4) Mammalians

Q.13 Characteristic features of cyclostomata are
(1) Elongated cylindrical body
(2) Round mouth
(3) Round mouth without jaws and paired appendages
(4) Round mouth with jaw and unpaired appendages

Q.14 Retrogressive metamorphosis is found in
(1) Balanoglossus (2) Branchiostoma
(3) Herdmania (4) All of these

Q.15 Correct Statement is
(1) Archaeopteryx is connecting link between aves and mammals
(2) Duck-billed platypus is connecting link between mammals and reptiles
(3) Sea horse is connecting link between horse and fish
(4) Hydra is connecting link between protozoa and metazoa

Q.16 Gnathostomata is divided into 2 super classes, these are
(1) Acrania and craniata
(2) Pisces and tetrapoda
(3) Amniota and bipedal
(4) Tetrapoda and gnathostomata

Q.17 The lamprey (Petromyzon) is included in the same taxonomic class as the
(1) Chamaeleon (Anolis)
(2) Hag fish (Myxine)
(3) Salamander (Ambystoma)
(4) Lung fish (Neoceratodus)

Q.18 The portal system seen in all vertebrates is
(1) Hepatic (2) Renal
(3) Both (1) and (2) (4) Pulmonary

Q.19 Chordates are distinguished from non-chordates by the presence of
(1) Ventral nerve cord
(2) Dorsal nerve cord
(3) Brain
(4) Dorsal tubular nerve cord

Q.20 Notochord is restricted to the anterior part of body proboscis in animals of which group
(1) Hemichordata (2) Urochordata
(3) Cephalochordata (4) Chordata

Q.21 Members of which group of the followings, have three ossicles in their internal ear
(1) Amphibia (2) Reptilia
(3) Aves (4) Mammalia

Q.22 Heterodont, thecodont and diphydont are the characteristics of
(1) Egg laying mammals
(2) Viviparous mammals
(3) Carnivorous mammals
(4) All of the above

Q.23 Only left aortic arches are present in
(1) Reptiles of order crocodilus
(2) Birds
(3) Mammals
(4) Both (1) and (3)

Q.24 Which is living fossil
(1) Coelacanth (2) Limulus
(3) Sphenodon (4) All of these

Q.25 The petromyzon belongs to
(1) Chondrichthyes (2) Osteichthyes
(3) Cyclostomata (4) Amphibia

Q.26 Which one of the following invertebrates is a deuterostome and enterocoelous coelomate
(1) Pila (2) Ascaris
(3) Aphrodite (4) Asterias

Q.27 Carpo-metacarpus and tarso-metatarsus are present in
(1) Reptilia (2) Mammalia
(3) Birds (4) Both (1) and (2)

Q.28 The group 'amniota' includes
(1) Birds and reptiles
(2) Birds and mammals
(3) Reptiles and mammals
(4) Reptiles, birds and mammals

Q.29 The animal group, where the adults are degenerated but larvae are well developed, is
(1) Agnatha (2) Tunicates
(3) Amphibians (4) Cephalo chordates

Q.30 Which one of the following sets of animals belongs to the same class of a phylum
(1) Hydra, jelly fish, cray fish
(2) Bat, pigeon, whale
(3) Spider, scorpion, centipede
(4) Whale, otter, kangaroo

Q.31 Which of the following is a matching set in taxonomy
(1) Man, chimpanzee, monkey
(2) Cuttle fish, jelly fish, silver fish
(3) Bat, pigeon, crow
(4) Oyster, octopus, star fish

Q.32 Constant body temperature is found in
(1) Earthworm (2) Snake
(3) Frog (4) Cow

Q.33 Which one of the following is a true terrestrial animal
(1) Frog (2) Tortoise
(3) Salamander (4) Toad

Q.34 The most important distinctive character of chordata is the presence of
(1) Vertebral column (2) Hairy skin
(3) Notochord (4) All the above

Q.35 Which one is different from others
(1) Whale (2) Porpoise
(3) Bat (4) Fish

Q.36 Heart pumps impure blood in case of
(1) Shark (2) Whale
(3) Frog (4) Lizard

Q.37 Which of the following groups has no member having gliding or flying appendages
(1) Arthropoda (2) Cyclostomata
(3) Mammals (4) Fishes

Q.38 Which one is a poikilothermic (cold blooded) animal
(1) Penguin (2) Whale
(3) Otter (4) Tortoise

Q.39 One of the primary character of chordates is
(1) Solid ventral nerve cord
(2) Dorsal tubular nerve cord
(3) Paired nerve cord
(4) Ganglionated nerve cord

Q.40 An animal having pentadactyl limbs without claws belongs to the class
(1) Amphibia (2) Reptilia
(3) Aves (4) Mammalia

PISCES

Q.41 Lateral line system is present in
(1) Fish (2) Frog
(3) Reptiles (4) Man

Q.42 Dolphins are
(1) Fishes (2) Amphibians
(3) Reptiles (4) Mammals

Q.43 Which one of the following is a cartilaginous fish
(1) Silver fish (2) Dog fish
(3) Cray fish (4) Star fish

Q.44 Scoliodon is called dogfish due to one of its following characteristics
(1) Mouth (2) Gait
(3) Carnivorous (4) Power of smell

Q.45 Sea horse is an example of
(1) Mammalia (2) Pisces
(3) Aves (4) Reptilia

Q.46 Which of the following has a cartilagenous endoskeleton
(1) Elasmobranch (2) Dipnoi
(3) Mollusca (4) Bony fishes

Q.47 Electric organs are found in
(1) Sharks (2) Porpoises
(3) Goldfish (4) Rays (Torpedo)

Q.48 A fish is characterised by the presence of
(1) Dermal scales (2) Paired fins
(3) Pharyngeal gills (4) All the above

Q.49 Which one of the following is exotic Indian fish
(1) Clarias (2) Labeo
(3) Cypris (4) Dephnia

Q.50 Which is a true fish
(1) Cat fish (2) Jelly fish
(3) Cuttle fish (4) Silver fish

Q.51 What would you call the study of fishes
(1) Ichthyology (2) Herpetology
(3) Saurology (4) Ornithology

Q.52 Petromyzon is a connecting link between
(1) Balanoglossus and Amphioxus
(2) Amphioxus and cyclostoma
(3) Cyclostoma and pisces
(4) Pisces and amphibians

Q.53 Elasmobranchs are exclusively
(1) Fresh water forms
(2) Marine water forms
(3) Brackish water forms
(4) None of these

Q.54 Jaws are absent in
(1) Protochordata
(2) Protochordata and cyclostomata
(3) Amphioxus and balanoglossus
(4) Herdmania and myxine

Q.55 Which of the following sets of animals belong to class cyclostomata
(1) Herdmania and petromyzon
(2) Petromyzone and myxine
(3) Amphioxus and balanoglossus
(4) Herdmania and myxine

Q.56 Swim bladder or air bladder is present only in
(1) Fish (2) Amphibia
(3) Aquatic reptilia (4) Aquatic mammals

Q.57 Lateral line system is not present in
(1) Sea horse
(2) Clarias
(3) Shark
(4) Aquatic amphibians

Q.58 Pristis belongs to the class
(1) Dipnoi (2) Telostomi
(3) Elasmobranchii (4) Holocephali

Q.59 Which of the following is not a fish
(1) Lung fish (2) Silver fish
(3) Cat fish (4) Dog fish

Q.60 The term 'protista' was given by
(1) Carolus Linnaeus (2) John Ray
(3) George Leapold Cuvier
(4) Ernst Haeckel

Q.61 Scales in chondrichthyes are
(1) Placoid (2) Ganoid
(3) Cycloid (4) Sesamoid

Q.62 Bony plates and scutes are found in addition to scales in
(1) Hag fish (2) Eel
(3) Flying fish (4) Sea horse

Q.63 Pharyngeal gill slits are found in
(1) Shark (2) Cray fish
(3) Cuttle fish (4) Star fish

Q.64 The fish Wallago is commonly called as 'fresh water shark', because it is
(1) Cartilaginous
(2) Dangerously predatory
(3) Lives in sea
(4) Resembles shark in body form

Q.65 Which fish gives birth to young ones
(1) Scoliodon (2) Anabas
(3) Heteropneustes (4) Catla

Q.66 True fishes possess gills and fins. Which of the following is not a true fish
(1) Silver fish (Lepisma)
(2) Gold fish (Carassius)
(3) Silver carp (Hythalamictyes)
(4) Sea horse (Hippocampus)

Q.67 In Icthyology, we study
(1) Aves (2) Reptiles
(3) Insects (4) Fishes

Q.68 Cartilaginous fishes are characterised by the presence of
(1) Terminal mouth (2) Ventral mouth
(3) A homocercal tail (4) A heterocercal tail

Q.69 Heart of fishes is
(1) One chambered (2) Two chambered
(3) Three chambered (4) Four chambered

Q.70 Placoid scales are found in
(1) Bony fishes (2) Cartilaginous fishes
(3) Lung fishes
(4) Palaeontogical fishes

Q.71 Fishes are
(1) Homoiothermic (2) Poikilothermic
(3) Both (1) and (2) (4) None of these

AMPHIBIA

Q.72 Tailless amphibians are the members of the group
(1) Salientia (Anura)
(2) Gymnophiona (Apoda)
(3) Urodela (Caudata) (4) Cyclostomata

Q.73 In amphibians the heart is
(1) Venous
(2) With double circulation
(3) With open circulation
(4) With arterial and venous circulation

Q.74 Which one of the following is not a true amphibian animal
(1) Frog (2) Tortoise
(3) Salamander (4) Toad

Q.75 The common name of necturus is
(1) Cave salamander (2) Congoeel
(3) Hell bender (4) Mud puppy

Q.76 The main difference between Gymnophiona (Apoda) and Urodela is that Urodela
(1) Have two auricles and one ventricle
(2) Have smooth moist skin
(3) Have a cloaca
(4) Respire by lungs in the adult stage

Q.77 Midwife toad is another name for
(1) Alytes (2) Hyla
(3) Rhacophorus (4) Pipa

Q.78 Which animal is surinam toad
(1) Pipa (2) Bufo
(3) Bombinator (4) Alytes

Q.79 Capacity of amphibians to change colour is called
(1) Metachrosis (2) Metachronous
(3) Synchronous (4) None of these

Q.80 Amphibians breed
(1) In crevices (2) In water
(3) On trees (4) In soil

Q.81 The name of flying frog is
(1) Rhacophorus (2) Bufo
(3) Phyllobates (4) Necturus

Q.82 Frog which lives on the trees
(1) Alytes (2) Bufo
(3) Hyla (4) Rana

REPTILIA

Q.83 Wall lizard can run efficiently on vertical surfaces because of
(1) Tetrapod condition
(2) Pentadactyle condition
(3) Lamellae present under digits
(4) Tip of digits are rounded

Q.84 Only poisonous lizard of the world is
(1) Draco (2) Heloderma
(3) Sphenodon (4) Varanus

Q.85 Classification of reptilia is based on
(1) Scales (2) Type of brain
(3) Vaccuties (4) None of these

Q.86 Limbless lizard is
(1) Draco (2) Ophisaurus
(3) Amblyrhynchus (4) Moloch

Q.87 Which of the following is a poisonous snake
(1) Eryx (2) Natrix
(3) Tree snake (4) Russel's viper

Q.88 The most highly advanced character in crocodile (reptilia) is the presence of
(1) Powerful jaws
(2) Shelled eggs
(3) Thecodont dentition
(4) Four chambered heart

Q.89 Which one of the following is a limbless lizard
(1) Hemidactylus (2) Chamelion
(3) Anguis (4) Phrynosoma

Q.90 Tortoise are
(1) Viviparous (2) Oviparous
(3) Bisexual (4) Parthenogenic

Q.91 A snake can be distinguished from a lizard by the absence of
(1) Limbs and tympanum
(2) Limbs and girdles
(3) Limbs, girdles and tympanum
(4) Limbs, girdles, tympanum and sternum

Q.92 Members of class Reptilia are
(1) Homoiothermic and amniotic
(2) Homoiothermic and anamniotic
(3) Poikilothermic and amniotic
(4) Poikilothermic and anamniotic

Q.93 Exclusively aquatic reptiles are included under the group
(1) Rhynchocephalia (2) Ophidia
(3) Lacertilia (4) Crocodilia

Q.94 Out of the following, reptiles and birds differ in only one, which is it
(1) The skin possesses scales
(2) They lay eggs
(3) Capacity of laying hard shelled eggs
(4) There is regulation of the body temperature

Q.95 Carapace is present in
(1) Toad (2) Bird
(3) Frog (4) Tortoise

Q.96 Which is a poisonous snake
(1) Enhydrina (2) Typhlops
(3) Python (4) Eryx

Q.97 In suborder ophidia, the vertebrae are
(1) Amphicoelus (2) Acoelus
(3) Heterocoelus (4) Procoelus

Q.98 Which of the following snake has hind legs
(1) Python (2) Bungarus
(3) Typhlops (4) King cobra

Q.99 Which is non-poisonous
(1) Spider (2) Scorpion
(3) Centipede (4) Crab

AVES

Q.100 Urinary bladder in birds is absent because
(1) Disturbs equilibrium of birds
(2) Urine is absent
(3) Solid excretory product
(4) All of them

Q.101 Quill feathers at the base of quill wings are called
(1) Remiges (2) Barbules
(3) Coverts (4) Down feathers

Q.102 The pelvic girdle of birds is attached to a complex structure formed by the fusion of last thoracic, all lumbar and first five caudal vertebra. This structure is called
(1) Synsacrum (2) Symphysis
(3) Synkaryon (4) Sympelvis

Q.103 Which of the following bird is viviparous
(1) Penguin (2) Humming bird
(3) Albatross (4) None of these

Q.104 Connecting link between reptiles and birds is
(1) Dimetrodon (2) Dodo
(3) Archaeopteryx (4) Sphenodon

Q.105 Birds are
(1) Cold blooded (2) Homoiothermal
(3) Poikilothermal (4) Homeopoiesis

Q.106 Flightless bird, cassowary is found in
(1) Australia (2) Newzealand
(3) Indonesia (4) Mauritious

Q.107 Which animals have a beak with jaws but no teeth
(1) Aves (2) Snakes
(3) Mammals (4) All the above

Q.108 Characteristic feature of aves is
(1) Presence of beak and features
(2) Ability to lay eggs
(3) Air spaces in lungs
(4) All the above

Q.109 Syrinx is present in
(1) Aves (2) Reptilia
(3) Mammals
(4) Aquatic amphibians

Q.110 Only right aortic arches are present in
(1) Reptilia (2) Mammals
(3) Birds (4) None of these

Q.111 Only one ovary is present in the
(1) Aquatic reptiles (2) Terrestrial reptiles
(3) Birds
(4) Egg laying mammals

Q.112 The study of migration of birds is known as
(1) Ecology (2) Nidology
(3) Phenology (4) Phrenology

Q.113 A pigeon in the absence of down feathers will not be able to
(1) Fly for long distance
(2) Protect against ectoparasites
(3) Exhibit secondary sexual dimorphism
(4) Keep the body warm

Q.114 Pneumatic bones of birds
(1) Increase the respiratory rate
(2) Increase the heart beat rate
(3) Increase the CO_2 output
(4) Increase the buoyancy

Q.115 Which one is characteristic for birds
(1) They are flying animals
(2) They are warm blooded
(3) They are Bipedal and have feathres
(4) They are quadruped and have scales

Q.116 The beak in birds is toothed in
(1) Ostrich (2) Kiwi
(3) Archaeopteryx (4) Pelican

Q.117 The most important characteristic of class aves is
(1) Homoiothermous animals
(2) Tetrapod vertebrates
(3) Bipedal vertebrates
(4) Exoskeleton of feathers

Q.118 The vertebrae of birds are characteristically
(1) Heterocoelous (2) Acoelous
(3) Opisthocoelous (4) Amphicoelous

Q.119 The members of class Aves are characterised by the presence of
(1) Hollow jaws and four chambered heart
(2) Bipedal locomotion and body covered with feathers
(3) Two chambered heart with ossified skeleton
(4) Homoiothermic condition and viviparity

Q.120 Which of the following is not found in birds
(1) Hind limb (2) Fore limb
(3) Pelvic girdle (4) Pectoral girdle

Q.121 Which of the following birds cannot fly
(1) Peacock (2) Duck
(3) Emu (4) Stork

MAMMAL

Q.122 Egg-laying mammals are grouped as
(1) Eutheria (2) Prototheria
(3) Rodentia (4) Metatheria

Q.123 'Bat' is classified as a mammal because
(1) It has hairs (2) It can fly
(3) It has pinna (4) It has testes

Q.124 Which of the following animals is an example of class mammalia?
(1) Manis (2) Planorbis
(3) Hydrophis (4) Psittacula

Q.125 External ears are characteristics of
(1) Birds (2) Mammals
(3) Birds and mammals
(4) Mammals and reptiles

Q.126 Eutherian mammals are
(1) Oviparous (2) Viviparous
(3) Ovoviviparous
(4) Both oviparous and ovoviviparous

Q.127 Marsupials are
(1) Oviparous (2) Viviparous
(3) Ovoviviparous (4) Omniparous

Q.128 Which one of the following is not a mammal?
(1) Ant eater (2) Echidna
(3) Heloderma (4) Dolphin

Q.129 Animals belonging to the order 'rodentia' have
(1) Long incisors (2) long canines
(3) short incisors (4) long molars

Q.130 Viviparous animal is
(1) Shark (2) Mud puppy
(3) Bony shark (4) Fish

Q.131 Corpora bigemina is not present in
(1) Frog (2) Snake
(3) Birds (4) Rabbit

Q.132 Which is the common character between all the mammals
(1) They are oviparous
(2) They are herbivorous
(3) They are carnivorous
(4) They have seven cervical vertebrae

Q.133 Why do mammals lack mucus glands in their skin
(1) The skin is not slippery
(2) The skin is tough
(3) The epidermis has many layers of cells
(4) The skin is not respiratory

Q.134 Corpus callosum is present only in
(1) Amphibia (2) Reptilia
(3) Birds (4) Mammalia

Q.135 Double circulatory heart is present in
(1) Birds only (2) Mammals only
(3) Reptilia only (4) (1) and (2) both

Q.136 The development of optic lobes is maximum in
(1) Birds (2) Reptilia
(3) Mammals (4) Amphibia

Q.137 Cerebellum of one of the following animals is provided with lateral lobes and arborvitae
(1) Reptilia (2) Mammals
(3) Birds (4) Amphibia

Q.138 12 pairs of cranial nerves are present in
(1) Reptilia (2) Birds only
(3) Mammals only (4) All the above

Q.139 In mammals, the name "Innominate" has been applied to
(1) A nerve and an artery
(2) A part of skeleton and an artery
(3) A bone and a nerve
(4) A vein and a kidney tubule

Q.140 Rabbit belongs to the order
(1) Rodentia (2) Lagomorpha
(3) Artiodactyla (4) Perissodactyla

Q.141 To which of the taxonomic group does whale belong
(1) Fishes (2) Reptilia
(3) Mammalia (4) Arthropoda

Q.142 Which one of the following is a metatherian
(1) Didelphis (2) Ornithorhynchus
(3) Tarsier (4) Hysterics

Q.143 The mammal which possesses both the characters of reptiles and mammals –
(1) Marsupials (2) Monotremes
(3) Equus (4) Oryctolagus

Q.144 Kangaroo is a member of which order
(1) Monotremata (2) Marsupialia
(3) Prototheria (4) Insectivora

Q.145 First flying animals are
(1) Mammals (2) Reptiles
(3) Insects (4) Aves

Q.146 Monotremata is a group of animals which includes
(1) Fishes with a single gill aperature
(2) Insects with a single pair of functional spiracles
(3) Mammals with a single common cloacal opening
(4) Protozoans with single flagellum

Q.147 Egg laying mammals are found in
(1) India (2) South Africa
(3) Africa (4) Australia

Q.148 Apart from mammals, other group of animals maintaining a high and constant body temperature is
(1) Insects (2) Fishes
(3) Worms (4) Birds

Q.149 Kangaroo is a native of
(1) Africa (2) Australia
(3) Austria (4) Mexico

Q.150 Chief distinguishing features of the mammals are
(1) Hairy skin and ovipary
(2) Hairy skin and mammary glands
(3) Mammary glands and teeth
(4) Pinna and teeth

Q.151 Milk glands are found in
(1) All vertebrates (2) All mammals
(3) All placental mammals
(4) All prototherians

Q.152 A rabbit shows resemblance with frog in
(1) Nucleated RBC (2) Oval RBC
(3) Renal portal system
(4) Dorsal tubular nerve cord

Q.153 Birds and bats are good fliers. The bat differs from bird in having
(1) Diaphragm
(2) Four chambered heart
(3) Wings (4) Small brain

Q.154 Largest animals belong to class
(1) Arthropoda (2) Pisces
(3) Mammalia (4) Reptilia

Q.155 The biological name of 'domestic cat' is
(1) Panthera domestica (2) Felis domestica
(3) Felis leo (4) Panthera indica

Q.156 Metanephros are present in
(1) Birds (2) Reptilia
(3) Mammals (4) All of the above

Q.157 Which of following group of mammals, the placenta is absent
(1) Prototheria (2) Metatheria
(3) Eutheria (4) Theria

Q.158 Which one of the following is a metatherian mammal
(1) Echidna (2) Kangaroo
(3) Shrew (4) Pangolin

Q.159 Most important characteristic of a mammal is
(1) Presence of thecodont dentition
(2) A four chambered heart
(3) Presence of corpus callosum in brain
(4) Presence of diaphragm

Q.160 Which pair of the animal groups, has oxygenated and de-oxygenated blood in the heart separately
(1) Amphibians and reptiles
(2) Birds and Mammals
(3) Reptiles and Birds
(4) Reptiles and Mammals

Q.161 Bats are included in the same taxonomial group as
(1) Birds (2) Butterflies
(3) Flying lizards (4) Whales

Q.162 The class of phylum chordata to which bat belongs
(1) Mammalia (2) Reptilia
(3) Aves (4) Amphibia

Q.163 External ears are characteristics of
(1) Mammals (2) Reptiles
(3) Amphibia (4) Pisces

Q.164 Which mammal lacks corpus callosum
(1) Ornithorhynchus (2) Balenoptera
(3) Macropus (4) Macaca

Q.165 The following mammal lays eggs
(1) Porcupine (2) Platypus
(3) Kangaroo (4) Koala

Q.166 Double Vagina are found in
(1) Monotremata (2) Eutheria
(3) Marsupials (4) All of the above

Q.167 Bat can travel with
(1) Eyes open
(2) Eyes plugged and ears open
(3) Ears plugged and eyes open
(4) Ears closed and eyes plugged

Q.168 The example of Marsupialia is
(1) Macropus (2) Elephant
(3) Horse (4) Rabbit

Q.169 Duck-billed platypus (ornithorhynchus) is
(1) A primitive egg laying reptile
(2) An advance egg laying reptile
(3) A primitive aquatic egg laying mammal
(4) An aquatic bird

Q.170 Members of which group of the following are egg laying
(1) Prototheria (2) Eutheria
(3) Metatheria (4) Theria

Q.171 The order Creatacea includes
(1) Monkey, gorilla and man
(2) Cat, dog, wolf and lion
(3) Whale, dolfin and porpoise
(4) Hippopotamus, pig and giraffe

Q.172 Whale is included among mammals because it has a
(1) Pair of lungs (2) Pair of nostrils
(3) Four chambered heart
(4) Diaphragm between thorax and abdomen

Q.173 Which of the following mammals have cloaca
(1) Prototheria (2) Metatheria
(3) Eutheria (4) Theria

Q.174 Which of the following mammals, has scrotal testes
(1) Prototherians
(2) All placental mammals
(3) Elephant (4) Man

Q.175 All the carnivores have
(1) Short incisors (2) Long incisors
(3) Short canines (4) Long canines

Q.176 The rodents are characterised by
(1) Long canines (2) Long incisors
(3) Hooves on feet (4) Claws on toes

Q.177 Which of the following is prototherian
(1) Platypus (2) Macropus
(3) Opposum (4) Bradypus

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	2	4	3	2	1	3	4	2	2	1	3	3	2	2	2	1	4	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	2	3	4	3	4	3	4	2	4	1	2	2	3	4	1	2	4	2	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	4	2	4	2	1	4	4	1	1	1	2	2	2	2	1	4	3	2	4
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	4	1	4	1	1	4	2	2	2	2	1	4	2	4	2	1	1	1	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	3	3	2	3	2	4	4	3	2	4	3	4	4	4	1	4	1	1	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	1	4	3	2	1	1	4	1	3	3	2	1	4	3	3	4	1	2	2
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	3	2	1	1	2	3	3	3	1	1	4	4	4	4	4	1	2	4	2	2
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	3	1	2	2	3	3	4	4	2	2	2	4	1	3	2	4	1	2	4	2
Ques.	161	162	163	164	165	166	167	168	169	171	171	172	173	174	175	176	177			
Ans.	4	1	1	1	2	3	2	1	3	1	3	4	1	4	4	2	1			

EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Which one of the following animal is not Deuterostome **[RPMT 2000]**
(1) Ambystoma (2) Amphilina
(3) Anguilla (4) Amphiuma

Q.2 Which animal is called as "Roofed Terrapin" **[RPMT 2000]**
(1) Tryonix (2) Kachuga tectum
(3) Chrysemys (4) Chelone

Q.3 Which animal is surinum toad **[RPMT 2000]**
(1) Pipa americana (2) Bufo
(3) Bombinator (4) alytes

Q.4 National bird of India is **[RPMT 2000]**
(1) Flamingo (2) Pavo cristatus
(3) Columba levia (4) Psittacula

Q.5 in Urochordata notochord is found in **[RPMT 2001]**
(1) Head of adult (2) Tail of adult
(3) Tail of larva (4) Test of adult

Q.6 Microlecithal eggs are found in **[RPMT 2000]**
(1) Reptilia + Aves
(2) Amphibia + Aves + Reptilia
(3) Reptilia + Aves + Chiroptera
(4) Eutheria

Q.7 Which of the following shows the sexual dimorphism **[RPMT 2000]**
(1) Hydra & Ascaris
(2) Hydra & Oryctolagus
(3) Ascaris & Pheretima
(4) Ascaris & Oryctolagus

Q.8 Which is not aerial adaptation of Birds **[RPMT 2001]**
(1) Single ovary (2) Pneumatic bone
(3) Gizzard (4) keeled sternum

Q.9 How does the Reptilia differ from other vertebrates **[RPMT 2001]**
(1) Due to epidermal scale
(2) Due to cleidoic eggs
(3) Due to tetrapod limb
(4) None of them

Q.10 In which of the following notochord is absent **[RPMT 2001]**
(1) Adult Herdmania & Balanoglossus
(2) Adult Herdmania & adult Branchiostoma
(3) Larva of Herdmania & Branchiostoma
(4) Larva of Herdmania & Balanoglossus

Q.11 Which of the following are Anamniotes **[RPMT 2001]**
(1) Chondrichthyes,Ostiechthyes,Amphibia
(2) Reptilia, Aves, Amphibia
(3) Amphibia, Aves, Mammals
(4) Reptilia, Mammals, Aves

Q.12 How many cranial nerves found in the Amniota **[RPMT 2000]**
(1) 6 (2) 8
(3) 12 (4) 10

Q.13 Which have macrolecithal eggs **[RPMT 2000]**
(1) Aves, Reptilia
(2) Aves, Reptilia, Amphibia
(3) Aves, Reptilia, Chiroptera
(4) Aves, Eutheria

Q.14 Cleidoic egg is an adaptation for **[RPMT 2001]**
(1) Aquatic life (2) Marine life
(3) Terrestrial life (4) Aerial life

Q.15 Which type of scales are found on skin of cartilaginous fishes **[RPMT 2001]**
(1) Cycloid (2) Ctenoid
(3) Gonoid (4) Placoid

Q.16 In which pair both characters are found without exception in all mammals **[RPMT 2001]**
(1) Hair & vivipary
(2) Vivipary & internal fertilization
(3) Vivipary & mammary glands
(4) Mammary glands & internal fertilization

Q.17 Eggs of birds are **[RPMT 2001]**
(1) Microlecithal (2) Centrolecithal
(3) Megalectithal (4) Alecithal

Q.18 Which character is found only in mammales **[RPMT 2002]**
(1) Neck (2) Diaphragm
(3) Optic lobes of brain (4) Tail

Q.19 Heterocercal tail is found in **[RPMT 2002]**
(1) Cartilaginous fishes (2) Bony fishes
(3) Whale (4) Amphibians

Q.20 Which type of kidneys are found in amphibian **[RPMT 2002]**
(1) Holonephric (2) Mesonephric
(3) Pronephric (4) Meta nephric

Q.21 Which animal is Non-chordate- **[RPMT 2002]**
(1) Herdmania (2) Balanoglossus
(3) Branchiostoma (4) Botryllus

Q.22 In which of the following reptiles four chambered heart is present **[RPMT 2002]**
(1) Lizard (2) Snake
(3) Scorpion (4) Crocodile

Q.23 Which character is not same in aves and mammals **[RPMT 2002]**
(1) Single systemic arch
(2) Metanephric kidney
(3) Seven cervical vertebrae
(4) Homeotherms

Q.24 Odd-toed mammals is **[RPMT 2004]**
(1) Equus (2) Panthera
(3) Chiroptera (4) Oryctologus

Q.25 Icthyophis belongs to which class **[RPMT 2004]**
(1) Reptilia (2) Amphibia
(3) Aves (4) Pisces

Q.26 Which of the following is not a characteristic of birds **[RPMT 2004]**
(1) Lungs with air sacs (2) Pneumatic bone
(3) Exothermic (4) Amniotic eggs

Q.27 Which of the following is a reptile **[RPMT 2004]**
(1) Salamandra (2) Turtle
(3) Newts (4) Toad

Q.28 In snakes, which gland is modified into poison gland **[RPMT 2005]**
(1) Lingual (2) Sublingual
(3) Maxillary (4) Parotid

Q.29 What is common in Bat, Whale and Rat **[RPMT 2005]**
(1) Absence of neck
(2) Muscular diaphragm between thorax and abdomen
(3) Testes, outside abdominal cavity
(4) External earpinna

Q.30 A mammal in which milk is squirted down to the throat of the body by muscular contraction of mother is **[RPMT 2005]**
(1) Bear (2) Camel
(3) Whale (4) Rhinoceros

Q.31 Placoid scales are formed in **[RPMT 2005]**
(1) Cartilaginous fishes
(2) Bony fishes
(3) Paleontical fishes
(4) Lung fishes

Q.32 Hollow air filled bones (pneumatic bones) occur in **[AIPMT 1998]**
(1) Mammals (2) Reptiles
(3) Urodela (4) Aves

Q.33 What is true **[AIPMT 2000]**
(1) Platypus is oviparous
(2) Bats have feather
(3) Elephant is ovo viviparous
(4) Diaphragm is absent in them

Q.34 Which of the following character is not found in all the chordates **[AIPMT 2000]**
(1) Diaphragm
(2) Coelom
(3) Pharyngeal gill clifts
(4) Dorsal nerve cord

Q.35 Cleavage in mammals **[AIPMT 2000]**
(1) Holoblastic equal
(2) Holoblastic unequal
(3) Superficial
(4) Discoidal

Q.36 In which of the following animal post anal tail is found **[AIPMT 2001]**
(1) Earthworm (2) Lower invertebrate
(3) Scorpion (4) Snake

Q.37 Which of the following is closest relative of man **[AIPMT 2001]**
(1) Chimpanzee (2) Gorilla
(3) Orangutan (4) Gibbon

Q.38 In which era reptiles were dominated **[AIPMT 2002]**
(1) Coenozoic era (2) Mesozoic era
(3) Paleozoic era (4) Archaeozoic era

Q.39 In which of the following notochord is present in embryonic stage **[AIPMT 2002]**
(1) All chordates (2) Some chordates
(3) Vertebrates (4) Non chordates

Q.40 In which animal nerve cell is present but brain is absent **[AIPMT 2002]**
(1) Sponge (2) Earthworm
(3) Cockroach (4) Hydra

Q.41 Which group of vertebrates comprises the highest number of endangered species **[AIPMT 2003]**

(1) Mammals (2) Fishes
(3) Reptiles (4) Birds

Q.42 Uricotelism is found in **[AIPMT 2004]**

(1) Fishes and fresh water protozoans
(2) Birds, reptiles and insects
(3) Frogs and toads
(4) Mammals and birds

Q.43 One of the following is a very unique feature of the mammalian body **[AIPMT 2004]**

(1) Presence of diaphragm
(2) Four chambered heart
(3) Rib cage
(4) Homeothermy

Q.44 Presence of gills in the tadpole of frog indicates that **[AIPMT 2004]**

(1) Fishes evolved from frog like ancestors
(2) Frogs will have gills in future
(3) Frogs evolved from gilled ancestors
(4) Fishes were amphibious in the past

Q.45 Which one of the following charcters is not typical of the class Mammalia **[AIPMT 2005]**

(1) Alveolar lungs
(2) Ten pairs of cranial nerves
(3) Seven cervical vertebrae
(4) Thecodont dentition

Q.46 Annual migration does not occur in the case of **[AIPMT 2006]**

(1) Arctic tern (2) Salmon
(3) Siberian crane (4) Salamander

Q.47 Which one of the following is not a living fossil **[AIPMT 2006]**

(1) Peripatus (2) King crab
(3) Sphenodon (4) Archaeopteryx

Q.48 In which one of the following sets of animals give birth to young ones **[AIPMT 2006]**

(1) Kangaroo, Hedgehog, Dolphin, Loris
(2) Lion, Bat, Whale, Ostrich
(3) Platypus, Penguin, Bat, Hippopotamus
(4) Shrew, Bat, Cat, Kiwi

Q.49 Which one of the following statements is incorrect **[AIPMT 2006]**

(1) The principle of countercurrent flow facilitates efficient respiration in gills of fishes
(2) The residual air in lungs slightly decreases the efficiency of respiration in mammals.
(3) The presence of non-respiratory air sacs, increases the efficiency of respiration in birds
(4) In insects, circulating body fluids serves to distribute oxygen to tissues.

Q.50 Which of the following pairs are correctly matched **[AIPMT 2007]**

Animals	**Morphological features**
(A) Crocodile	4-chambered heart
(B) Sea Urchin	Parapodia
(C) Obelia	Metagenesis
(D) Lemur	Thecodont

(1) Only A and B (2) A, C and D
(3) B, C and D (4) Only A and D

Q.51 What is common between parrot, platypus and kangaroo **[AIPMT 2007]**

(1) Ovoaparity (2) Homoiothermy
(3) Toothless jaws
(4) Functional post-anal tail

Q.52 Which one of the following in birds, indicates their reptilian ancestry **[AIPMT 2008]**

(1) Scales on their hind limbs
(2) Four-chambered heart
(3) Eosinophils (4) Moncytes

Q.53 Axolotal larva is the name of larva of **[AIIMS 1996]**

(1) Amphioxns (2) Silkworm
(3) Ambyostoma (4) Round worm

Q.54 Gambusia is a **[AIIMS 1997]**

(1) Parasitic fish (2) Pest of fish
(3) Fish predator of mosquitos larva
(4) Mosquito spreading yellow fever

Q.55 Marsupials occur in **[AIIMS 1999]**

(1) Africa (2) America
(3) Asia (4) Australia

Q.56 An egg laying mammal is **[AIIMS 2001]**

(1) Kangaroo (2) Platypus
(3) Koala (4) Whale

Q.57 The early stage human embryo distinctly possesses **[AIIMS 2003]**
(1) Gills (2) Gill slits
(3) External ear (pinna)
(4) Eye brows

Q.58 Which one of the following groups of structures/organs have similar function : **[AIIMS 2005]**
(1) Typholosle in earthworm, intestinal villi in rat and contractile vacuole in Amoeba.
(2) Nephridia in earthworm, Malpighian tubules in cockroach and urinary tubules in rat.
(3) Antennae of cockroach, tympanum of frog and clitellum of earthworm.
(4) Incisors of rat, gizzard (proventriculus) of cockroach and tube feet of startish.

Q.59 Ornithorhynchus is a **[BHU 1986]**
(1) Duck (2) Dinosaur
(3) Monotreme mammal
(4) Fossil bird

Q.60 Vetebral column is derived from **[BHU 1987]**
(1) Dorsal nerve cord
(2) Ventral nerve cord
(3) Outgrowth of cranium
(4) Notochord

Q.61 Living fossil is **[BHU 1989]**
(1) Dog fish (2) Flying fish
(3) Dodo
(4) Coelacanth/Latimeria

Q.62 Most favourable land adaptation in reptiles is **[BHU 1989]**
(1) Lungs (2) Scales
(3) Moist skin (4) Pentadacty limbs

Q.63 Retention of larval characters even after sexual maturity is called **[BHU 1993]**
(1) Pathenogensis (2) Ontogenesis
(3) Phyllogenesis (4) Neoteny

Q.64 Which one is not excusively marine **[BHU 1996]**
(1) Seal (2) Warlus
(3) Whale (4) Dolphin

Q.65 Mammals giving rise to immature young ones and nursing them in a pouch are **[BHU 1996]**
(1) Monotremes (2) Marsupials
(3) Primates (4) Carnivores

Q.66 Lateral line system occurs in **[AIIMS 1996]**
(1) Star fish (2) jelly fish
(3) Dog fish (4) All the above

Q.67 Ichthyophis belongs to **[AIIMS 1997]**
(1) Amphibia (2) Mollusca
(3) Annelida (4) Reptilia

Q.68 Rumimants belong to order **[AIIMS 1997]**
(1) Proboscida (2) Artiodactyla
(3) Sirenia (4) Cetacea

Q.69 Carapace occurs in **[AIIMS 1997]**
(1) Toad (2) Frog
(3) Bird (4) Tortoise

Q.70 Bony fishes are **[AIIMS 1997]**
(1) Ammonotelic (2) Ureotelic
(3) Uricotelic (4) Both 2 and 3

Q.71 Vetrebrates have **[AFMC 1989]**
(1) Dorsal tubular nerve cord
(2) Ventrally situated heart
(3) Body cavity with alimentary canal
(4) All the above

Q.72 Larva of Balanoglossus is **[AFMC 1991]**
(1) Muller's larva (2) Tadpole
(3) Tornaria (4) Kentrogen larva

Q.73 In fishes the kidney is **[AFMC 1993]**
(1) Pronephric (2) Metanephric
(3) Mesonephric (4) Nephridial

Q.74 The glands present in the skin of frog are **[AFMC 1993]**
(1) Sweat and mammary glands
(2) Sweat and sebaceous glands
(3) Sweat and mucous glands
(4) Mucous and poisonous glands

Q.75 Which is the smallest taxonomic group having cranium, vertebral column, ventral heart, pulmonary respiration and two pairs of legs **[AFMC 1998]**
(1) Chordata (2) Gnathostomata
(3) Vertebrata (4) Tetrapoda

Q.76 Eggs of placental mammals are **[MP PMT 1999]**
(1) Homolecithal (2) Alecithal
(3) Microlecithal (4) Mesolecithal

Q.77 Corpus callosum is found in the brain of **[MP PMT 2000]**
(1) elephant (2) pigeon
(3) crocodile (4) frog

Q.78 The evidence for the origin of birds from reptiles is the presence in them of **[MP PMT 2000]**
(1) feathers (2) scales
(3) claws (4) hairs

Q.79 Scoliodon is called dogfish due to one of its following characteristics **[MP PMT 2000]**
(1) mouth (2) gait
(3) carnivorous (4) power of smell

Q.80 Which is a living fossil **[MP PMT 2000]**
(1) Coelacanth (2) Limulus
(3) Sphenodon (4) All of these

Q.81 Limbless lizard is **[MP PMT 2000]**
(1) Darco (2) Ophiosaurus
(3) Amblyrhynchus (4) Moloch

Q.82 The zoological name of lion is **[MP PMT 2000]**
(1) Panthera pardus (2) Panthera-leopersica
(3) Panthera leoperrca (4) Felis leo

Q.83 Urinary bladder is absent in **[MP PMT 2000]**
(1) Bird (2) Snakes
(3) Crocodiles (4) All the above

Q.84 The greatest evolutionary change that enabled the land vertebrates to be completely free from water, was the development of **[MP PMT 2000]**
(1) four appendages (2) lungs
(3) cleidoic eggs
(4) four chambered heart

Q.85 Which living connecting link is an evidence for organic evolution **[MP PMT 2000]**
(1) Archaeopteryx between reptiles and birds
(2) Lungs fishes between pisces and reptiles
(3) Coelacanth between pisces and amphibians
(4) Tachyglossus between reptiles and mammals

Q.86 Sonar system is found only **[MPPMT 2000]**
(1) Bats (2) Whales
(3) Bats & Whales (4) Otter

Q.87 Cleidoic eggs are characteristic of **[MPPMT 2002]**
(1) Mammals (2) Reptiles and Birds
(3) Insects (4) Fishes

Q.88 Microlecithal eggs with small amount of food reserve are found in **[MPPMT 2002]**
(1) Frog (2) Insects
(3) Man (4) Fish

Q.89 Jaw suspension characteristics of mammals is **[MPPMT 2002]**
(1) Amphistylic (2) Craniostylic
(3) Autodiastylic (4) Hyostylic

Q.90 In which of the following subclasses of reptiles the skull has a solid roof **[MPPMT 2002]**
(1) Anapsida (2) Diapsida
(3) Synapsida (4) Parapsida

Q.91 Icthyophis is **[MPPMT 2002]**
(1) a fish (2) an Amphibian
(3) a reptile (4) a mammal

Q.92 The type of dentition in Crocodile is **[MPPMT 2002]**
(1) Acrodont (2) Bunodont
(3) Pleurodont (4) Thecodont

Q.93 Ornithorhynchus is a **[MPPMT 2002]**
(1) Fossil bird (2) Flightless bird
(3) Connecting link between reptiles are birds
(4) Mammal

Q.94 Archeopetryx, a transitional fossil between birds and reptiles was discovered from the rocks of following period **[MPPMT 2002]**
(1) Jurassic (2) Archeozoic era
(3) Cretaceous (4) Triassic

Q.95 Stenohaline fishes are represented by **[MPPMT 2002]**
(1) Fresh water fishes only
(2) Marine fishes only
(3) Those which can tolerate a narrow range of salinity in water only
(4) Those which can tolerate a wide range of salinity in water

Q.96 Swim bladder is present in **[UTTARANCHAL-2004]**
(1) Star fishes (2) Bony fishes
(3) Carp fishes (4) All of these

Q.97 The Indian salamander is **[UTTARANCHAL-2004]**
(1) Siren (2) Trilotrition
(3) Ambystoma (4) Necturus

Q.98 The charater of birds, without exception, is **[UTTARANCHAL-2004]**
(1) Omnivorous
(2) Flying wings
(3) Beak without teeth
(4) Lay eggs with calcareous shell

Q.99 Which of the following is an exclusive character of class Mammalia **[UTTARANCHAL-2004]**

(1) Homoiothermy
(2) Internal fertilization
(3) Presence of a 4-chambered heart
(4) Presence of a muscular diaphragm

Q.100 Poisonous Sea-snake possess a **[UTTARANCHAL-2005]**

(1) Compressed tail (2) Printed tail
(3) Depressed tail (4) Conicl tail

Q.101 Echidna is found in **[UTTARANCHAL-2005]**

(1) India (2) Africa
(3) Malaya (4) Australia

Q.102 Cause of death during snake bite **[Bihar-2002]**

(1) Failure of nerves
(2) destruction R B Cs
(3) permanent contraction of muscles
(4) Both 'a' and ' b'

Q.103 Oviparous mammals are **[Bihar-2002]**

(1) Kangaroo (2) Duck bill platypus
(3) Whale (4) Rabbit

Q.104 Ophiosaurus belong to **[Bihar-2001]**

(1) Amphibia (2) Pisces
(3) Reptilia (4) Mammalia

Q.105 Torpedo is commonly **[Bihar-2006]**

(1) Sucherfish (2) Electric ray
(3) Globefish (4) Sea horse

Q.106 Formen of panizzae is found in the heart of **[Bihar-2006]**

(1) Rabbit (2) Pigeon
(3) Crocodile (4) Frog

Q.107 Which of the following is viviparous **[UTTARANCHAL-2006]**

(1) Running birds (2) Whales
(3) Bats (4) Both 2 and 3

Q.108 Which of the following snakes non-poisnous **[UPCPMT 2001]**

(1) Cobra (2) Krait
(3) Viper (4) Python

Q.109 Sea horse belongs to **[UPCPMT 2003]**

(1) Mammals (2) Amphibia
(3) Aves (4) Pisces

Q.110 Cranial nerves in frog are

(1) 12 pairs (2) 9 pairs + 1
(3) 10 pairs + 1 (4) 10 pairs

Q.111 Which of the following has exoskeleton of scales and paired copulatory organ or penis **[UPCPMT 2006]**

(1) Sharks (2) Lizards
(3) Urodela (4) Urochordata

Q.112 All chordates at one or the other stage have **[MPPMT 2004]**

(1) Pharyngeal gill-slits
(2) Vertebral column
(3) Two pairs of pentadactyte limbs
(4) A moveable jaw

Q.113 Sea cows are aquatic mammals include under **[MPPMT 2001]**

(1) Lagomorpha (2) Pinnipedia
(3) Cetacea (4) Sirenia

Q.114 Diapsid skull is found in the following **[MPPMT 2001]**

(1) Crocodile, Turtle and Seymauria
(2) Sphenodon, Crocodile and Viper
(3) Natrix, Draco and Turtle
(4) Calotes, Cobra and Varanosaurus

Q.115 A group of animals having marsupium **[MPPMT 2001]**

(1) Monotremata (2) Eutheria
(3) Metatheria (4) Pantotheria

Q.116 Which of the following belongs to Phylum Arthropoda **[MPPMT 2001]**

(1) Star fish (2) Gold fish
(3) Silver fish (4) Cuttle fish

Q.117 Which of the following does not belong to Phylum Coelentrata? **[MPPMT 2002]**

(1) Sea pen (2) Sea feather
(3) Sea cucumber (4) Sea fan

Q.118 Nematocysts are found in **[MPPMT 2002]**

(1) Porifera (2) Coelenterata
(3) Nematodes (4) Annelida

Q.119 In which of the following subclasses of reptiles, the skull has a solid roof **[MP PMT 2001]**

(1) Anapsida (2) Diapsida
(3) Synapsida (4) Parapsida

Q.120 Ichthyophis is **[MP PMT 2002]**
(1) A fish (2) An amphibian
(3) A reptile (4) A mammal

Q.121 The type of dentition in Crocodile is **[MP PMT 2002]**
(1) Acrodont (2) Bunodont
(3) Pleurodont (4) Thecodont

Q.122 The eggs of eutherian mammals are **[MP PMT 2003]**
(1) Mesolecithal type (2) Microlicithal type
(3) Telolecithal type (4) Megalecithal type

Q.123 Taxomically which of the following set is matched correctly? **[MP PMT 2001]**
(1) Cattle fish, Jelly fish, Silver fish
(2) Bat, Pigeon, Kite
(3) Lobsters, spider, shrimps
(4) Oyster, Otter, Octopus

Q.124 Sea horse is **[CG PMT 2009]**
(1) A bird (2) A Mammal
(3) An Amphibion (4) A fish

Q.125 Which one of the following lays eggs yet the female secretes milk? **[CG PMT 2009]**
(1) Bat (2) Kangaroo
(3) Platypus (4) Ostrich

Q.126 Archaeopteryx is **[CG PMT 2009]**
(1) A living fossil
(2) A mammal
(3) A connecting link between annelida and arthropoda
(4) A connecting ling between reptiles and birds

Q.127 The largest endangered bird in India **[CP PMT 2009]**
(1) Vulture
(2) Flamingo
(3) Great Indian Bustard
(4) Great Indian Hornbill

Q.128 Which of the following does not make a nest of its own? **[CG PMT 2009]**
(1) Crow (2) Parrot
(3) Cuckoo (4) Sparrow

Q.129 The sea snakes have **[CG PMT 2009]**
(1) Cylindrical tail
(2) Dry hrony scale at tail end
(3) Laterally compressed tail
(4) Dorsoventrally flattened tail

Q.130 Which one of the following is an example of ex-situ conservation? **[CPMT 2010]**
(1) Wild life sanctuary (2) Seed bank
(3) Sacred groves (4) National park

Q.131 Darwin's finches are a good example of - **[CPMT 2010]**
(1) Industrial melanism
(2) Connecting link
(3) Adaptive radiation
(4) Convergent evolution

Q.132 Which one of the following kinds of animals are triploblastic ? **[CPMT 2010]**
(1) Flat worms (2) Sponges
(3) Ctenophores (4) Corals

Q.133 Which one of the following animals is correctly matched with its particular named taxonomic category? **[AIPMT 2011]**
(1) Housefly – Musca, an order
(2) Tiger – tigris, the species
(3) Cuttlefish – Mollusca, a class
(4) Humans – Primata, the family

Q.134 Which one of the following groups of animals is correctly matched with its one characteristic feature without ieven a single exception? **[AIPMT 2011]**
(1) Mammalia : give birth to young ones.
(2) Reptilia : possess 3-chambered heat with one incompletely divided ventricle
(3) Chordata : possess a mouth provided with an upper and a lower jaw
(4) Chondrichthyes : possess catilaginous endoskeleton

Q.135 Mammals's heart is : **[RPMT 2011]**
(1) myogenic (2) neurogenic
(3) voluntary (4) sympathetic

Q.136 Which of the following snakes is nonpoisonous? **[RPMT 2011]**
(1) Cobra (2) Krait
(3) Viper (4) Python

Q.137 A group of animals having marsupium is : **[RPMT 2011]**
(1) monotremata (2) eutheria
(3) metatheria (4) panthotheria

Q.138 Which sound producing organ is found in birds? **[RPMT 2011]**

(1) Pharynx (2) Larynx

(3) Syrinx (4) Trachea

Q.139 What will you look for to indentify the sex of the following **[AIPMT 2011]**

(1) Male shark – Claspers borne on pelvic fins

(2) Female Ascaris – Sharply curved posterior end

(3) Male frog – A copulatory pad on the firts digit of the hind limb.

(4) Female cochroach – Anal cerci

ANSWER KEY

EXERCISE – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	1	1	2	3	4	4	3	1	1	1	3	2	3	4	4	3	2	1	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	4	3	1	1	3	2	3	2	3	1	4	1	1	2	4	1	2	1	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	1	3	2	4	4	1	4	2	1	1	3	3	4	2	2	2	3	4
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	1	4	4	2	3	1	2	4	4	4	3	3	4	4	3	1	3	4	
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	2	4	3	1	3	2	3	2	1	2	4	4	1	3	2	2	2	4	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	4	2	3	2	3	4	4	4	4	1	1	3	2	3	3	3	2	1	2
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	
Ans.	4	2	3	4	3	4	3	3	3	2	3	1	2	4	1	4	3	3	1	

Use the following options of the following questions for chose the correct answer.

(1) If both **Assertion** & **Reason** are true and the reason is the correct explanation of the assertion.

(2) If both **Assertion** & **Reason** are true but the reason is not the correct explanation of the assertion.

(3) If **Assertion** is true statement but **Reason** is false.

(4) If both **Assertion** and **Reason** are false statements.

Q.1 **A :** Amphibians have evolved from fishes.
R : Take the example of the fossil Archaeopteryx.

Q.2 **A :** Snakes exposed to gamma rays become non poisonous.
R : Poisonous snakes have poison glands and a pair of poison fangs. They are affected by gamma rays.

Q.3 **A :** Among the land animals, the Cheetah can run fastest over the ground.
R : The Cheetah uses its powerful forelimbs to push itself forward during running.

Q.4 **A :** Salamander, Sphenodon are classified as amphibian.
R : Their skin is naked, moist and glandular

Q.5 **A :** Lateral line system is found in fishes and aquatic larval amphibians.
R : Lateral line system has receptors which are the clusters of sensory cells derived from ectoderm

Q.6 **A :** Bats and whales are classified as mammals.
R : Bats and whales have four-chambered heart.

Q.7 **A :** All birds, except the ones like koel (cuckoo) build nests for retiring and taking rest during night time (day time for nocutrnal).
R : Koel lays its eggs in the nests of tailor bird.

Q.8 **A :** A bony fish can stay at a particular depth without expending energy in swimming contrary to the cartilaginous fishes.
R : In bony fishes swim bladder is present which helps in buoyancy.

Q.9 **A :** Lycaenops is mammal like reptile.
R : Mammal like reptiles originated in the permian period.

Q.10 **A :** Reptiles can be termed as first true land animals.
R : These are completely independent of water due to development of internal fertilization and the presence of a special membrane, amnion around the developing embryo.

ANSWER KEY

EXERCISE – 4

Ques.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	1	4	2	2	3	1	1	2

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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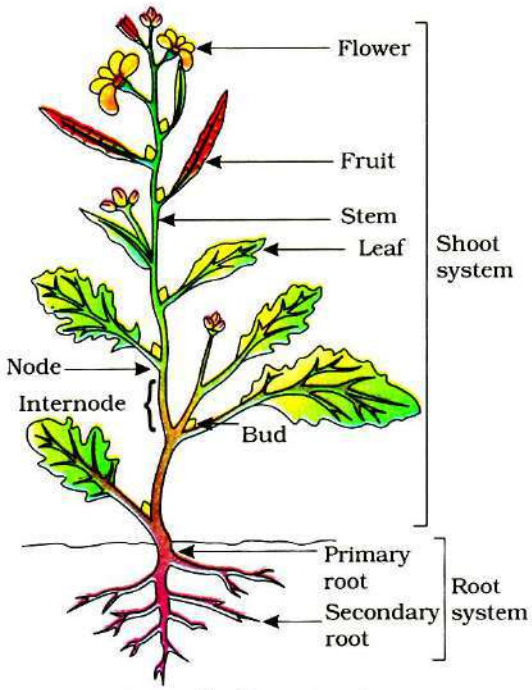
MORPHOLOGY OF FLOWERING PLANTS

INTRODUCTION



Parts of a flowering plant

- **Morphology –** (Morphe = form + logos = study). It deals with the **study of forms and features** of different plant organs like roots, stems, leaves, flowers, seeds, fruits etc.
- The body of a typical angiospermic plant is differentiated into :
  - an underground root system
  - an aerial shoot system.
  - The shoot system consists of stem (including branches), leaves, flowers and fruits.
- The roots, stems and leaves are **vegetative parts**, while flowers constitute the **reproductive part**.

CLASSIFICATION OF PLANTS (BASIS LIFE SPAN)

Depending upon their life span, plants are classified as –

- **Annuals –** Complete their life cycle in **one year** or **single growing season** or few weeks to a few months. They pass the unfavourable period in the form of **seeds** *e.g.*, Mustard, Pea.
- **Biennials –** Complete their life cycle in two years-**growing, vegetative** and storing food **in the first year, flowering and fruiting in the second year**. They die off after producing flowers and fruits *e.g.*, Radish, turnip, carrot are **biennial** in **colder** areas. They become **annual** in **warmer** places.
- **Perennials – Survives for several years**. These plants usually bears flowers and fruits every year and do not die after producing flowers. *e.g.*, Mango, Banana, Guava

CLASSIFICATION OF PLANTS (BASIS MODE OF NUTRITION)

1. **Autotrophs :** These are photosynthetic plants synthesizing their own food, *e.g.*, all green plants.
2. **Heterotrophs :** These plants cannot synthesize their own food. They are of following types-

(a) Parasitic plants : Depend on other plants for food and water. They have special structures for absorption of food and water. They may be of following types.

(i) Obligate or total parasite : Depend on other plants for both food and water.

- **Total stem parasite.** *e.g., Cuscuta, Cassytha* and *Arceuthobium* (smallest angiospermic parasite, only the flowers are visible externally, *A. minutissimum* is found on stem of *Pinus wallichiana*).
- **Total root parasite.** *e.g., Orobanchae* (Broom rape), *Balanophora, Rafflesia, Sapria, Cistanche*.

(ii) Partial or semi-parasites. Depend on other plants for water and minerals only.

- **Partial stem parasites.** *e.g., Viscum* (Mistletoe), *Loranthus*.
- **Partial root parasities.** *e.g., Santalum, Striga, Thesium.*

(b) Saprophytic plants. Grow on dead organic matter *e.g., Monotropa* (Indian pipe), *Neottia* (Bird's nest). They are mycotrophic plants.

(c) Symbiotic plants. Symbiosis or mutualism is obligatory beneficial partnership of two organisms *e.g.*, lichens (algae and fungi), *Rhizobium* (N_2 fixing bacteria and leguminous plants), mycorrhiza (fungi and roots of higher plants). Symboitic relationship between ants and some higher plants is another good example where the ants obtain food and shelter from the plant. They protect the plant from other animals *e.g., Acacia sphaerocephala* (Stipules are hollowed to function as ant shelter, leaflet tips and rachis possess feeding materials).

(d) Insectivorous or carnivorous plants. They grow in soil deficient in nitrogen. They trap insects and digest their protein. These are chlorophyllous plants thus can synthesize their own food. So all insectivorous plants are producers and secondary consumers.

(i) ***Utricularia*** **(Bladder wort).** It is a rootless aquatic plant with highly dissected leaves. some of the leaf segments are modified into small bladders which have trap valves for catching small animals like Cyclops and Daphnia.

(ii) ***Drosera*** **(Sundew).** It is a herbaceous plant growing in water logged places. The upper surface of its leaves possess club shaped tentacles. The tentacle heads secrete sticky purple juice that shines in the sun (hence called sundew). An insect touching a tentacle is stuck up and trapped by bending of tentacles. The trapped insect is then digested by enzymes secreted by digestive glads and amino acids are absorbed by the leaf.

(iii) ***Dionaea*** **(Venus fly trap).** It is a herbaceous plant bearing rosette leaves. Leaves have winged petiole and lamina modified into two toothed jaws (bilobed) normally open at an angle forming a trap. Each jaw contains several teeth. Upper surface of each jaw (lobe) bears sensitive hair, spines or bristles (three in number) and digestive glands.

Stimulation of a senstive spine or hair by an insect causes folding of leaf and secretion of digestive juices.

(iv) ***Nepenthes*** **(Pitcher plant).** It is a climber. The pitcher is formed from the lamina of leaf and the lid is the modified leaf tip. The flattened leaf like part below the petiole is the leaf base. Petiole is elongated and tendrillar. A large number of glands are situated on the upper half of the inner wall of pitcher which secrete proteolytic enzymes. The enzymes hydrolyse the protein of insects and amino acids so produced are absorbed by the plant. *Sarracenia, Darlingtonea* and *Cephalotus* are other insectivorous pitcher plants.

(v) ***Aldrovanda*** **(Water flea trap).** It has a thin rootless floating stem, which bear whorls of modified leaves. Each leaf has a spanthulate stalk and a folding two lobed lamina with teeth round the edges. The surface bears numerous sensitive joined hairs and digestive glands.

ROOT

Radicle comes out/arise from the seed coat in the form of soft structure and move toward the soil. It develops and forms primary root.

GENERAL CHARACTERS

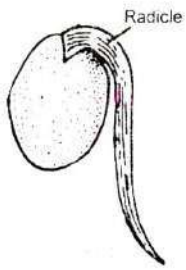
- Roots are **non green**, **underground**, (+) geotropic, (–) phototropic and (+) hydrotropic.
- Roots do not bear buds.
- Buds present for vegetative propagation in sweet potato (***Ipomea***) and Indian red wood (***Dalbergia***)
- Roots do not bear **nodes** and **internodes**.
- Roots have **unicellular** root hairs.

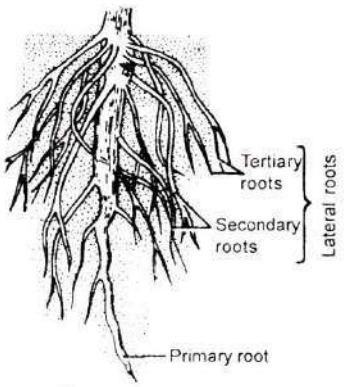
TYPES OF ROOTS :

Roots are of two types :

1. Tap root
2. Adventitious root

1. **Tap root :** It develops from radicle and made up of one main branch and other sub branches. The primary roots and its branches constitute tap root system. e.g. Dicot roots.
2. **Adventitious roots :** In some plants, after sometime of the growth of tap root which arises from radicle, stops and then roots, develop from other part of plant, which are branched or unbranched, fibrous or storage, are known as adventitious roots and constitute fibrous root system. *e.g.,* Monocot roots.





Tap root system

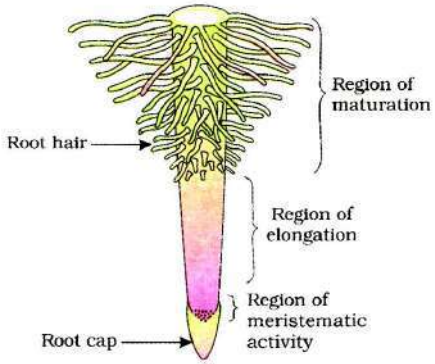
Adventitious root
Fibrous root system

REGIONS OF ROOTS :

Morphologically four distinct regions are present in roots.

- **Root cap :** It is terminal structure. It protects tender apex of root.

- **Meristematic zone :** Cells of this regions are very small and thin walled. They divide repeatedly and increase cell number
- **Elongation region :** The cells proximal to meristematic zone undergo rapid elongation and enlargement and are responsible for rapid growth of roots.
- **Maturation region :** Cells proximal to region of elongation gradually differentiate and mature. Root hairs are present in maturation zone.

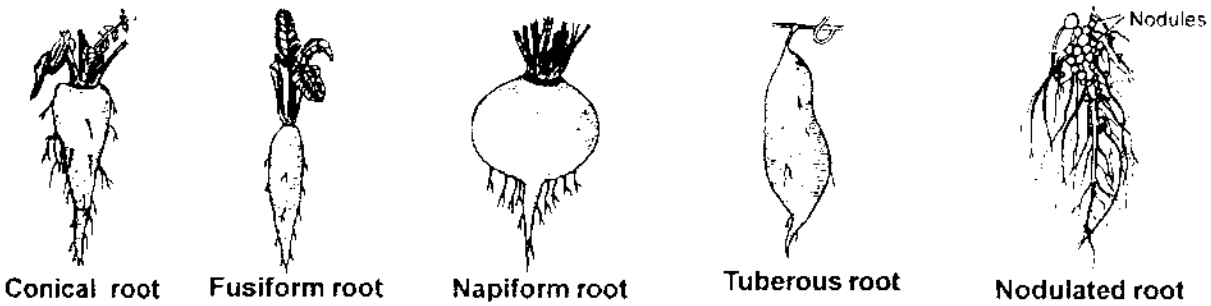


The regions of the root-tip

MODIFICATION OF ROOTS

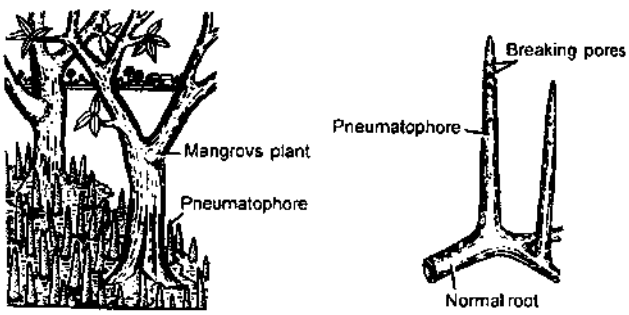
1. **Modified tap root for storage :**
   - **Fusiform roots :** These root are thicker in the middle and tappered on both ends. In this type of roots both hypocotyl and root help in storage of food. ***e.g.,*** **Radish**.
   - **Conical roots :** These roots are thicker at their upper side and tapering at basal end. ***e.g.,*** **Carrot.**
   - **Napiform :** These roots become swollen and spherical at upper end and tappered like a thread at their lower end. ***e.g.,*** **Turnip (*Brassica rapa*), Sugarbeet**
   - **Tuberous root :** Such roots do not have regular shape and get swollen & fleshy at any portion of roots. ***e.g.,*** **Mirabilis.**
2. **Nodulated root :**

   Nodules are formed on branches of roots by nitrogen fixing bacteria, (*Rhizobium*). *e.g.,* Plants of leguminosae family (Papilionatae) – **Pea.**



3. **Respiratory roots :**

   Halophyte or mangrove grow in oxygen deficient marshy area. Some branches of tap root in these plant grow vertically & comes out from soil. These roots are called pneumatophores through which air entered inside the plant. ***e.g., Rhizophora, Heritiera, Sonaratia*** **and other mangrove plant.**

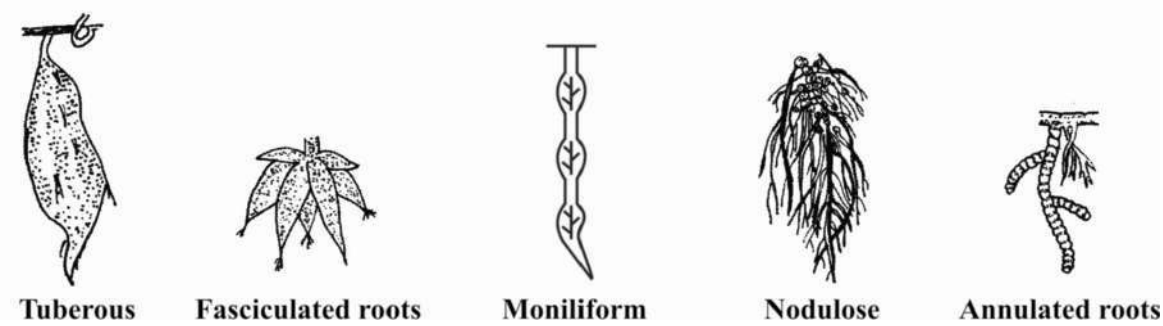


Respiratory roots (Pneumatophores) of Rhizophora

MODIFICATION OF ADVENTITIOUS ROOTS

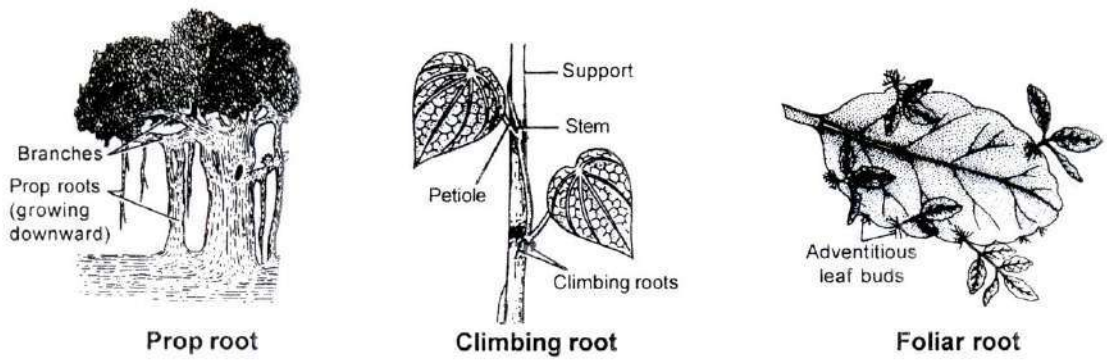
1. **Storage adventitious roots :**

- **Tuberous root :** When food is stored in these roots, they become swollen and form a bunch. *e.g.,* **Sweet potato (*Ipomea batata*)**
- **Fasciculated –** Roots arise in **bunch** (cluster) from lower node of the stem and become fleshy *e.g.*, ***Dahlia, Asparagus***.
- **Nodulose :** In this type, tips of roots swell up. ***e.g., Melilotus, Curcuma amoda.***
- **Beaded or moniliform :** When root swells up like a bead at different places after a regular interval. ***e.g., Vitis, Momordica*** **(Bitter gourd), Portulaca.**



- **Annulated :** Roots having series of ring like swellings ***e.g., Psychrotia***

2. **Stilt roots or brace roots :** When root arises from lower nodes and enter in soil obliquely, known as stilt roots ***e.g.*****, Maize, Sugarcane,** ***Pandanus*** **(screwpine)**
3. **Prop root or pillar roots :** when root arises from branches of plant and grows downward towards soil. It function as supporting stem for the plant. ***e.g.*****, Banyan**.
4. **Butteress root –** Such roots appear from the basal part of stem and spread in different directions in the soil. ***e.g., Ficus, Bombax , Terminalia.*** It is a characteristic feature of tropical rain forest.
5. **Climbing roots –** These roots arise from nodes and helps the plant in climbing. ***e.g.*****, Money plant (*Pothos*), Betel, Black pepper,** ***Techoma.***
6. **Foliar roots or Epiphyllous roots –** When roots arise from leaf they are called as foliar roots. ***e.g., Bryophyllum, Bignonia.***
7. **Sucking or haustorial roots or Parasitic roots :** In parasitic plant roots enter in the stem of host plant to absorbed nutrition from host. ***e.g., Dendrophthoe, Cuscuta, Viscum.***



8. **Assimilatory roots :** The aerial roots of ***Tinospora*** and submerged roots of ***Trapa*** (Water chestnut) become green and synthesize food. ***Podostemon*** also has green assimilatory roots.

9. **Hygroscopic roots :** These are found in epiphytes, specially in orchids and help in absorption of moisture from the atmosphere using special tissue called **velamen**. ***e.g., Orchids, Banda***
10. **Contractile roots :** They shrink 60 – 70% of the original length and bring underground organ at proper depth in the soil *e.g.,* corm of ***Crocus*** (saffron), ***Fresia***.
11. **Root thorns :** These are hard, thick and pointed thorns e.g. ***Pothos armatus***.

- **Reproductive roots :** These are fleshy, adventitious roots used for vegetative reproduction *e.g.,* sweet potato (*Ipomea batata*), Dahlia.
- **Leaf roots :** In Salvinia, one leaf of each node modifies into root like structure for balancing the plant in water.

FUNCTION OF ROOT

- Fixation (Primary function)
- Absorption of water and minerals
- Storage of food
- Conduction of water
- Photosynthesis and respiration

STEM

Stem is a part of plant which lies above from surface of soil i.e. it shows negative geotropic growth. It has nodes and internodes. Branches, leaf, flower bud and bracts are developed from nodes. Stem arises from plumule.

FORMS OF STEM

- **Caudex :** It is unbranched, erect, cylindrical stout stem and marked with scars of fallen leaves. Crown of leaves are present at the top of plant. *e.g.,*: Palm
- **Culm :** Stem is jointed with solid nodes & hollow internodes. *e.g.,* Bamboo (Graminae)
- **Excurrent :** The branches arise from the main stem in acropetal succession and the tree assumes a cone like appearance e.g. ***Pinus, Eucalyptus, Casuarina,*** etc.
- **Decurrent (Deliquescent) :** The lateral branches grow more vigorously and outcompetes the main trunk, giving a dome-shaped appearance, *e.g.,* mango (***Mangifera indica***), shishem (***Dalbergia sissoo***) and banyan (***Ficus bengalensis***).

TYPES & MODIFICATION OF STEM

1. AERIAL STEMS (EPITERRANEAN STEM) :

It may be reduced, erect and weak.

- **Reduced –** Stem reduced to a disc. *e.g.,*, Radish, Carrot, Turnip.
- **Erect stem -** It is strong and upright *e.g.,* maize, wheat, mango.
- **Weak stems –** These are thin, soft and weak and need support. They can be upright or prostrate.

– **Creepers –** The stem creeps on earth and the roots arise at the nodes, *e.g.,* Grasses, Strawberry, Oxalis.

– **Traliers –** The stem creeps on the ground, but the roots do not arise at the nodes. They may be of two types :

(i) Prostrate or procumbent – The stem creeps on ground totally, *e.g., Evolvulus, Tribulus*.

(ii) Decumbent – When prostrate stem projects its tip, *e.g., Portulaca, Linderbergia*.

– **Lianas (Stem climber).** Woody perennial climbers found in tropical rain forests are lianas. They twin themselves around tall trees to secure sunlight, *e.g.*, ***Hiptage***, ***Bauhinia vahlii*** (Phanera).

– **Climbers –** Plants are with long weak stem and have organs of attachment to climb the object. They may be of following type .

(i) Rootlet climbers – Roots produced at nodes help in climbing *e.g.*, ***Tecoma, Pothos, Piper betal*** (pan).

(ii) Hook climbers – In *Bougainvillea, Duranta* and *Carrisa*, the thron is modification of axillary vegetative bud which helps in climbing. In *Bignonia*, terminal leaflet is converted into hook.

(iii) Tendril climbers – Tendrils are thread like structure which help the plants in climbing. Tendrils are modifications of :

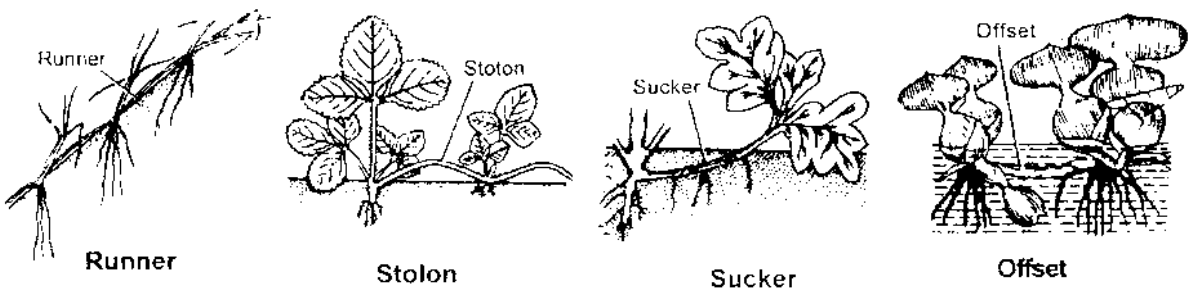
- Entire leaf e.g. ***Lathyrus sativus.***
- Leaflet e.g. ***Pisum sativum***
- Petiole e.g. ***Clematis, Nepenthes***.
- Stipule e.g. ***Smilex***.
- Leaf apex e.g. ***Gloriosa***
- Inflorescence e.g. ***Antigonon.***
- Stem *e.g.*, ***Vitis*** (grapevines), gourds, ***Passiflora*** (modified axillary bud).

– **Twiners –** The stem body twines around the support without any special organ of attachment. *e.g., Cuscuta, Dolichos*.

2. SUB-AERIAL MODIFICATION :

- **Runner –** When stem grows and spread on the surface of soil. Roots are developed at lower side and leaves from upper side from node *e.g.*, ***Cynodon dactylon*** **(Doob grass),** ***Oxalis*****.**
- **Stolon –** In it branches are small and stem condensed and grow in all direction. After sometime, of growing, their apical region comes out from the soil. *e.g.*, ***Fragaria*** **(Wild strawberry), Jasmine Peppermint.**
- **Sucker** – In it the main stem grow in the soil horizontally and branches develop obliquely from nodes above the soil, *e.g.*, **Mint, Pineapple,** ***Chrysanthemum*****.**
- **Offset** – A lateral branch with short internode and each node bearing a rossette of leaves and tuft of roots at base. *e.g.*, ***Pistia, Eichhornea.***

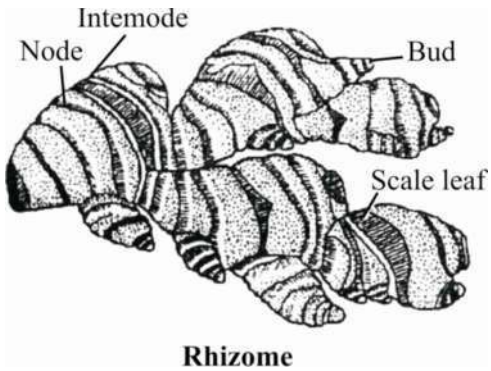
These modification are also involved in vegetative reproduction.



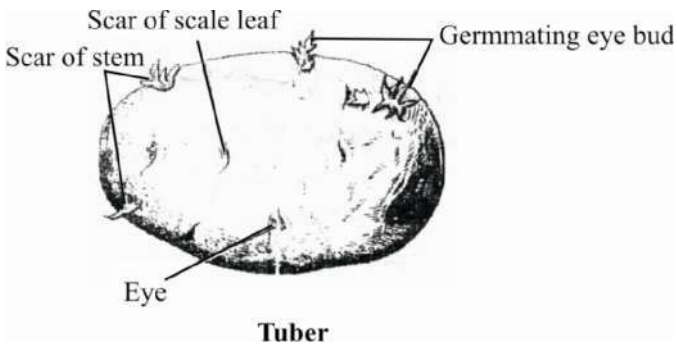
3. UNDERGROUND MODIFICATION

This type of modification occurs generally for food storage and vegetative propagation.

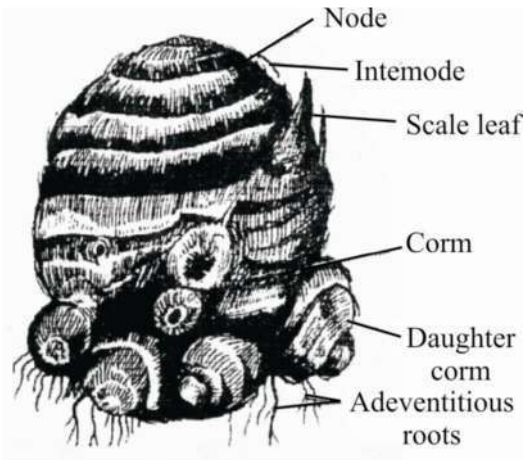
- **Tuber –** The tips of underground branches become swollen in the soil. Eyes are found on then which are axillary buds and covered with scaly leaves. *e.g.,* **Potato, *Helianthus tuberosus***
- **Rhizome –** It is fleshy and horizontally stem found below in soil. Small nodes and internodes are found which are covered by scaly leaves. *e.g.,* **Ginger, Turmeric, Canna, Water lily, Banana.**
- **Corm** – It is condensed structure which grow vertically under the soil surface. They are having spherical node and inter node *e.g.,* ***Colocasia, Alocasia,* Zaminkand, Saffron, *Gladiolus, Colchicum***
- **Bulb** – This stem is reduced and has disc like structure and surrounds with numerous fleshly scaly leaves. Many roots arise from its base. Food is stored in flashy leaves. They show apical growth *e.g.,* Onion, Garlic.



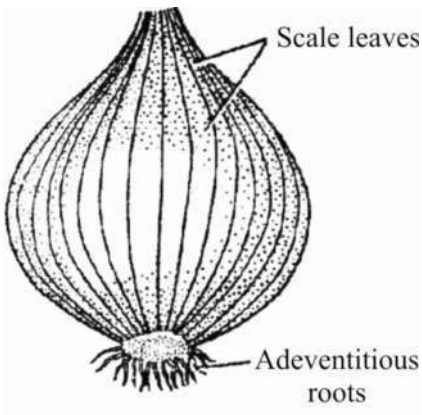
Rhizome



Tuber



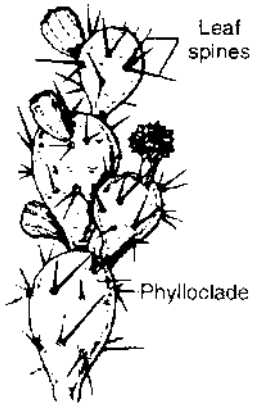
Corm



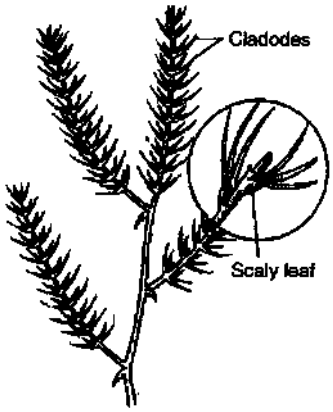
Bulb

4. Special stem modification :

- **Phylloclade –** It is green photosynthetic flattened or rounded succulent stem with leaves either feebly developed or modified into spines *e.g.,* ***Opuntia, Casuarina***, ***Euphorbia, Cactus***.
- **Thorn –** It is modification of axillary bud, *e.g.,* ***Bougainvillea, Duranta, Carissa.*** Thorns of ***Alhagi*** possess flowers, while thorns of ***Duranta*** bears leaves.
- **Cladode** – Phylloclade usually having one or two internode long & succulent is called cladode, *e.g.,* ***Asparagus***, ***Ruscus***.

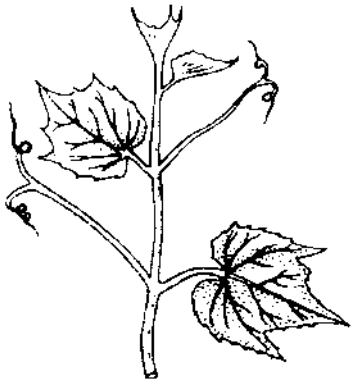


Phylloclade of *Opunita*

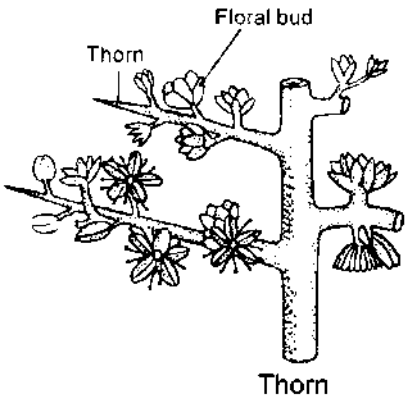


Cladode of *Asparagus*

- **Stem tendrill** – it is a leafless, spirally coiled structure found in climbers. It may be a modification of Axillary bud, e.g. ***Passiflora*** or terminal bud *e.g.*, ***Vitis***.



Stem tendril



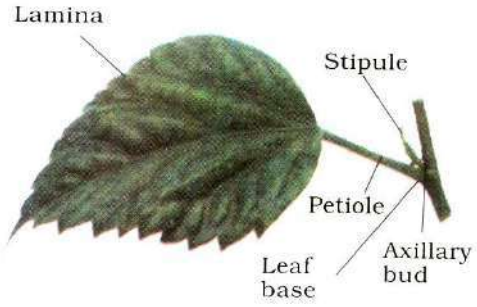
- **Bulbils** – A condensed , axillary fleshy bud is called ***bulbils***. It helps in vegetative reproduction. *e.g.,*, ***Dioscorea, Glabba, Agave, Oxalis***.

FUNCTION OF STEM

The main function of the stem is spreading out branches bearing leaves, flowers and fruits. It conducts water, minerals and photosynthates. Some stems perform the function of storage of food, support, Protection and of vegetative propagation.

LEAF (PHYLLOPODIUM)

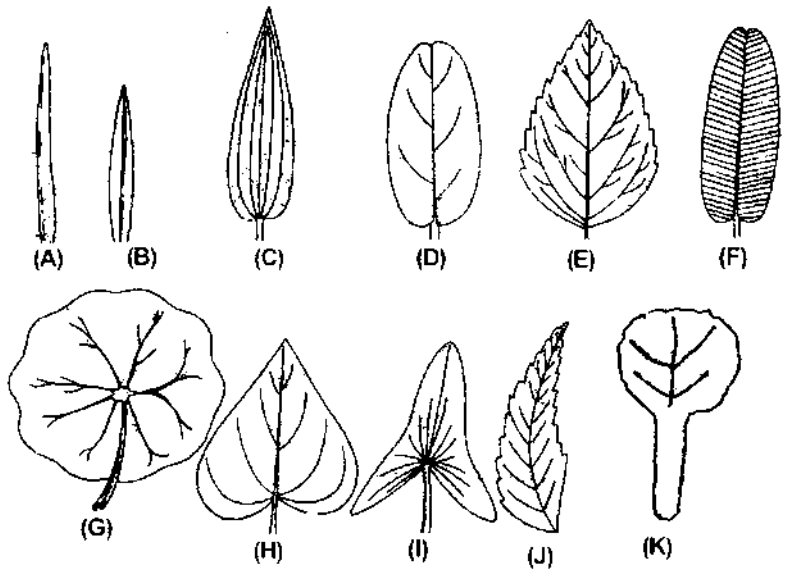
The leaf is a lateral generally flattened structure borne on the stem. The leaves develop from the nodes. Their main function is photosynthesis and food making, axillary buds are found in its axil. All the leaves of a plant is known as phyllome. Axillary bud later develops into a branch. Leaves originated from shoot apical meristem and are arranged in acropetal order.



- Leaf is divided into 3 main parts :

1. **Leaf base (Hypopodium) –**
   - Leaves are attached to stem by leaf base.
   - In some plants, leaf base becomes swollen and is called **pulvinus** which is responsible for sleep movement *e.g.,* Cassia, mimosa, bean.
   - In some plants, leaf base expands into **sheath** (**Sheathing leaf base**), *e.g.,* grasses and banana (monocots).
   - When the leaf base partially encloses the stem, it is called **semi amplexicaule** *e.g.,* Prickly poppy, ***Calotropis procera*** (Madar).
   - It completely encloses the stem, it is called **amplexicaule** *e.g.,* ***Sonchus, Polygonum***.
2. **Petiole (Mesopodium)** –
   - The part of leaf connecting the lamina with the branch of stem. Petiole help to hold the blade to light.
   - In ***Eichhornia*** petiole swell and in citrus it is winged.
   - Petiole is modified in tendrils in ***Nepenthes***.
   - In Australian acacia petiole is modified in phyllode.
   - Long thin flexible petiole allow leaf blade to flutter in air, thereby cooling the leaf and bringing fresh air to leaf.
3. **Lamina (Epipodium)** –

   It is a broad and flattened part of leaf. Its main functions are photosynthesis and transpiration.



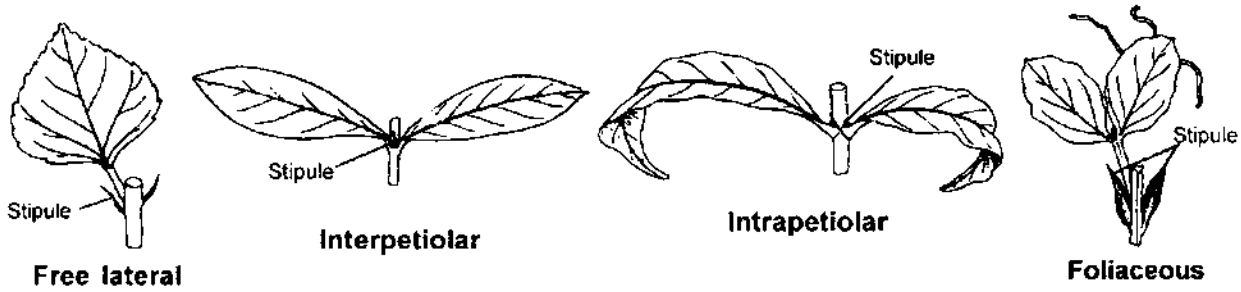
Shapes of lamina :
(A) Acicular, (B) Linear, (C) Lanceolate,
(D) Elliptical, (E) Ovate, (F) Oblong, (G) Rotund,
(H) Cordate, (I) Sagittate, (J) Oblique (K) Spathulate

STIPULES

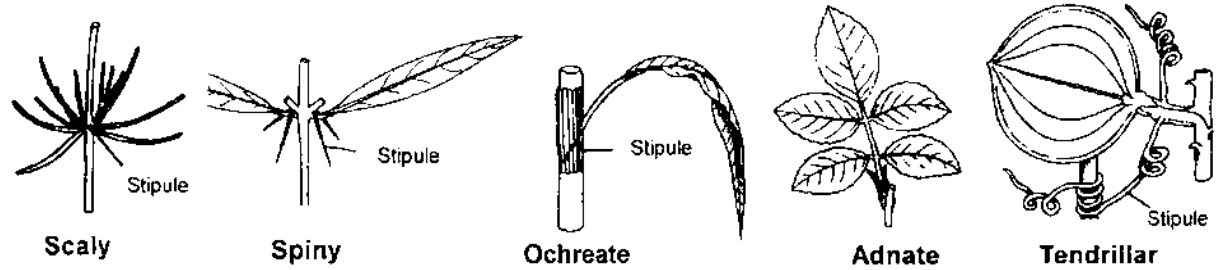
Leaves of some plants have lateral appendages on either side of leaf base, known as stipules. If stipules are present in leaf it is called stipulated leaf, if it is absent then leaf is called exstipulated.

- **Stipules are of various types –**
  - **Free lateral –** They are independently present on both sides of leaf base. *e.g.,* ***Hibiscus rosasinensis*** (China rose)

- **Interpetioler –** When two leaves are meet oppositely at the node then nearest stipules of each leaf join with each other. In this way only two stipules of two leaves are found in place of four. *e.g.,* ***Ixora, Anthocephalus.***
- **Intrapetioler –** In this type both stipules of a single leaf join with each other to form a single stipule. *e.g.,* ***Gardenia***
- **Foliaceous** – These type of stipules form a leaf like structure. *e.g.,* **Pea**



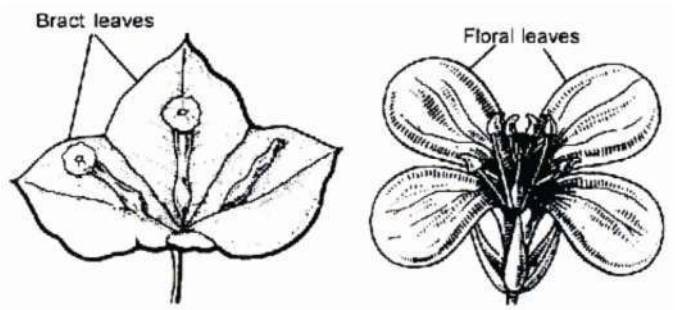
- **Scaly –** Stipules are dry, small and paper like. *e.g.,* ***Desmodium***
- **Spiny –** Stipules modified into spine. *e.g.,* ***Zizyphus*** (Beri), ***Acacia***.
- **Ochreate –** When both stipules of leaf combine together and form a tube like structure, It is called ochreate. *e.g.,* **Polygonum**
- **Adnate** – Both stipules are attached with petiole. *e.g.,* **Rose**
- **Tendrillar –** Stipules are modified into tendrils like structure. *e.g.,* ***Smilax***
- **Bud scale –** Protect the young Bud. e.g. **Ficus**



TYPES OF LEAVES

- **Foliage leaf –** They are usually green coloured and their main function is photosynthesis.
- **Cotyledonary leaf –** This leaf comes out during germination and helps in nutrition until the first leaf is not formed.
- **Scaly leaf (Cataphylls)** – Such leaves are usually dry membrane like and they can not perform photosynthesis

- **Bract (Hypsophyll)** – Bract are the leaves which is present in flower axis.
- **Bracteole** – These are leaf like structure found on pedicel.
- **Floral leaf** – Sepals, petals, stamen and carpel are found in flower which are included in this type of leaf.



- **Perianth –** In some flowers, Calyx and Corolla are not distinct and are termed as Perianth and unit of perianth is called tepal. *e.g.,* ***Lily***

Duration of leaf :

- **Persistent / Evergreen –** Leaves of such plants are found in all season and do not (fall) shed combindly. *e.g.,* ***Pinus, Saraca indica,*** **Datepalm.**
- **Deciduous –** All leaves of such plants shed at the same time *e.g.,* ***Azadirachta.***
- **Caducous –** Leaves fall soon just after appearance or after opening of bud. *e.g.,* **Rose**

Leaf insertion :

- **Cauline leaves –** When the leaves are found on node of stem, then these are called cauline leaves. *e.g.,* **Maize, Hollyhock.**
- **Ramal leaves** – When leaves are found on branches, then these are called ramal leaves. *e.g.,* ***Delbergia, Zizypus*****.**
- **Radical leaves –** During favourable season, leaves develop from the nodes of under ground stem and seem that they are developing from roots. This type of leaves are known as radical leaves. *e.g.,* **Radish, Turnip.**

VENATION OF LAMINA

The arrangement of veins and veinlets in leaves (Lamina) is known as venation. It is of two types :

1. **Reticulate :** It is found in dicots. Exception – ***Calophyllum***, ***Eryngium.*** It has parallel venation.
2. **Parallel :** It is found in monocots. Exception – ***Smilax***, ***Dioscorea, Alocasia, Colocasia***. It has reticulate venation.

1. Reticulate venation :

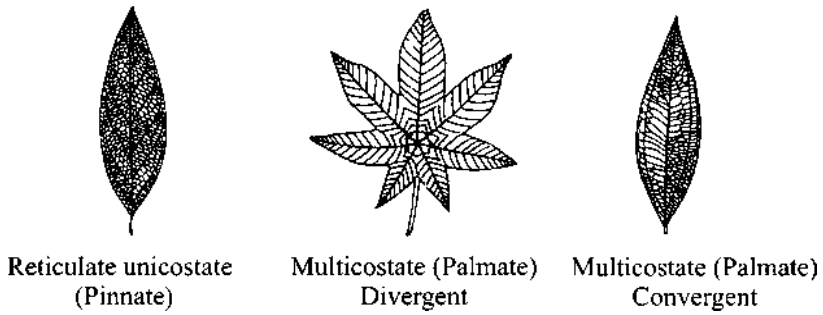
In it main vein divided into various branches (veinlets) and form a net like structure. Reticulate venation is of two types :

(i) Unicostate or pinnate – In this type of venation leaf have only one principal vein or midrib that give off many lateral veins which proceed toward margin and apex of lamina of the leaf and form a network. *e.g.,* **Mango, guava, Peepal.**

(ii) Multicostate or palmate – In this type of venation many principal veins arising from the tip of petiole and proceed towards tip of lamina. This is again two types –

(a) Multicostate divergent – Many principal veins arising from the tip of petiole, diverge from the another toward the margin of leaf blade *e.g.,* Cotton, Caster, Cucurbita, grape.

(b) Multicostate convergent – Many principal veins arising from the tip of petiole. At the base of leaf they are closely arranged but diverage from one another in middle part and converge towards the apex of leaf. *e.g.,* Camphor, ***Zizyphus***, Tejpat, Chinarose, plum.



Reticulate unicostate (Pinnate) | Multicostate (Palmate) Divergent | Multicostate (Palmate) Convergent

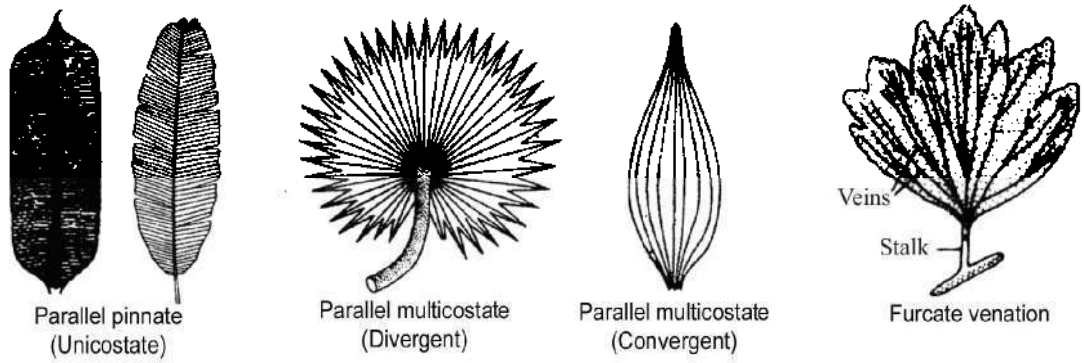
2. Parallel venation :

In this type of venation, all veins run parallel to each other and they do not from network. They are of two types :

(i) Unicostate or pinnate – This type of pattern having only one principal vein, that gives off many lateral veins, which proceed toward the margin of leaf blade in a parallel manner but they donot have veinlets. *e.g.,* **Banana, Ginger, Canna.**

(ii) Multicostate or palmate – Having many principal veins arising from the tip of the petiole and proceeding upwards.

- **Multicostate divergent –** Many principal veins arising from the tip of petiole and diverge toward the margin of leaf. They donot divide into veinlets and do not form network. *e.g.,* ***Coconut, Date palm***
- **Multicostate convergent –** Many principal veins arising from the tip of petiole run in a curved manner in lamina and converge towards the apex of leaf blades. *e.g.,* – Wheat, Sugar-cane, Bamboo.
- **Furcate venation –** The veins branch dichotomously but the reticulum is not formed by the finer branches. *e.g., **Adiantum*** (fern).



Parallel pinnate (Unicostate) | Parallel multicostate (Divergent) | Parallel multicostate (Convergent) | Furcate venation

TYPES OF LEAF

SIMPLE AND COMPOUND LEAF

- **Simple Leaf –** A leaf which may be incised to any depth, but not down to the midrib or petiole, then this type of leaf called **simple leaf**. *e.g.,* **Mango, Chinarose, Ficus**, etc.
- **Compound leaf –** A leaf in which the leaf blade is incised up to the midrib or petiole, thus dividing it into several small parts, known as **leaflets**. This type of leaf is known as **compound leaf**.

- **It is of two types** –

1. PINNATELY COMPOUND LEAF

In this type of leaf mid rib is known as **rachis**. Leaflets are arranged on both sides of rachis. *e.g.,* **Neem**.

- **It is of following types –**

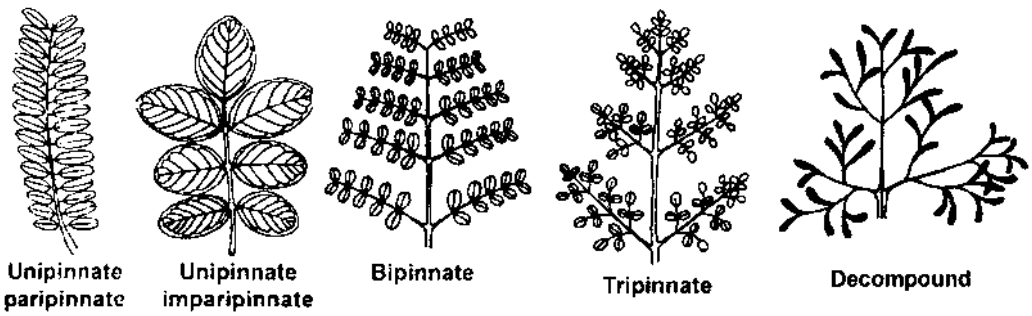
A. Unipinnate – In this type of leaf, division occurs only once and leaflets are directly attached on both sides of rachis.

- If the number of leaflet is even, then leaf is known as paripinnate. *e.g.,* ***Cassia fistula, Sesbania***
- If the number of leaflet is odd, it is known as imparipinnate. *e.g.,* **Rose, Neem.**

B. Bipinnate – A twice pinnate compound leaf *e.g.,* ***Acacia,*** **Gulmohar,** ***Mimosa*****.**

C. Tripinnate – A thrice pinnate compound leaf *e.g.,* ***Moringa.***

D. Decompound – A compound leaf, which is more than thrice pinnate. *e.g.,* **Carrot, Coriander.**



2. Palmate compound leaf –

In this type incision of leaf are directed from leaf margin to apex of petiole and all leaflets are attached on the upper end of petiole.

- **It is of following types –**

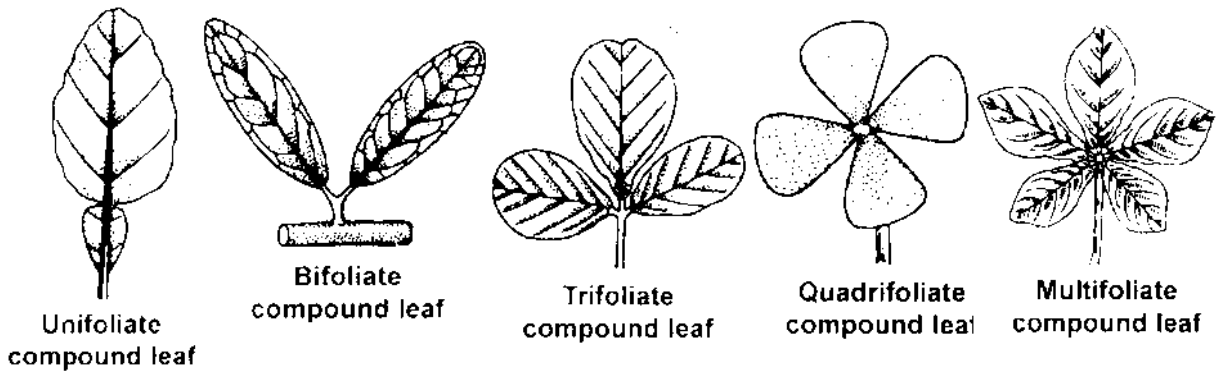
A. Unifoliate – When single leaflet is found. *e.g.,* **Lemon**

B. Bifoliate – When two leaflets are present. *e.g.,* ***Bauhinia, Regnelidium***, ***Bignonia***.

C. Trifoliate – When three leaflets are attached. *e.g.,* ***Oxalis, Aegle, Trifolium***

D. Tetrafoliate – When four leaflets are attached to the petiole. *e.g.,* ***Marsilea.***

E. Multifoliate – when more than four leaflet are found, then leaf is called multifoliate palmate compound leaf. *e.g.,* **Silkcotton.**



PHYLLOTAXY :

- It is of following type –

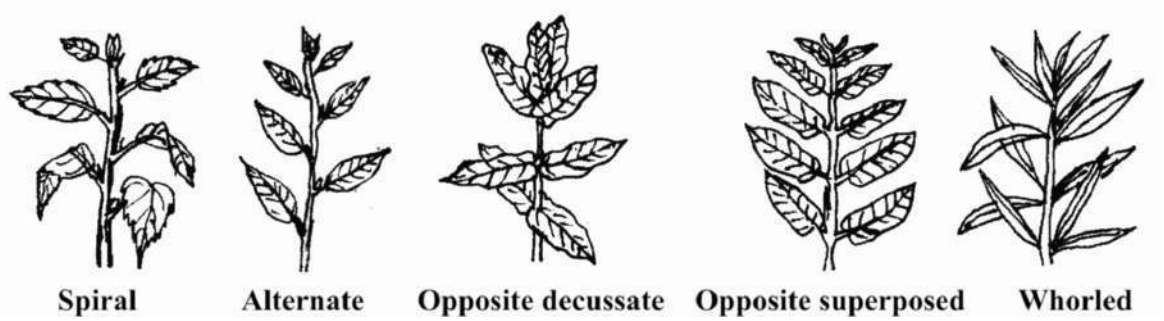
A. Alternate or spiral – Single leaf arising at each node. *e.g.,* ***Cyprus rotandus,*** Chinarose, mustard & Sunflower,.

B. Opposite – Leaves occuring in pairs at the node, they may be –

C. Decussate : Leaves that stands at right angle to next upper or lower pair *e.g.,* ***Calotropis, Mussaenda***.

D. Superposed : Successive pairs of leaves stand directly over a pair in the same plane *e.g.,* ***Psidium*** (guava), ***Ixora***.

E. Whorled – More than two leaves at each node *e.g.,* ***Nerium, Alstonia***.



HETEROPHYLLY –

- It is the occurrence of more than one type of leaves on the same plant. It is of three types –

A. Developmental Heterophylly : Leaves of different forms and shape occur at different period or places on the same plant *e.g.,* Mustard, Sonchus, Eucalyptus.

B. Environmental Heterophylly : It is aquatic adaptation which is commonly found in rooted emergent hydrophytes. In this, submerged leaves differ from the floating and aerial leaves. *e.g.,* ***Limnophila***, ***Heterophylla, Ranunculus aquatiles, Sagittaria***.

C. Habitual Heterophylly : Due to habit mature leaves differ in their shape and incissions *e.g., Artocarpus* (Jack fruit).

MODIFICATION OF LEAVES

(a) Leaf tendril – In it, whole leaf is modified into thin thread like structure which is called leaf tendril *e.g.,* ***Lathyrus aphaca*** **(wild pea).**

(b) Leaflet tendril – When leaflet is modified into tendril like structure than it is called leaflet tendril. *e.g.,* ***Pisum sativum*** (Garden pea), ***Lathyrus odoratus*** (sweet pea)

(c) Leaf spine – Leaves or any part of leaflet are modified into pointed spine. *e.g.,* ***Asparagus, Opuntia, Aloe, Argemone.***

(d) Leaf scale – In it, leaves become thin, dry and form a membrane or paper like structure and serve to protect axillary buds as in ***Ficus*** and ***Tamarix, Ruscus***, ***Casurina***.

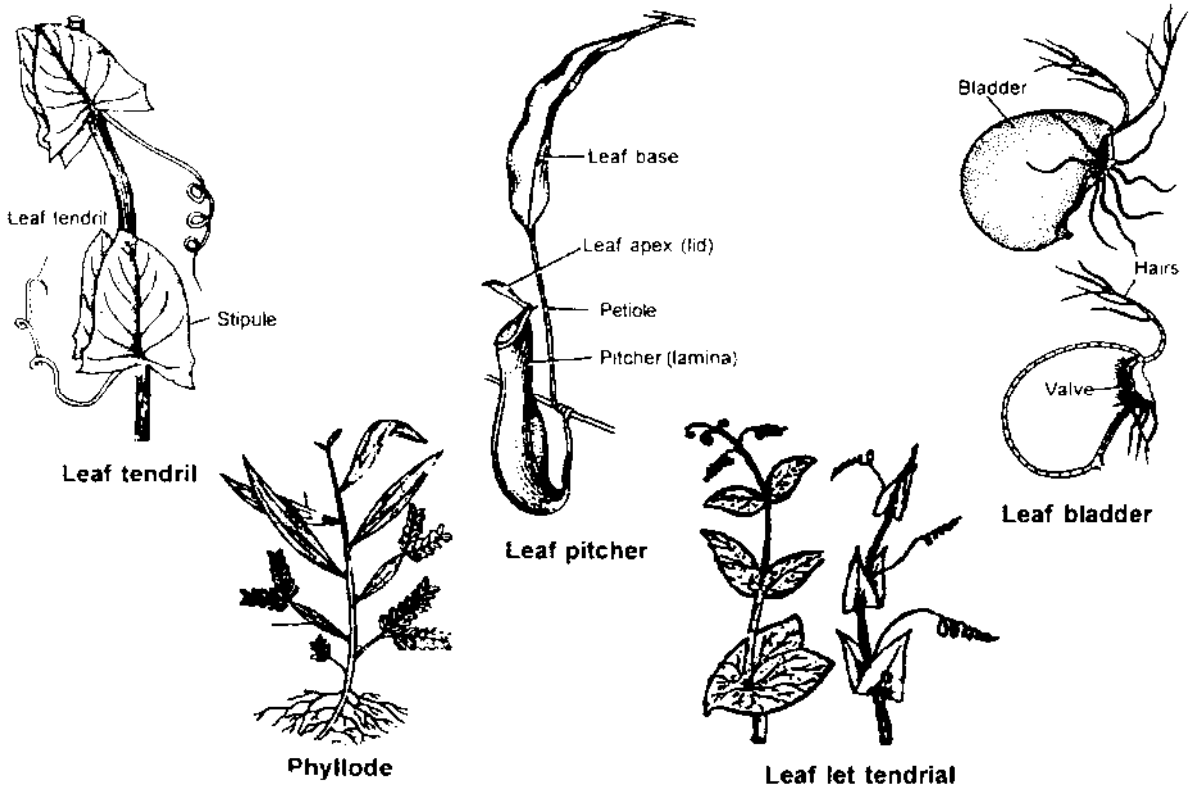
(e) Leaf pitcher – Leaves of some plants are modified to pitcher shape. *e.g.,* ***Nepenthes, Dischidia.***

(f) Leaf bladder – In some plant , leaves are modified into bladder like structure *e.g.,* ***Utricularia.***

(g) Leaf Hooks – In some plants terminal leaflets are modified into curved hooks for helping the plant in climbing. *e.g.,* ***Argemone, Opuntia, Aloe,*** **Cat's nail (*Bignonia unguis – cati*)**

(h) Phyllode – In its, petiole becomes flat structure and function as normal leaf. *e.g.*, ***Australian acacia*.**

(i) Flashy leaves – In onion and garlic food storing flashy leaves are present.



INFLORESCENCE

Arrangement of flower on floral axis is called inflorescence.

RACEMOSE

- In this type of inflorescence the main axis continues to grow and does not terminate in a flower and give off flower laterally in acropetal manner where old flowers are arranged toward base and young flowers are at tip. When peduncle is broad then flowers are centripetally arranged.
- This is of following different types :

(a) Raceme – When peduncle (main axis) is elongated and flowers are pedicellate.

e.g., **Radish,** characteristic feature of cruciferae family

When peduncle is branched and each branch bear pedicellated flowers like racemose and are arranged in acropetal manner known as compound raceme or panicle. *e.g.*, Gulmohar, Neem.

(b) Spike – In it peduncle is elongated but flowers are bisexual and sessile.

e.g., ***Achyranthes***

When peduncle is branched and each branch bear spike, like inflorescence then the small branch having flower is called spikelet and this arrangement is called as spike of spikelet. Characteristic inflorescence of family gramineae.

Catkin – In it peduncle is thin, long and weak, and flowers are sessile and unisexual. Peduncle is pendulus.

e.g., **mulberry, betula, oak.**

(c) Spadix – In it peduncle is thick, long and fleshy and have small sessile and unisexual male and female flowers covered with one or more green or colourfull bracts known as spathe.

e.g., **Colocasia, Maize, Aroids, Palms.**

(d) Corymb – In it peduncle is short and all flowers are present at same level because the lower flower has much long pedicel than the upper one *e.g.,* Candytuft **(*Iberis amara*)**.

- If in this type of inflorescene peduncle is branched, then each branch has flower cluster then this type of inflorescence is called compound corymb.

  e.g., **Cauliflower,**
- In mustard corymbose raceme type of inflorescence is present

(e) Umbel – An inflorescence in which the flower stalks of different flowers are of more or less equal length, arise from the same point. At the base of flowers stalks, there is whorl of bracts forming the involucre.

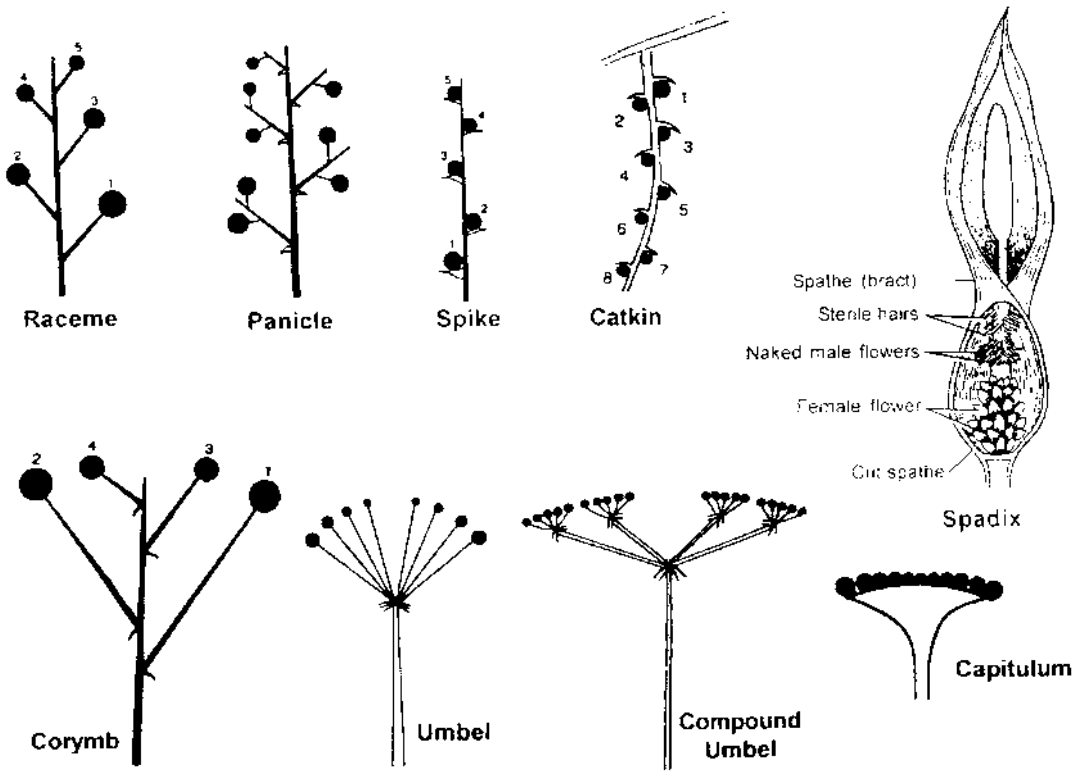
*e.g., **Centella***

- If in this type of inflorescence, peduncle is branched then each branch has flower cluster then this type of inflorescence is called compound umbel.

  *e.g., **Coriander, Foeniculum, Cuminum***.
- Characteristic feature of umbeliferae.
- **Scapigerous umbel is found in onion**

(f) Capitulum / Racemose head – In it the growth of peduncle is retarded and it become broad, flattened concave or convex. On it small flowers are found. These flowers are called floret. If all the flower of capitulum are same , then it is called homogamous. If two different type of floret, ray floret and disc floret are present in same inflorescence than it is known as heterogamous. In this type of inflorescence florets may be unisexual, bisexual and sterile. This inflorescence is surrounded by one or more involucre. It is most advanced type of inflorescence. *e.g.,* **Sunflower, Zinnia, Marigold**, **Cosmos**.

- Characteristic feature of asteraceae family.



CYMOSE

In this type of inflorescence, the peduncle terminate in a flower. In it the older flowers are present at tip and young buds are arranged towards base. This arrangement is called basipetal succession.

- It is of following types :

1. Uniparous cyme / Monochasial cyme –

- The peduncle ending in a flower producing lateral branch at a time of ending in flower.
- It is of two types –

(i) Helicoid cyme – When all lateral branches developed on the same side on peduncle then it is called helicoid cyme. *e.g.,* ***Heliotropium, Saraca, Atropa***, ***Datura.***

(ii) Scorpioid cyme – In it the lateral branch is alternately develop on left and right side. *e.g.,* ***Bignonia***,

2. Riphidium – In monochasial cyme all flowers are borne on same plane. *e.g.,* ***Solanum nigrum***

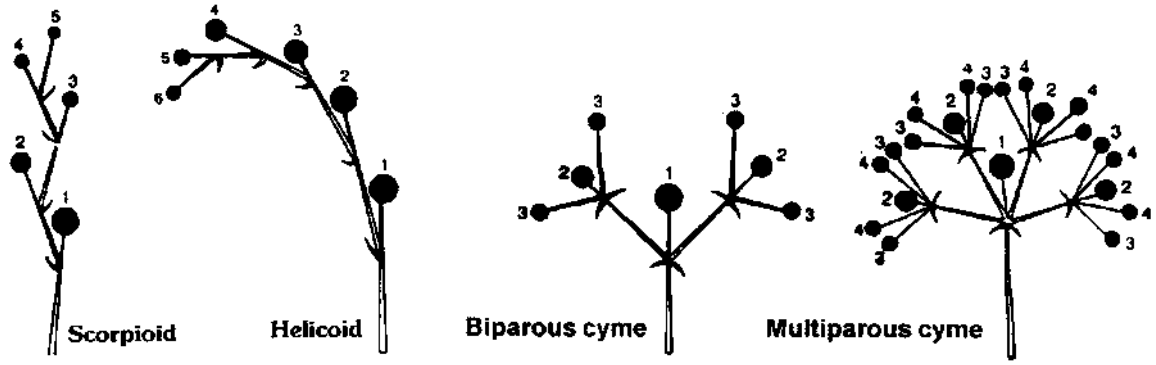
3. Dichasial or biparous cyme –

In it peduncle ends in a flower, from the basal part of peduncle two lateral branches arise, which also end in a flower, now this same arrangement occur on these lateral branches.

e.g., ***Bougainvillea,*** **Jasmine, Teak,** ***Mirabilis, Dianthus, Nyctanthes*****.**

4. Multiparous cyme / polychasial –

In it peduncle ends in a flower and from the base of it many lateral branches arise which also terminates in flower, this arrangement now also occur on these lateral branches. *e.g.,* ***Calotropis*** (Madar)**,** ***Nerium, Asclepias, Hamelia***



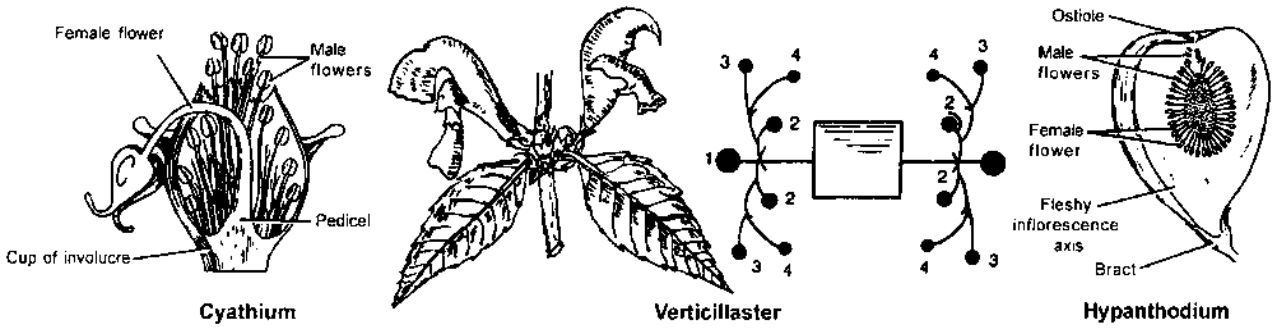
SPECIAL TYPE OF INFLORESCENCE

1. **Cyathium** – The bracts or the involucre become fused to form a cup shaped structure on the margin. In the central part of cup shaped structure a single female flowers is found, which mature earlier. Due to the growth of pedicel this come out from the cup shaped structure. Female flower are surrounded by large no. of small male flowers. The male flower, which lie toward centre mature earlier than the flower which are towards periphery. This inflorescence is found in Euphorbiaceae family like ***Euphorbia, Poinsettia, Pedilanthus***.

2. **Verticillaster -** A cluster of subsessile or sessile 3-9 flowers born on a dichasial cyme ending in monochasial cyme (scorpioid) in the form of condensed whorl on either side of the node. The opposite clusters give the appearance of whorl or verticel due to over crowding. The verticels are further arranged in a racemose manner *e.g.*, ***Ocimum*** (Tulsi), ***Salvia***. Characteristic inflorescence of labiateae family.

3. **Hypanthodium –** In it peduncle is modified in narrow cup like structure. At the base of cup female flowers develop while towards mouth male flower develops. All three types of flowers are present in this inflorescence. *e.g.,* **Banyan, Peepal, Ficus species**.

4. **Coenanthium :** In Dorsitenia, the receptacle becomes saucer shaped and its margins are slightly curved. Arrangement of florets are similar to hypanthodium.



5. **Mixed inflorescence –** Some times flowers are arranged in both racemose and cymose manner on same peduncle called mixed inflorescence.

- **Mixed spadix** – Banana
- **Cymose raceme or thyrsus** – Grapes.

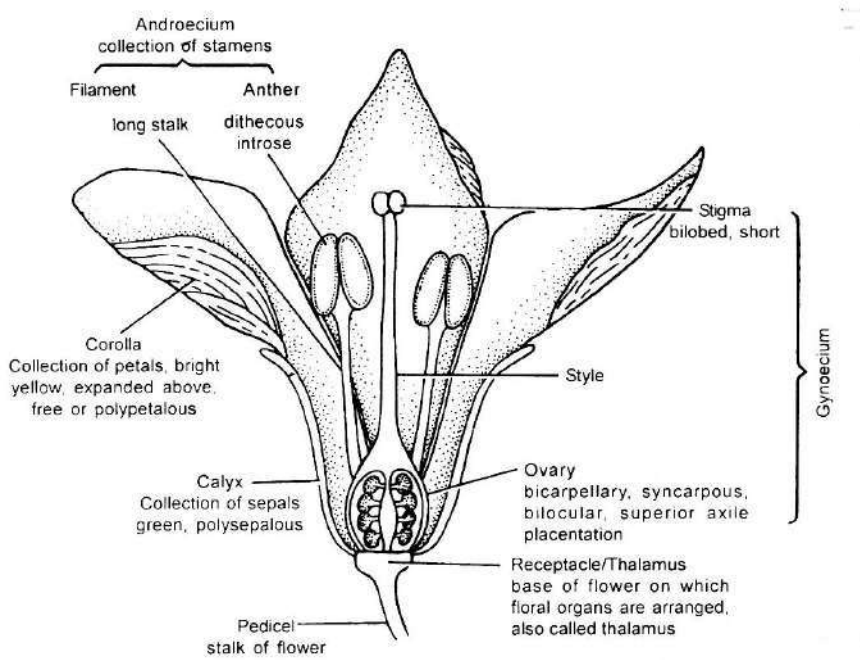
FLOWER

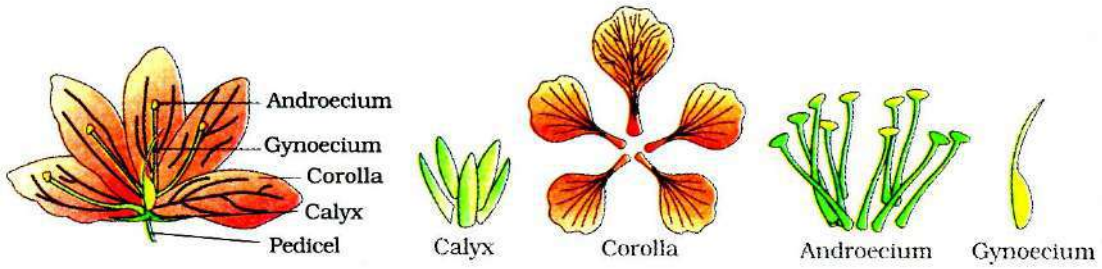
Flower is defined as highly condensed and modified reproductive shoot. The part from where flower arise is called **bract**. Flower has short or long flower stalk which is called pedicel. The upper part of pedicel is swollen, spherical shaped or conical which is called **thalamus / Receptacle**.

Floral leaves are present on it.

In a flower there are 4 type of floral leaves are found.

1. Sepal **2.** Petal **3.** Stamen **4.** Carpel





Parts of a flower

SOME WORDS RELATED TO FLOWER

- **Complete Flower –** When calyx, corolla, androecium and gynoecium are present.
- **Incomplete Flower –** Flower with one of the four whorl missing.
- **Bisexual Flower –** Both gynoecium and androecium present in the same flower.
- **Unisexual Flower –** Androecium (staminate flower) or gynoecium (Pistillate flower) any one of them are present in the flower.
- **Monoecious Plant –** When both male and female flowers are present on the same plant. *e.g.*, ***Cocos***, ***Ricinus, Colocasia, Zea, Acalypha***.
- **Dioecious Plant –** When male and female flowers are present on separate plant *e.g.*, Mulberry, Papaya.
- **Polygamous Plant –** When unisexual (male or female), bisexual and neuter flowers are present on the same plant *e.g.*, Mango, Polygonum.
- **Monocarpic Plant –** The plant which produces flowers and fruits only once in life *e.g.*, Pea, Mustard, Bamboo, Agave.
- **Polycarpic Plant –** The plants which produces flowers and fruits many times in life, *e.g.*, Pear, Mango,
- **Achlamydeous Flower –** Flowers are naked without sepals and petals *e.g.*, piperaceae.

– **Monochlamydeous Flower :** Only one accessory whorl is present (Perianth) *e.g.*, Polygonaceae, Liliaceae.

– **Dichlamydeous Flower :** Both accessory whorls present in flower.

- **Hemicyclic or Spirocyclic Flower :** Some of the floral parts are in circles and some are spirally arranged. *e.g.*, Ranunculaceae.
- **Cauliflory :**Production of flowers on old stem from dormant buds *e.g.*, ***Artrocarpus, Ficus***.
- **Symmetry of flower –** If the floral leaves are cyclic arranged in a flower, then it is called cyclic flower. If floral leaves are spirally arranged then it is called spiral flower. Floral symmetry is of three type –

(i) Actinomorphic / Radial / Regular – When flower is divided by any vertical plane into two equal halves, then it is called actinomorphic flower *e.g.*, Mustard, China rose, Datura, Chilli.

(ii) Zygomorphic / Bilateral – When the flower is divided into two equal halves only by one vertical plane, then it is called zygomorphic flower *e.g.*, Pea, Bean, Gulmohur, Cassia.

- If it is divided into two equal halves, from median plane, then it is called medianly zygomorphic, *e.g.*, **Ocimum** (Tulsi)
- But if it is divided into two equal halves, by lateral plane then it is called laterally zygomorphic

(iii) Asymmetrical / irregular – When the flower cannot be divided into two equal halves from any plane, then it is called asymmetrical flower. *e.g.*, Canna.

- **Internodal elongation in flower :**

– **Anthophore –** Internode between calyx and corolla is called anthophore. *e.g.*, ***Silane***

– **Androphore –** Internode between corolla and androecium is called androphore. *e.g.*, ***Passiflora***

– **Gynophore** – Internode between androecium and gynoecium is called gynophore. *e.g.*, ***Capparis*.**

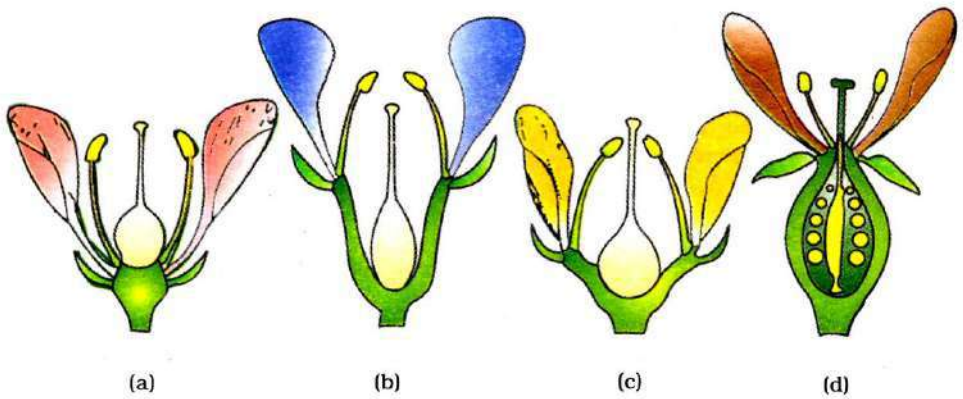
– **Gynandrophore or Androgynophore –** When both androphore and gynophore both conditions are found in same flower then this condition is called gynandrophore or androgynophore. *e.g.*, ***Cleome gynandra***.

– **Carpophore –** Elongation of thalamus beyond carpels. *e.g.*, **coriandrum**

Note : - Part of flower which lies near to mother axis is posterior part while the part which is far from mother axis is anterior part of flower.

INSERTION OF FLORAL LEAVES

1. **Hypogynous condition –** When petals, sepals and stamens are situated below the ovary, the flower is called hypogynous and in this condition ovary will be superior. *e.g.*, mustard, Chinarose, Brinjal.
2. **Perigynous condition –** In it thalamus grow upwardly and form a cup shaped structure. Gynoecium is situated in the centre and other parts of flower are located on the rim of the thalamus almost at the same level. It is called perigynous. The ovary here is said to be half inferior *e.g.*, plum, peach, rose.
3. **Epigynous condition –** The margin of thalamus grows upward enclosing the ovary completely and getting fused with it, the other parts of flower arises above the ovary, the ovary is said to be inferior and this condition is known as epigynous *e.g.*, Guava, Cucumber and ray florets of sun flower



Position of floral parts on thalamus
(a) Hypogynous (b) and (c) Perigynous (d) Epigynous

Notes :

- **Bracts :** Bracts are specialized leaves present in axis of flower.
- **Bracteate –** The flower which have bract is called bracteate flower.
- **Involucre –** The whorl of bract surrounding peduncle is called involucre.
- **Involucel –** Group of bracteole is called involucel.
- **Spathe –** In flowers when large bract completely encloses whole inflorescence, then it is called spathe. *e.g.*, Banana, Maize.
- **Petaloid bract –** When the size of bract of flower is greater than size of flower and these are of various coloured then it is called petaloid bract. *e.g.*, ***Bougainvillea.***
- **Glumes –** Small, dry, scaly bracts are called Glumes. *e.g.*, Wheat, Grass.

CALYX

- The outermost whorl of flower is called calyx. Each member of this whorl is called sepal when all the sepals are free from each other, then it is called poly-sepalous condition *e.g.*, Mustard, Radish. When the sepals are fused each other, then it is called gamosepalous condition *e.g.*, Cotton, Datura, Brinjal.
- In calyx of ***Mussaenda***, one of the sepal enlarge and form a leaf like structure. It may be white or brightly coloured. It attracts the insects and thus act as advertisement flag.
- In ***Trapa***, calyx is modified into spines and helps in protection of fruit.
- In ***Argemone*** spines are present on the surface of sepal which protect the flower bud.
- In larkspur and Balsum, the posterior part of sepal is modified into a narrow tube. This structure is called sepal spur. Nectar is stored in it for insect attraction.
- In asteraceae family, sepals are modified into hairy structure. It is called pappus. The pappus is a modified calyx and helps in dispersal of fruit.

DURATION OF SEPALS

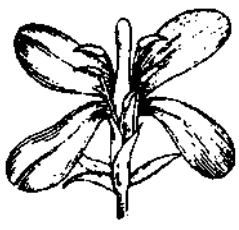
+ **Caducous** – Sepals fall just at the time of opening of flower bud. *e.g.*, Poppy.
+ **Deciduous** – Sepals fall after pollination *e.g.*, Mustard
+ **Persistant** – If sepals do not fall and remain attached to fruit. *e.g.*, Tomato, Capsicum, Brinjal, Cotton, Datura.
* Sometime below calyx, a whorl similar to sepals is found which is called epicalyx. *e.g.*, Malvaceae family

COROLLA

- The second whorl of flower is called corolla and each member of it is called Petals. When the shape and size of petals are similar then it is called symmetrical while when they are not similar then they are asymmetrical. When all the petals are free, then it is called polypetalous while when petals are fused, then it is called gamopetalous.
- **Forms of Corolla -**

1. Polypetalous :

- **Cruciform** – 4 petals are present in it. The lower narrow part of petal is called claw while the outer broad part is called limb. These petals are arranged crosswise. *e.g.*, **Radish, Mustard**.
- **Caryophyllaceous** – It consists of 5 petals the claw of petals are short and the limb of petals from right angle to the claw *e.g.*, **Dianthus.**
- **Rosaceous –** It consist of 5 or more petals. Claws are absent in it and limbs are spread regularly outwards. *e.g.*, Rose, Coconut.


Cruciform

Caryophyllaceous

Rosaceous

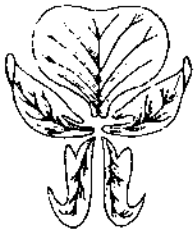
2. Gamopetalous :

- **Campanulate** – Five petals are arranged like bell. *e.g.*, **Tobacco, Raspberry, Campanula**.
- **Funnel shaped or infundibuliform** – Funnel like petals arrangement *e.g.*, **Datura, Railway creeper**.

- **Tubular –** Petals are like tube *e.g.,* **Disc florets of sunflower**.

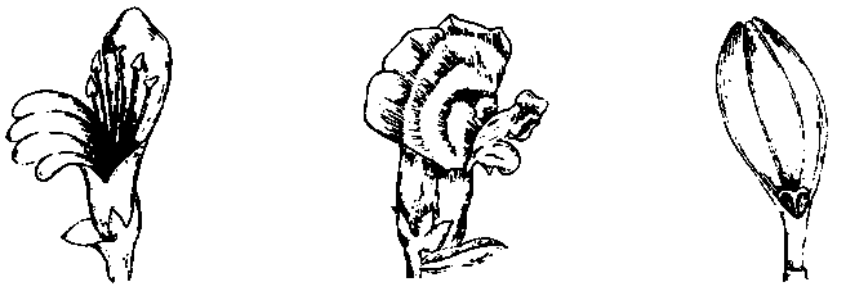
3. Zygomorphic polypetalous corolla -

- **Papilionaceous –** Five petals are present. It's posterior petal is largest and is known as **standard** or **vexillum**. Vexillum covers two lateral petals which are called as wings and the innermost basal petals are united to form a keel or carina. Both lateral parts covers the keel. *e.g.*, **Pea, Gram, Arher**


Papilionaceous

4. Zygomorphic gamopetalous corolla –

- **Bilabiate –** The petal of gamopetalous corolla is divided into two lips. The place between two lips is called **corolla mouth**. *e.g.*, ***Ocimum, Salvia*.**
- **Personate –** In this case the corolla is bilabiate but the two lips are near to each other *e.g.*, ***Antirrhinum***
- **Ligulate –** The upper part of corolla is long, flattened which is attached with short narrow tube. *e.g.*, **Ray florets of sunflower**.



5. Aestivation -

- The mode of arrangement of sepals or petals in floral bud with respect to the other members of the seme whorl is known as aestivation. It is of following types –

(i) Valvate – When the petal of a whorl lie adjacent to each other petal and just touches it. *e.g.*, ***Calotropis*, Custard-apple, Mustard.**

(ii) Twisted – In it one part of a petal covers adjacent petals and the other part is covered by posterior petal. One margin of the petal overlaps that of the next one, and the other margin is overlapped by the third one. *e.g.*, Cotton, Ladyfinger, Chinarose

(iii) Imbricate –

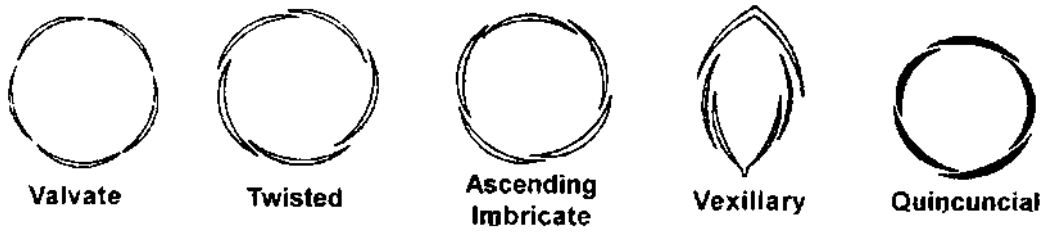
- When both margin of the one petal are covered by the others two petals and both margin of another one, covers other, Rest are arranged in twisted manner.
- It is of two types –

(a) Ascending imbricate – The posterior petal is innermost i.e., its both margins are overlapped. *e.g.*, ***Cassia*, *Bauhinia***, Gulmohur etc.

(b) Vexillary or Descending imbricate – The anterior petal is innermost and posterior petal is outermost & largest. *e.g.*, Pea, Bean.

(iv) Quincuncial –

It is a modification of imbricate type. Out of the five petals, two are completely internal, two completely external and in the remaining petal, one margin is internal and the other margin is external. *e.g.*, ***Murraya, Ranunculus***.



6. PERIANTH

- When there is no distinction between calyx and corolla the whorl is described as perianth.
- Individual perianth segments are called **Tepals**. Green tepals are called **sepaloid** and coloured tepals are called **petaloid**. Tepals are free (polytepalous) or fused (gamotepalous). *e.g.*, ***Liliaceae*** and ***Graminae*** family

ANDROECIUM

- It constitutes the third whorl of the flower and is made up of one or more stamens. Each stamen consist of filament, anther and connective. Each anther is usually bilobed and each lobe has two chambers the pollensac. The pollen grains are produced in pollensac.

A. Attachment of filament to anther lobe :

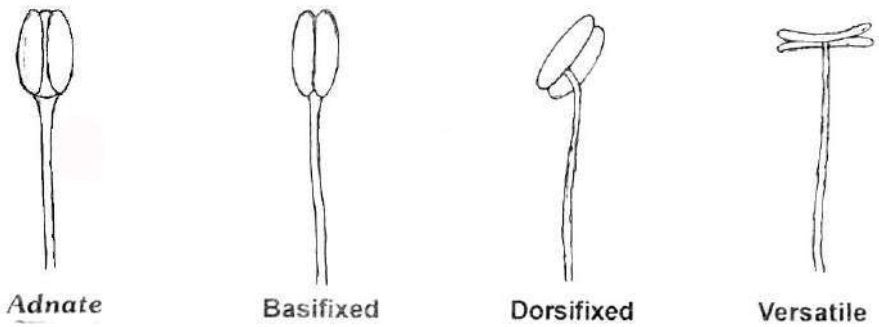
- The attachment of filament to another lobe is of 4 type –

(i) Adnate – Filament runs through the whole length of the anther from the base to the apex. *e.g.*, ***Michelia*** (Champa)**,** ***Magnolia***

(ii) Basifixed – Filament is attached to anther by its base. *e.g.*, **Datura, Radish, Mustard.**

(iii) Dorsifixed – The filament is attached at the centre to the back of the anther. *e.g.*, **Passion flower**

(iv) Versatile – Filament attached to the back of the anther at a point only, thus the anther can swing freely. *e.g.*, Wheat, grass, maize.



B. Cohesion of stamens :

When the floral parts of similar whorl are fused, then it is called **cohesion**. When the stamens of an androecium are free from one another, it is called **polyandrous condition**.

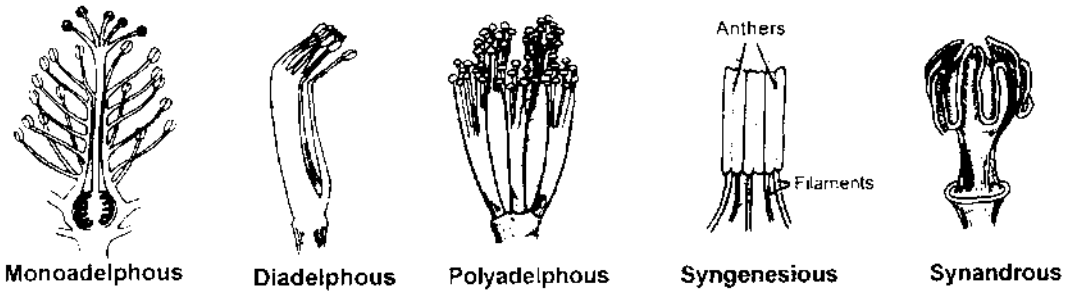
(i) Adelphous : when stamens are united by their filament only, it is called adelphous. It is of following types–

- **Monoadelphous** – When all the filaments are united into a single bundle but anthers are free from each other. In this type of cohesion a tube is formed around the gynoecium which is called staminal tube *e.g.*, Cotton, Hollyhock, Ladyfinger.
- **Diadelphous –** When the filaments are united in two bundles but the anther remains free *e.g.*, Gram, Pea, Bean

  In these plants from 10 stamens, 9 stamens are arranged in bundle while 1 remains free.
- **Polyadelphous –** When filaments are united into more then two bundles. *e.g.*, Citrus, Castor.

(ii) Synandrous – When anthers as well as filaments of stamens are united through their whole length. *e.g.*, ***Colocasia, Alocasia, Momordica,*** Cucurbitaceae family

(iii) Syngenesious – In it only anthers are united in bundle but filaments remain free *e.g.*, Compositae family



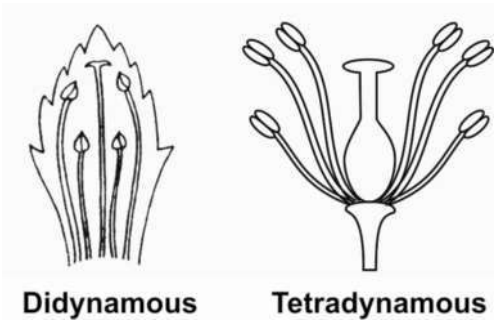
C. Adhesion of stamens :

When the stamens are attached to other parts of flower, then it is called adhesion of stamens.

- **Epipetalous –** When stamens are attached to petals. *e.g.*, Brinjal, Datura, Tobacco, Sunflower, Potato.
- **Epiphyllous –** When stamens are attached to tepals. *e.g.*, Onion, Lily.
- **Gynandrous** – When stamens are attached to gynonecium either throughout their whole length or by their anther *e.g.*, ***Calotropis***.

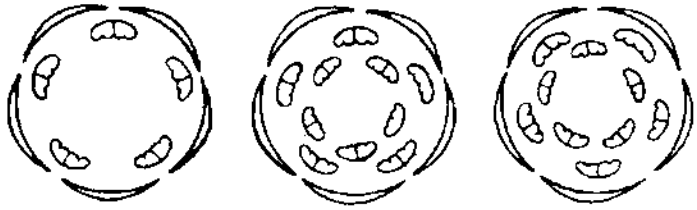
D. Length of stamens :

- **Didynamous –** When four stamens are present, out of them two are long and two are short, then it is called didynamous. *e.g.*, Labiatae family.
- **Tetradynamous –** When there are six stamens and they are arranged in two whorls. In outer whorl, there are two short stamens while in inner whorl, there are four long stamens, this condition is called tetradynamous. *e.g.*, Cruciferae family.



Note –

- **Inserted –** When the stamens are smaller than corolla. *e.g.*, Datura
- **Exserted –** Stamens are longer than corolla and are radially outward. *e.g.*, Gulmohar.
- **Diplostemonous –** The stamens are double the number of petals and present in two whorls. The outer whorl of stamens is alternating with petals (alternipetalous), while inner whorl is opposite to petals (antipetalous). *e.g.*, **Liliaceae family.**
- **Obdiplostemonous –** It is reverse of diplostemonous. The outer whorl of stamen is opposite to petals, while inner whorl of stamen is alternating with petals. *e.g.*, **Caryophyllaceae.**



- **Isostemonous or Haplostemonous –** In such type of condition stamens are present in single whorls. No. of stamens is equal to no. of sepals and petals and generally whorl of stamens is alternating with petals.
- **Heterostemonous –** Stamens are of different length in some flowers.
- **Staminodes –** When stamens are without pollen grains & remain sterile through out life are called staminodes e.g. ***Salvia verbascum***.

GYNOECIUM (PISTIL)

- It is the fourth and second essential whorl of the flower. It is female part of the flower comprising of the inner whorl of megasporophylls in the form of carpels bearing ovules. It consists of ovary, style and stigma. Ovary is the enlarged basal part, on which lies the elongated tube the style, the style connects the ovary to the stigma. The stigma is usually at the tip of the style and is receptive surface for pollen grains. The gynoecium may be monocarpellary or multicarpellary.
- If only one carpel is present in gynoecium this condition is called monocarpellary.
- If more than one carpel is present in gynoecium this condition is called polycarpellary.
- If all the carpels in polycarpellary / multicarpellary condition are free, then condition is called apocarpous.
- If all the carpels are fused together, then condition is called syncarpous.

COHESION OF CARPEL

- In syncarpous gynoecium four types of cohesion are found :

(a) When ovaries are fused, but stigma and style are separated with each other, *e.g.*, **Dianthus, Plumbag**

(b) Ovary and style are fused, but stigma are not fused. Malvaceae family. ***Hibiscus rosasinensis,*** cotton.

(c) When stigma are fused but the ovary and style are free. *e.g.*, ***Calotropis, Cassia fistula, Nerium*****.**

(d) Carpels are completely fused. This condition is found in max. flowers, *e.g.*, **Mustard, Radish, Tomato**.

PLACENTATION

- The ovules are attached on ovary walls on one or more cushion called placenta. The arrangement of ovule within ovary wall is known as placentation. It is of following types –

(i) Marginal : Marginal placentation is found in unilocular ovary. The placenta forms a ridge along the ventral suture of the ovary and the ovules are borne on this ridge forming two rows. *e.g.*, Leguminosae.

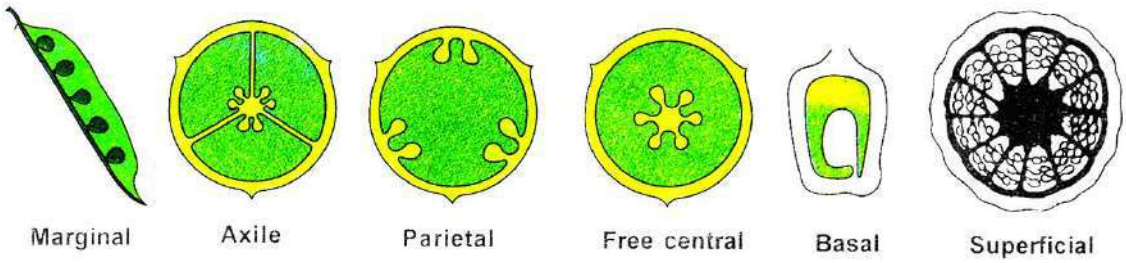
(ii) Parietal : This type of placentation is found in unilocular syncarpus ovary. In it the ovule develops on the innerwall of the ovary or on peripheral part. Ovary become bi or multilocular due to formation a false septum *e.g.*, ***Cucurbita, Argemone,*** and Cruciferae family (Mustard)

(iii) Axile : It is found in multicarpellary syncarpous gynoecium. The fusion margin of carpels grown inward and meet in the centre of the ovary. Thus an axis forms in the centre of ovary, thus ovary becomes multichambered. The ovules are born at the central axis. Number of these chambers are equal to the number of carpel ***e.g.*****, Potato, China rose, Onion, Lemon, Orange, Tomato**.

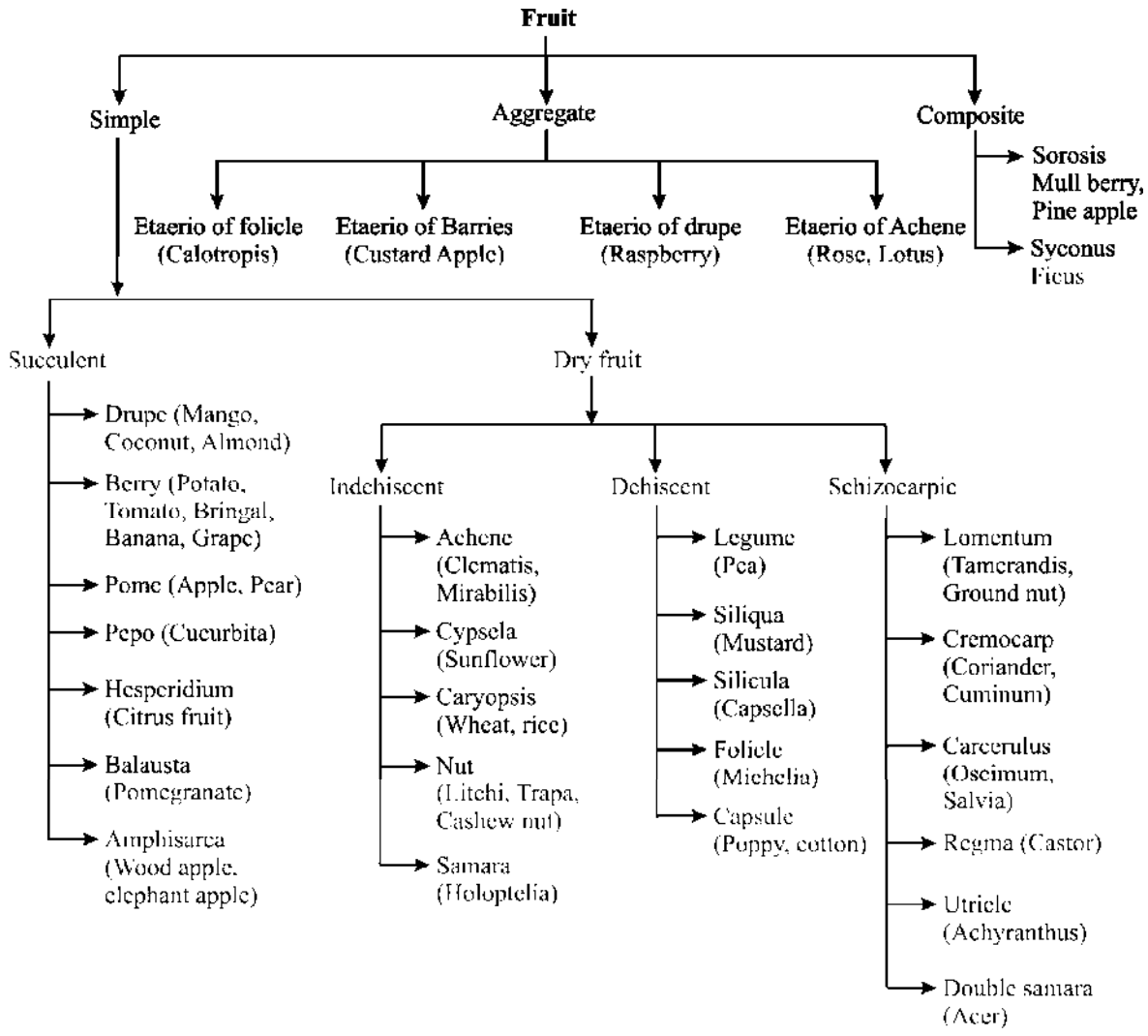
(iv) Free central : This type of placentation is found in syncarpous gynoecium. In it, the ovary is unilocular and the ovules are borne on the axis in the centre of the ovary. septum are absent in ovary. Placentation is axile in beginning. After sometimes walls of chamber destroy and only ovulated central axis left. *e.g.*, **Primrose, Dianthus (Caryophyllaceae)**

(v) Superficial – This type of placentation is found in multicarpellary syncarpous gynoecium. The ovules are attached on the walls of locule *e.g.*, **Nymphea** (Water lily)

(vi) Basal : The ovary is unilocular and a single ovule is borne at the base of ovary. *e.g.*, Marigold, Sunflower (Asteraceae family).



FRUIT



- Fertilized and ripened ovary is fruit. A Fruit consist of (i) Pericarp (fruit wall), (ii) seed.
- The seeds are protected inside fruit. But in some fruits, seeds are not found like in grapes, banana and such type of fruits are seedless fruit.
- If a fruit is formed without fertilization of the ovary it is known as **parthenocarpic fruit**.

PERICARP

- After ripening, the ovary wall change into pericarp. This pericarp may by thick and fleshy or thick and hard or thin and soft.
- Pericarp is differentiated in 3 layers

(i) Epicarp :- It is the outermost layer, which is also called rind

(ii) Mesocarp :- It is the middle layer.

(iii) Endocarp : It forms the innermost layer.

TRUE FRUIT :

When the fruit is developed only from the ovary, the fruit is called as **true fruit**. *e.g.*, Mango, Coconut, ***Zizyphus***

FALSE FRUIT OR PSEUDOCARP :

- In some fruits, in place of ovary, some other parts of flower like thalamus, inflorescence, calyx are modified to form a part of fruit. These types of fruit are called **false fruits**. *e.g.*, Apple, Strawberry, Pear.

CLASSIFICATON OF FRUIT

- Fruits are divided in three groups :

1. Simple **2.** Aggregate **3.** Composite

1. SIMPLE FRUIT :-

- These fruit develop from monocarpellary ovary or multicarpellary syncarpous ovary. Only one fruit is formed by the gynoecium. Simple fruits are of two types –

(A) Fleshy fruit **(B)** Dry fruit

A. Fleshy Fruit:- These fruit develop from superior or inferior syncarpous gynoecium. These may be unilocular or multilocular. These fruits are indehiscent. Dispersal of seeds occur after pericarp is destroyed.

- Fleshy fruits are of following types :

(i) Drupe fruit :- These fruit develops from mono or multicarpellary, syncarpous, superior ovary. In these fruits endocarp is hard and stony so these fruits are also called stony fruits. *e.g.*, Mango, coconut almond, Peach walnut, plum. Brachysclereids are present in endocarp.

In mango edible fleshy part is mesocarp and the part where seed is protected is called as **endocarp**.

In ber, epicarp and mesocarp both are edible part.

The rind of Almond and walnut are endocarp and their edible part is seed.

In coconut epicarp is hard and thin while mesocarp is thick and consist of hard fibers The endocarp is hard and seed is protected in it. Endosperm is edible in coconut.

(ii) Berry : These fruits develop from mono or multicarpellary syncarpous ovary. Ovary may be superior or inferior, Placentation is axile or parietal. In these epicarp is thin and seeds are embedded in fleshy part.

Initially seeds are attached with placenta of fruit but after maturation these seeds are deteched with placenta and are spread randomly in fleshy part.

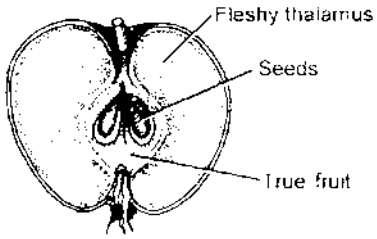
- Plants with superior ovary = Tomato, Grapes, Brinjal.
- Plants with inferior ovary = Guava, Banana

Date palm is one seeded berry. In it pericarp is divided into epicarp, mesocarp and endocarp. Epicarp is thin and soft while mesocarp is thick and fleshy and endocarp is thin like a membrane. Which is attached with seed.

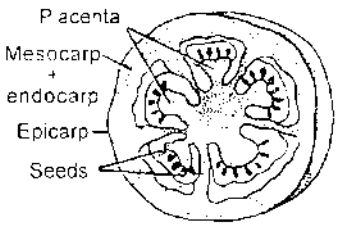
Arecanut is one seeded fibrous fruit berry. When its thick fibrous layer is removed then seed comes out which is hard.

(iii) Pepo - These fruit develops from tricarpellary, syncarpous and inferior ovary. This fruit is unilocular and have parietal placentation. These fruits are fleshy and spongy. sometime fruits are bitter in taste due to presence of tetracyclic triterpine in flashy pulp. *e.g.,* fruits of cucurbitaceae family.

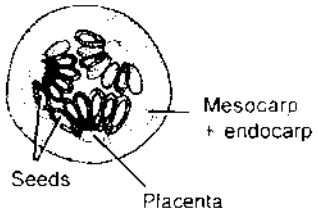
(iv) Pome - This fruit develops from bi or multicarpellary syncarpous inferior ovary. The rind and fleshy pulp are made up of thalamus. The main part of ovary is hard and dry and remain inside the fruit. Seeds are present in it. *e.g.,* Apple, Pear.



L.s. of Apple

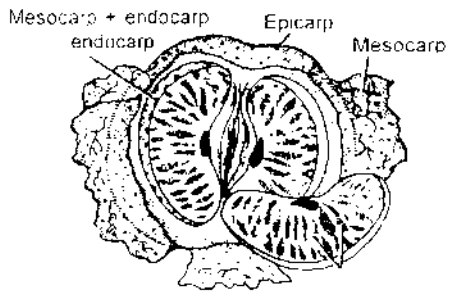


L.s. of Tomato

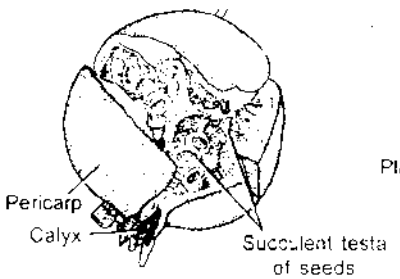


T.s. of Cucumber

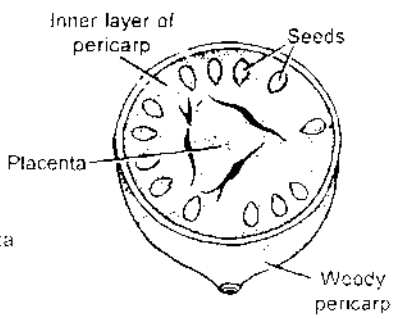
- **Hesperidium :** This fruit develops from multicarpellary, syncarpous, superior ovary. This fruit is specialy found in plants of Rutaceae family. *e.g.,* Orange, Lemon, Citrus fruit.
  Epicarp of these is made up of thick rind which is leathery and many oil glands are found in it. Mesocarp is white fibrous structure which is attached with epicarp. Membranous endocarp projects inward and form many chambers. Many glandular hairs are present on the inner side of endocarp. These glandular hairs are only edible parts.
- **Balausta :** It is a multilocular multiseeded fruit, which develops from inferior ovary. Its pericarp is hard. Persistent calyx is arranged in the form of crown. Seeds are irregularly arranged on placenta. Endocarp is hard. Testa is fleshy. This is the edible part of fruit. *e.g.,* Pomegranate **(*Punica granatum*).**
- **Amphisarca :** This fruit is multicarpellary and multichambered which develops from superior ovary. Pericarp is hard and fleshy placenta is found in them. The inner part of pericarp and placenta is edible part of fruit. Testa of seed is mucilegenous *e.g.,* wood apple **(*Aegle marmelos*),** elephant apple.



Hesperidium of orange



Balausta of pomegranate



Amphisarca of wood apple

B. Simple Dry Fruit - Pericarp of simple dry fruit is hard and dry and not differentiated into epicarp, mesocarp and endocarp. Such fruits are called **dry fruit**.

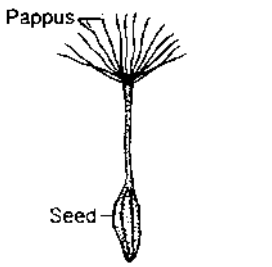
- Simple dry fruits can be divided into following three groups :

  (i) Indehiscent **(ii)** Dehiscent **(iii)** Schizocarpic

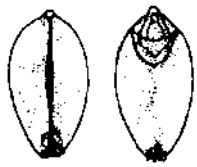
(i) Indehiscent fruits : These simple dry fruits are generally of small size and single seeded pericarp does not rupture even after maturity.

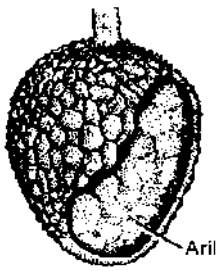
- **Cypsela :** It is a small, single seeded dry fruit which develops from bicarpellary, syncarpous inferior ovary. Pericarp and seed coat are free from each other. In these fruits a bunch of hair is attached with the fruit which is known as Pappus. Pappus helps in fruit dispersal. *e.g.,* Compositae family Plants.
- **Caryopsis :** These are small, single seeded dry fruits. It develop from monocarpellary, superior ovary. Pericarp of these fruits is fused with the seed coat and form a joint surface. These fruits are present in family gramineae. Wheat grain or rice grain is a fruit.
- **Achene :** These are single seeded fruit which develops from monocarpellary superior ovary. In it, pericarp is free from the seed coat *e.g.,* ***Clematis, Mirabilis, Boerhaavia***
- **Nut :** This is a single seeded fruit which develop from monocarpellary syncarpous superior ovary. In it pericarp is hard *e.g.,* ***Quercus*** (oak), ***Anacardium occidentale*** (Cashewnut) ***Trapa***, (Water chest-nut), Litchi.

  In Litchi epicarp and mesocarp is fused and give leathery apperence. Endocarp is membrane like thin. Outer seed coat grows forward and forms an additional coat around the seed which is called as aril. In mature fruit, this aril is fleshy and is only edible part.
- **Samara :** These are dry indehiscent one seeded feathery fruit. It develops from bi or tri carpellary, syncarpous and superior ovary. The main character of these fruits is wing like structure develops from its pericarp which helps in dispersal. *e.g.,* ***Holoptelia***.

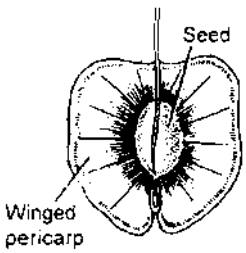


Cypsela of sunflower


Caryopsis of wheat



Nut of Litchi



Samara of Holoptelia

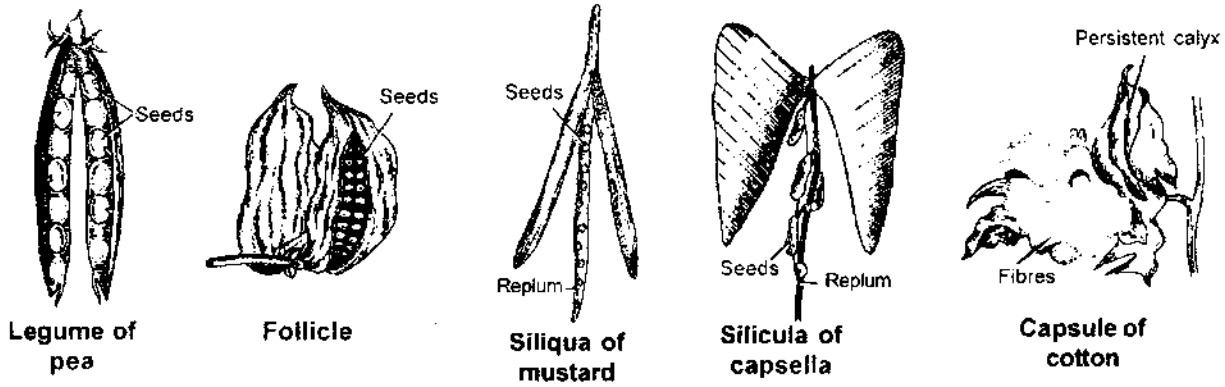
In ***Shorea robusta*** wing develops from calyx instead pericarp and these fruit are called **samaroid**.

(ii) Dehiscent Fruits : After ripening pericarp are ruptured and seeds are dispersed outside.

- **Legume or pods :** These fruits develop from monocarpellary, unilocular, superior ovary. It is generally long and multiseeded fruit. Dehiscense of fruit occurs at both sutures i.e. Dorsal and ventral side. Dehiscence start from apex and reaches to basal part. *e.g.,* Pea, Beans.

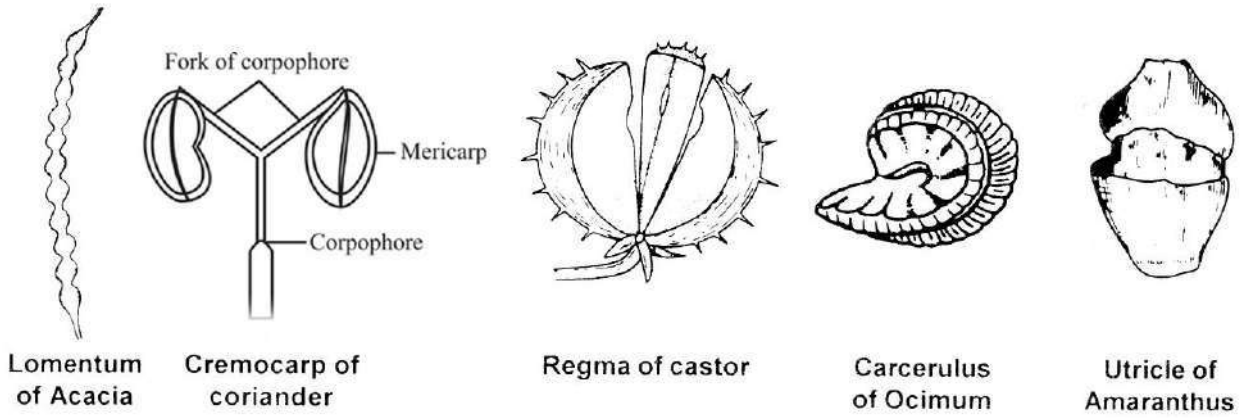
  When only one or two seeds are present in fruit, then it is also called as pod.
- **Follicle :** It is also multiseeded fruit which develops from superior unilocular, monocarpellary ovary but the dehiscence of it occur only at ventral suture. *e.g.,* ***Asclepias, Rauwolfia, Vinca, Michelia*** (Champa), ***Delphinium***.

- **Siliqua :** This fruit develops from bicarpellary, syncarpous superior ovary with parietal placentation. Dehiscence occurs at both dorsal and ventral suture and starts from lower part and proceeds upward. Due to formation of false septum ovary become bilocular. On false septum, seeds are attached, This type of fruit is found in Cruciferae family. *e.g.,* Mustard.
- **Silicula :** A short broad siliqua is known as Silicula. It is also found in Cruciferae family. *e.g.,* Candytuft (***Iberis amara***), Capsella,
- **Capsule :** This is dry multichambered and multiseeded fruit and develop from multicarpellary syncarpus, superior ovary. In it, Axile placentation is found and dehiscence occurs by various methods. Poricidal (Poppy), loculicidal (cotton), septifragal (Datura), septicidal (Lineseed).



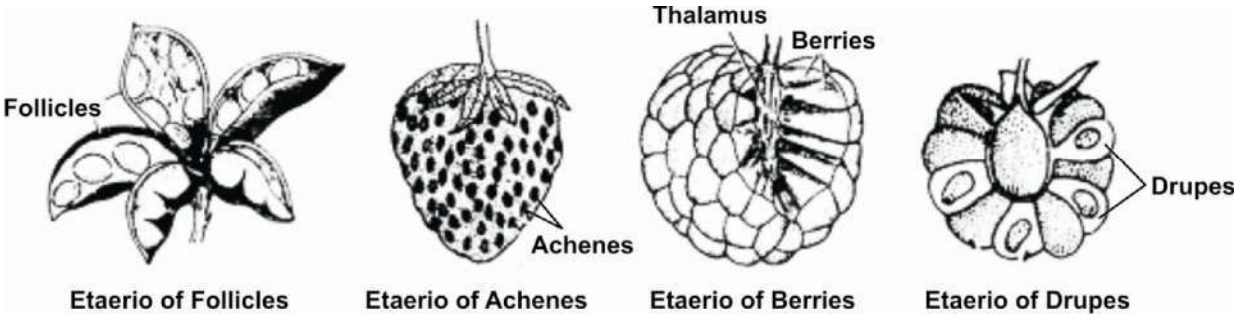
(iii) Schizocarpic fruit : It is a multiseeded fruit. After ripening, it is devided into mericarp and seeds come out after destruction of pericarp. The fruits develop from mono or bi or multicarpellary superior or inferior ovary. The mericarp contains one or two seeds.

- **Lomentum :** It develops like legume. Fruits are constricted or divided in one seeded mericarp, after maturity these are separated with each other. Eg ***Tamarind, Cassia fistula, Mimosa pudica, Archis hypogea, Desmodium***.
- **Cremocarp :** It is a double seeded fruit and develops from bicarpellary, syncarpous, inferior ovary. On maturation, it dehisces from apex to base in such a way that two mericarp forms and each contain one seed. These mericarp are attached with carpophore. Carpophore is the extended part of receptacle. *e.g.,* **Coriander, Cuminum, Foeniculum.**
- **Regma :** This fruit develops from tri to pentacarpellary, syncarpous superior ovary. In it three locules are present and its fruit is breaks into three one seeded part. Each part is known as coccus. At the outer end of pericarp, spines are found. *e.g.,* Euphorbiaceae family, Castor has three cocci Geranium has 5 cocci.
- **Carcerulus :** It is a dry fruit which develops from multi carpellary or bicarpellary, syncarpous, superior ovary. Number of mericarp is more than locules because of formation of false septum. It divides into four one seeded locules. *e.g.*, ***Ocimum*** (Basil), ***Salvia.***
  In hollyhock and abutilon (family malvaceae), the no. of locules is more than four.
- **Utricle :** It is a single seeded fruit which has thin membrane. It dehiscence generally from cap. It develops from bicarpellary, unilocular, syncarpous, superior ovary. *e.g.*, ***Achyranthes, Amaranthus.***
- **Double Samara :** It develop from bicarpellary syncarpous superior ovary. Pericarp develops into two wings. On maturation it divides in two single seeded mericarp eg . samara , acer.



AGGREGATE FRUIT

- These fruits develop from multicarpellary apocarpous ovary. Because in apocarpous ovary, each carpel is separated from one another, therefore it forms a fruitlet. These fruits are made up of bunch of fruitlets which is known as **etaerio**.
- **Etaerio of follicles :** Each fruitlet is a follicle. *e.g.,* ***Calotropis, Catharanthus, Magnolia*.**
- **Etaerio of achenes :** In this aggregate fruit, each fruitlet is an achene. *e.g.,* ***Rananculus***, Strawberry, Rose, Lotus
- **Etaerio of berries :** It is an aggregate of small berries. *e.g.,* ***polyalthia, Annona squamosa*** (Custard-apple). In etaerio of Anona all the berries are arranged densly on thalamus.
- **Etaerio of drupes :** In this type of fruit, many small drupes develop from different carpels. *e.g.,* Raspberry



COMPOSITE FRUIT

- All composite fruits are false fruits.
- This type of fruit differ from aggregate fruit that in place of single ovary many ovaries and other floral parts combine together to form fruit. In composite fruits, generally whole inflorescence is modified into fruit. These are of two types.

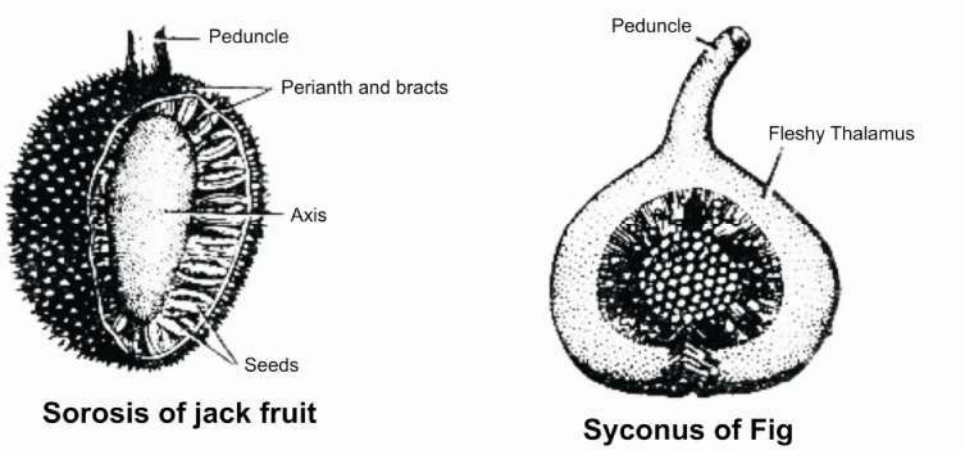
(i) Sorosis : This fruit develops from spike, spadix or cartkin inflorescence. Peduncle become thick spongy and woody. *e.g.*, Jack fruit, ***Pandanus*** **(screwpine)**, Pineapple

In jack fruit (Kathal) pistillate flowers are developed around the peduncle. In fruit formation pericarp become spongy and fused.

In Pine apple peduncle bracts and perianth become fleshy. Due to the fusion of perianths of flower a composite fruit is formed.

In mulberry perianth become fleshy and calyx of every flower becomes thick, sweet and fleshy and are edible.

(ii) Syconus : This fruit develops from hypanthodium inflorescence. *e.g.*, **Ficus** species like fig, Peepal



Geocarpic fruit : When fruit development occurs inside soil e.g. **ground nut**

DISPERSAL OF FRUIT AND SEED

- The seeds falling directly under the mother plant have to germinate and develop under limited food supply and space. To overcome this problem, the fruits and seeds have developed several special devices for wide dispersal.
- The natural agents like wind, water, animals and even mechanism of dehiscence in some fruits, help the seeds and fruits to disperse from one place to another, and to long distances from the parent plant.

1. WIND (Anemochory) :

- In the species where the seeds are light in weight or have some accessory part to help dissemination, are dispersed by the air current.
- The seeds of Drum-stick and Cinchona, and fruits of yam, maple and sal tree, are having appendages in the form of thin, flat and membranous wings, which help them to float in the air and be carried away to long distances.
- In the members of Asteraceae, the calyx is modified into hair like structures called pappus. They persist in fruit and open out like umbrella, helping the seeds to float in the air.
- In poppy and prickly poppy (Argemone), the fruit dehisces and seeds are thorwn out to a distances away from the parent plant. (Censor mechanism)
- The seeds of Calotropis, Alstonia and cotton are provided with hair and cover sufficient distances alongwith the wind.
- The seeds of orchids and some grasses are very small and light in weight and may be easily carried away by wind to far off places.
- In fruits of physalis swollen persistant calyx is present and fruit can easily be carried out by air.
- Some plant like chenopodium, amaranthus etc. are uprooted after drying and carried away by wind and seeds are dispersed distantly. These plants are known as tumbler weed.

2. WATER (Hydrochory) :

- The fruit and seeds with specialised devices which may be in the form of spongy and fibrous outer walls as in coconut and spongy thalamus as in lotus, and small seeds with airy aril as in water lily, float very easily in water and are carried away to long distances with the water current.

3. ANIMAL (Zoochory) :

- The fruit and seeds with hooks, spines, bristles, stiff hair, etc., get attached to the body of animals and are carried away by them to distant places.
- Fruits of ***Xanthium*** and ***Urena*** bear curved hooks.
- Spear grass has a bunch of stiff hair.
- ***Tribulus*** has sharp and rigid spines.
- ***Boerhaavia*** has sticky hair, which help their dispersal by animals. In *Martynia* two curved hooks are present.
- The edible fruits like guava, grape, fig and plum are dispersed by birds and even human beings by feeding on them and passing out undigested seeds with faeces or by carrying them to other places for later feeding.

4. DEFENSE MECHANISM IN PLANTS :

- These specialized structures, organs, substances and adaptations which protect the plants from destroying by animals, insects and disease carriers are called as defence mechanism in plants. Some of these are as follows:
- Epidermis, periderm, cork and bark.
- Trichomes, hairs and spines.
- Laticiferous glands or ducts.
- Secretory glands.
- Taste of different plant parts.
- Underground plant parts.
- Myrmecophily
- Colour, shape and structure of plants.

5. Epidermis, Periderm, Cork and Bark :

- Epidermis acts as a protective layer which saves internal tissues from being damages by high temperature, microbes, acidic rain and high wind velocity etc.
- In ***Vanda*** (orchid), ***Nerium, Peperomia*** etc. it is multilayed. In ***Peperomia,*** it consists of 14 to 15 layers of cells.
- All parts of a plant except root, have a layer of wax-like substance or cutin on the outer surface of the epidermis. This layer is known as cuticle.
- In ***Cycas*** and ***Pinus*** the cuticle is lignified.
- On aerial parts of ***Equisetum*** and members of grass family silica or silicon oxide is found which protect them from grazing animal.
- On epidermis of some plants wax, oil, resin crystallized salts, silica, lignified substances etc. are deposited.
- In woody plants periderm is present which is a secondary epidermal tissue and is formed by activity of the phellogen. Here the cork is a protective layer.
- Bark is the tertiary epidermal tissue found in woody plants. Its main function is to protect the internal tissues from mechanical injury.

6. Trichomes, Hairs and spines :

- Leafy epidermal hairs regulate atmospheric humidity,
- Covering hairs protect plants from disease causing insects
- Glandular epidermal hairs secrete some chemical substances to protect them from animals.
- Stinging hairs pierce the skin of animals and secrete poisonous substances which cause irritation and protect the plants from animals. *e.g.,* ***Urtica diocea.***
- Spiny stipules and spines found in xerophytes protect these plants from grazing animals. *e.g.*, ***Zizypus, Acacia***.
- Spines of ***Euphrbia*** act as defensive devices against grazing animals.
- Prickles of ***Capparis, Bombax*** and rose and needle like hairs of cacti save these plants from animals.

7. Laticiferous glands or Ducts :

- Woody plants of arid and semi arid areas secrete a white milky fluid which is called **latex**.
- It is a viscous fluid which contains various substances like water, hydrocarbons, resins, oils, proteins, acids, salts, sugars and rubber in suspended form. It is found in members of family Moraceae, Euphorbiaceae, Apocyanaceae etc. Latex help in protection of these plants from animals. The latex secreted by plants of ***Calotropis*** is poisonous.

8. Secretory glands or cells :

- They are filled with different types of excretory or secretory substances such as oils, tannins, gums, mucilage and different type crystals.
- Smell of oily substances secreted by oil glands present in the leaves and bark of **Eucalyptus** and pericarp of lemon fruit protect these plants from animals.

9. Taste of different plant parts :

- Aerial parts like fruits, seeds leaves, branches and bark of some plants contain different type of alkaloids or excretory substances which are repulsive or bitter in taste and are disliked by animals e.g. ***Azadirachta indica, Momordica charantia, Trigonella, Ocimum sanctum, Datura stramonium, Papaver somniferum, Mentha arvensis, Nicotiana tabacum, Carica papaya, Cinchona officinalie*** etc.

10. Underground plants :

- In some plants, plant parts remain under the soil i.e. out of reach of grazing animals e.g. underground modified roots of radish **(*Raphanus sativus*),** carrot **(*Daucus carota*), turnip (*Brassica rapa*), chukandar (*Beta vulgaris*), heeng (*Ferula asafoetida*)** etc. underground modified stems of potato **(*Solanum tuberosum*),** arbi **(*Colocasia antiquoru*m),** onion **(*Allium cepa*),** garlic **(*Allium sativum*).** ginger **(*Zingiber officinale*),** turmeric **(*Cucrcuma domestica*)** etc. and underground fruits of ground nut **(*Arachis hypogea*).**

11. Myrmecophily :

- Gauva **(*Psidium guajava*),** mango **(*Mangifera indica*),** litchi **(*Litchi chinensis*),** mulberry **(Morus alba)** etc. secrete some substances which attracts some ants. These ants take their abode on these plants and act as bodyguards against any animal attack. This relationship is called myrmecophily.

12. Colour, shape and structure of plants :

- Certain plants strickingly resemble some dreaded animals so that they are carefully avoided by other animals. This is known as mimicry e.g. plants of ***Caladium*** and ***Sensviria*** resemble spotted serpents.

SOME FRUIT & THEIR EDIBLE PART

S.No.	Fruit	Type of fruit	Edible part
1.	***Abelmoschus esculentus*** / Lady's Finger	Capsule	Whole fruit (vegetable)
2.	***Achrus sapota***/Cheeku	Berry	Mesocarp and endocarp
3.	***Aegle marmelos***/Wood Apple	Amphisarca	Pulpy endocarp (inner pericarp) and placentae.
4.	***Anacardium occidentale***/Cashewnut	Nut	Cotyledons and Peduncle
5.	***Ananas comosus*** = Pineapple	Sorosis	Outer fleshy axis, bracts fused perianth & Pericarp
6.	***Annona squamosa***/Custard Apple	Etaerio of Berries	Mesocarp (Pericarp)
7.	***Arachis hypogea***/Ground nut/Peanut	Lomentum	Seeds/Cotyledons
8.	***Areca catechu***/Betel or Areca Nut	Berry	Seed/Endosperm
9.	***Artocarpus integrifolia***/Jack Fruit	Sorosis	Bracts, perianth and seeds
10.	***Carica papaya***/Papaya	Berry	Mesocarp and Endocarp
11.	Cereals, ***Avena sterilis*** (Oat), ***Oryza sativa*** (Rice), ***Hordeum vulgare*** (Barley), ***Triticum duram*** (Durum Wheat), ***Triticum aestivum*** (Bread Wheat), ***Zea mays*** (Maize)	Caryopsis	Whole fruit
12.	***Citrus reticulate***/Orange, ***Citrus sinensis***/Sweet Orange, ***Citrus aurantifolia***/Lime	Hesperidium	Glandular hair
13.	***Cocos nucifera***/Coconut	Drupe	Endosperm
14.	***Cucumis melo***/Musk Melon	Pepo	Mesocarp, Endocarp & seeds
15.	***Cucumis vulgaris***/Water melon	Pepo	Mesocarp, Endocarp & seeds
16.	***Cucumis sativus***/Cucumber	Pepo	Mesocarp, Endocarp and Young seed
17.	***Ficus carica***/Fig/Anjeer	Syconus	Fleshy receptacle
18.	***Fragaria vesca***/Strawberry	Etaerio of achenes	Fleshy thalamus
19.	***Grewia asiatica***/Dhamin/Phalsa	Drupe	Mesocarp
20.	***Juglans regia***/Walnut	Drupe	Lobed cotyledons
21.	***Litchi chinensis***/Litchi	Nut	Aril
22.	***Lycopersicon esculentum***/Tomato	Berry	Pericarp and placenta
23.	***Pyrus malus*** (M. sylvestris)/Apple	Pome	Thalamus
24.	***Mangifera indica***/Mango	Drupe	Mesocarp
25.	***Morus alba, M. nigra***/Mulberry	Sorosis	Fleshy perianth, Fleshy axis

26.	***Phoenix dactylifera***/Date	Berry	Pericarp
27.	***Prunus amygdalus***/Almond	Drupe	Seed (Cotyledons and embryo)
28.	***Musa paradisiaca***/Banana	Berry	Less developed Mesocarp and well developed endocarp
29.	***Psidium guajava***/Guava	Berry	Thalamus, pericarp and placenta
30.	Pulses	Pod/Legume	Seed
31.	***Punica granatum,*** Pomegranate/Anar	Balausta	Testa
32.	***Pyrus comunis***/Pear	Pome	Fleshy thalamus
33.	***Solanum melongena***/Brinjal	Berry	Pericarp & Placenta
34.	***Tamarindus indica***/Tamarind	Lomentum	Pericarp (Mesocarp)
35.	***Trapa bispinosa***/Water Chestnut/Singhara	Nut	Seed
36.	***Vitis vinifera***/Grape	Berry	Pericarp and placenta
37.	***Zizyphus mauritiana***/Jujube/ Chinese Dates/Ber	Drupe	Epicarp and mesocarp

MORPHOLOGY OF ANGIOSPERM (Point to be remembered always)

- Arrangement of flowers on peduncle and study of flowers is called **Anthology.**
- **National flower** of India is **Lotus** (***Nelumbo nucifera***)
- **Longest styles** are found in **maize.**
- **Longest inflorescence** is in **Agave** (12m),
- In **Mussanda**, One (odd) sepal is enlarged to form a leafy structure called **Advertisement Flag.**
- **National fruit** of India is **Mango** (***Mangifera Indica***)
- **Largest fruit** and **largest seed** is of ***Lodoicea maldivica*** (double coconut, weight is 18 Kgs.)
- **False nuts** are **Coconut** (drupe), **Areca nut** (Berry), **Pea nut or Ground nut** (Lomentum), **Walnut** (drupe) and **Chilgoza** (seed)
- Dispersal of fruits and seeds by ants is called **myrmechory** *e.g.*, ***Ulex*** and ***Trillium*** (seeds).
- ***Monophyllea*** is a plant with **single leaf**.
- ***Welwitschia*** (a gymnosperm) is a plant with **two leaves** throughout the life.
- ***Victoria regia*** has **broadest** leaves each with a diameter of 1.5–1.8m.
- Leaves are **longest** in ***Raphia vinifera*** (10–15m)
- Small protein rich glands called ***Belt's corpuscles*** are present at the tip of leaflets in ***Acacia sphaerocephola.***
- In ***Musca*** the suckers are called **sword suckers**.
- In **knol-khol** (Ganth Gobhi) the entire stem becomes tuberous.
- **Largest bud** is cabbage.
- **Pseudostem** is a trunk formed by leaf bases in Banana.

- A plant with reduced stem is called as **Acaulescent**.
- ***Ulex*** possesses both **stem thorns** as well as **leaf spines**.
- Shruby climbers which climb with the help of hooks are called **Stragglers** *e.g.,* ***Bougainvillea, Artobotrys.***
- **Marine** angiosperm is ***Zostera***.
- **Pseudobulb** is swollen part of stem in orchids for storing water and food reserve.
- Annuals and biennials are **monocarpic**. The perennials are **polycarpic** as they bear fruits every year. Some perennial plants such as ***Agave***, Bamboo are **monocarpic** as they flower and fruit only once in their **life** after a long period of vegetative growth.
- **Smallest** angiosperm is ***Wolffia*** (less than 0.1 mm) and **largest** or **tallest** angiosperm is ***Eucalyptus regnans*** (height more that 114 m or 375 ft)
- Plants with **roots only** are ***podostemon***, ***Arceuthobium***, ***Rafflesia*** and ***Sapria***.
- Hypocotyl develops into a large tuber in ***Myrmecodia enchinata*** family Rubiaceae. In the cavities of tuber many ant live. So it is an example of **myrmecophily**.
- Gynostagium : It is formed due to the fusion of crowned stamens with the carpels. It forms a protective covering around the carpels, thus protects the gynoecium. Presence of Gynostagium is the characteristic feature of family Asclepediaceae.
- Maize (***Zea mays***) has largest stigma and style.
- The sterile pistil is called **pistalloide**.
- State tree of Rajasthan → ***Prosopis cineraria***.
- State flower of Rajasthan → Rohira (***Tecomela undulate***)

EXERCISE - 1

Q.1 Plant lives for many years and bears fruits every year. These platns are known as
(1) Annual and polycarpic
(2) Biennials and polycarpic
(3) Perennial and polycarpic
(4) Perennial and monocarpic

Q.2 If flowering occurs only once in life time. That plant is called
(1) Annual (2) Monoecieus
(3) Monocarpic (4) Monocot

Q.3 Pinus and Casuarina plants are
(1) Caudex (2) Excurrent
(3) Deliquescent (4) Clum

Q.4 Root pocket is present in Pistia, Lemma and Eichhornia. It is the substitute of
(1) Root hair (2) Root cap
(3) Tap root (4) Roots

Q.5 'Zone of cell maturation' is an important part of root. because
(1) It helps in the absorbtion of water
(2) It bears unicellular root hairs
(3) A and B both are correct
(4) In hydrophyte root hairs are absent in the zone of cell maturation

Q.6 Find out the incorrect match.
Type of Root – Plants
(1) Fusiform – *Rhaphanus sativus*
(2) Conical – *Brassica rapa*
(3) Napiform – *Beta vulgaris*
(4) Tuberous – *Mirabilis*

Q.7 *Ipomoea batata* (Sweet Potato) is a tuberous root for storage of food. It is a
(1) Tap root
(2) Adventitious root
(3) Modified stem
(4) Either tap root or adventitious root

Q.8 Prop and Stilt roots both are for extra support. Which is/are present in maize ?
(1) Prop root (2) Stilt root
(3) Both A and B (4) Climbing root

Q.9 Cladode and phylloclade are modified stem, the only difference is
(1) Cladode is the modification of entire stem but phylloclade is the modification of only single internode
(2) Phylloclade is the modification of entire stem but cladode is the modification of only single internode
(3) Cladode is common in Casuarina
(4) Phylloclade is common in Asparagus

Q.10 Which is the most reduced modification of stem and look like disc shaped
(1) Rhizome (2) Tuber
(3) Corm (4) Bulb

Q.11 Rhizome is modified stem. Which is correct for it ?
(1) It grow vertical to the soil surface
(2) It is reported in Banana
(3) They are swollen at the terminal end due to storge of food
(4) Rhizome is not found in fern

Q.12 Which pair is the correct combination of sub aerial modification of stem
(1) Sucker and Offset
(2) Sucker and Rhizome
(3) Offset and Rhizome (4) Rhizome and Bulb

Q.13 Find out the incorrect example of Sucker
(1) Mentha (2) Chrysanthemum
(3) Rosa (4) Oxalis

Q.14 What is incorrect for stem
a. Leaf bearing part of stem is called bud
b. Shoot is leafless part of stem
c. Stem are negatively phototropic
d. Stem are positively geotropic
(1) Only a (2) Only b
(3) only c and d (4) All a, b, c, d

Q.15 Woody perennial climber found in tropical rain forest are modified stem. They are called

(1) Climber (2) Lianas

(3) Twiners (4) Trailers

Q.16 Fertilized and ripened ovary is

(1) Seed (2) Fruit

(3) Fruit and Seed both (4) Bud

Q.17 Seedless fruits develop without fertilzation called

(1) Parthenocarpic fruit (2) Apocarpic fruit

(3) Pseudocarpic fruit (4) False fruit

Q.18 Pericarp is

(1) Seed wall (2) Fruit wall

(3) Cell wall (4) China wall

Q.19 What is correct match.

a. Pod – Gram, Pea

b. Siliqua – Mustured, Radish

c. Silicula – Iberish, Capsella

d. Capsule – Cotton, Datura

(1) Only a is correct

(2) Only b and c are correct

(3) All are correct (4) All are incorrect

Q.20 Caryopsis type of fruit is

(1) Characteristic fo cypreceae family

(2) Not split or brust for discharge of seed

(3) Fruit wall and seed coat do not completly fused

(4) Not present in wheat

Q.21 The fruit of litchi and tomato is

(1) Nut and Berry (2) Berry and Nut

(3) Pepo and Pome (4) Pome and Pepo

Q.22 Sorosis type of fruit is common in

(1) Jack fruit (2) Pine Apple

(3) Mulberry (4) All of these

Q.23 Sorosis and syconus are

(1) Simple dry fruit (2) Simple fleshy fruit

(3) Aggregate fruit (4) composite fruit

Q.24 Which one of the following is incoreect w.r.t obligate stem parasite.

(1) Cuscuta (2) Cassytha

(3) Arceuthobium (4) Sapria

Q.25 Which of the following is incorrect match

(1) Orobanchae – Broom rape

(2) Monotropa – Indian Pipe

(3) Neottia – (Bird's nest fungus)

(4) Viscum – Mistletoe

Q.26 Match the Column I & Column II.

Column I	Column II
(i) Utricularia	(1) Water flea trap
(ii) Drosera	(2) Venus fly trap
(iii) Dionaea	(3) Sundew
(iv) Aldrovanda	(4) Bladderwort

(1) i – a, ii – b, iii – c, iv – d

(2) i – d, ii – c, iii – b, iv – a

(3) i – c, ii – d, iii – b, iv – a

(4) i – d, ii – c, iii – a, iv – b

Q.27 Which of the following is not true for epiphytes

(1) They are usually found in tropical rain forest.

(2) They contain velamen tissues

(3) The roots are hygroscopic

(4) They have tentacles over leaves

Q.28 Choose the false statement.

(1) Phylloclades are photosynthetic in function

(2) Pitcher of Nepenthes is a modification of stem

(3) bulb of garlic and onion have disc shaped stem.

(4) Cladode is found in Asparagus

Q.29 Identify the incorrectly matched pair.

(1) Hygroscopic roots – Orchids

(2) Assimilatory roots – Tinospora

(3) Leaf roots – Bryophyllum.

(4) Lianas – Tropical rain forest.

Q.30 Which of the following statement is incorrect
(1) Prop roots are found in Ficus benghalensis
(2) Stilt roots provide extra support to Pandanus
(3) Scape is leafless flower bearing branch of mustard
(4) Cluster root is fonud in Dahlia

Q.31 Which of the following is not true w.r.t halophytes
(1) They are found in salty soil
(2) They bear pneumatophores
(3) They shows viviparity
(4) The leaves are amphistomatic and parallel veined

Q.32 In Amorphophalus and Crocus vegetative propagation takes place by means of :
(1) Corm (2) Rhizome
(3) Offset (4) Both 1 & 3

Q.33 a-A fleshy vegatative bud is called bulbil.
b-Multiple root cap is found in Screwpine
c-Root cap is absent in hydrophytes
d-Phylloclade is found in opuntia.
(1) All are correct except b
(2) All are correct
(3) a & b are correct
(4) b & c are corret

Q.34 Sheathing leaf base is characteristic feature of
(1) Legumes (2) Poppy
(3) Grasses (4) Touch me not

Q.35 A plant which possesses a single leaf is
(1) Welwitschia (2) Platanus
(3) Monophyllea (4) Ulex

Q.36 The most common type of compound leaf found in nature are
(1) Bipinnate (2) Tripinnate
(3) Trifoliate (4) Decompound

Q.37 Cauliflory is the formation of flowers
(1) On the young branches from new buds
(2) On old branches from new buds
(3) From epiphyllous buds
(4) In bunch

Q.38 Tendrils modified from leaf lets are not found in
(1) Lathyrus aphaca (2) Lathyrus odoratus
(3) Pisum sativum (4) Both 2 & 3

Q.39 Heterophylly of Limnophila is
(1) Adaptive (2) Developmental
(3) Habitual (4) Environmental

Q.40 In Gloriosa, the tendril is the modified from of
(1) Axillary bud (2) Leaf
(3) Leaf apex (4) Stipule

Q.41 Which of the following is odd one out w.r.t reticulate venation?
(1) Dioscorea (2) Colocasia
(3) Smilax
(4) More than one option

Q.42 Which of the following is not a modified stem?
(1) Ginger (2) Turnip
(3) Colocasia (4) Potato

Q.43 Uni – internodal phylloclade is called
(1) Cladophyll (2) Sporophyll
(3) bulbil (4) Brachyplast

Q.44 The stem of which of the following is not a rhizome:
(1) Nelumbo (2) Curcuma
(3) Crocus (4) Zingiber

Q.45 Sucking roots are characteristic of
(1) Cuscuta (2) Tinospora
(3) Piper betel (4) Orchid

Q.46 Pneumathodes are morphologically similar to
(1) Stomata (2) Lenticels
(3) Hydathodes (4) Wounds

Q.47 The feature that distinguish a stem from a root is
(1) Ascending part of axis bearing, branches, leaves, flowers and fruits.
(2) Develops plumule of the embryo of a germinating seed
(3) Bears nodes and internodes.
(4) All of the above.

Q.48 Which of the following is not correct.

(1) Leaf develops at the node.

(2) Axillary bud develops into a branch

(3) Leaves originate from Shoot apical meristem

(4) Leaf is not important due to lack of photosynthesis

Q.49 Identify the incorrectly matched pair

(1) Lianas – Tropical rain forests

(2) Scape – Leafless Stem of onion bearing flowers

(3) Pitcher of Nepenthes – Modification of Stem

(4) Cocoloba – Phylloclade

Q.50 The pattern of arrangement of leaves on the Stem or branch is called :

(1) Reticulate venation

(2) Parallel venation

(3) Phyllotaxy

(4) Vernation

ANSWER KEY

EXERCISE – 1

Q.1	**3**	**Q.2**	**3**	**Q.3**	**2**	**Q.4**	**2**	**Q.5**	**3**	**Q.6**	**2**	**Q.7**	**2**
Q.8	**2**	**Q.9**	**2**	**Q.10**	**4**	**Q.11**	**2**	**Q.12**	**1**	**Q.13**	**4**	**Q.14**	**4**
Q.15	**2**	**Q.16**	**2**	**Q.17**	**1**	**Q.18**	**2**	**Q.19**	**3**	**Q.20**	**2**	**Q.21**	**2**
Q.22	**4**	**Q.23**	**4**	**Q.24**	**4**	**Q.25**	**3**	**Q.26**	**2**	**Q.27**	**4**	**Q.28**	**2**
Q.29	**3**	**Q.30**	**3**	**Q.31**	**4**	**Q.32**	**1**	**Q.33**	**2**	**Q.34**	**3**	**Q.35**	**3**
Q.36	**1**	**Q.37**	**2**	**Q.38**	**1**	**Q.39**	**1**	**Q.40**	**3**	**Q.41**	**4**	**Q.42**	**2**
Q.43	**1**	**Q.44**	**3**	**Q.45**	**1**	**Q.46**	**2**	**Q.47**	**4**	**Q.48**	**4**	**Q.49**	**3**
Q.50	**3**												

EXERCISE - 2

Q.1 In root, branches (secondary roots) are-
(1) Stellar in origin
(2) Cortical in origin
(3) Stellar and endogenous
(4) Cortical and exogenous

Q.2 In Pandanus (Screw Pine) root cap is-
(1) Simple, multicellular
(2) Multiple, multicellular
(3) Absent
(4) Replaced by root pocket

Q.3 A plant called plantless root is-
(1) Arceuthorbium (2) Podostemon
(3) Rafflesia & Sapria (4) All of these

Q.4 Root bears-
(1) Nodes only (2) Internodes only
(3) Both nodes and internode
(4) None of the above

Q.5 Root pockets act as balancers and found in-
(1) Hygrophytes
(2) Free floating hydrophytes
(3) Fixed floating hydrophytes
(4) Submerged hydrophytes

Q.6 The geotropic response of root is due to starch grains (statoliths) in-
(1) Cells of root cap
(2) Cells of root hair
(3) Cells in root apex
(4) Cells in growing point

Q.7 Root cap is absent in-
(1) Hydrophytes (2) Xerophytes
(3) Lithophytes (4) All of these

Q.8 Root hair lost during transplantation but reappear within a week. These root hairs are found in-
(1) Zone of division (2) Zone of elongation
(3) Zone of maturation (4) All zones

Q.9 Root hairs are found on-
(1) Secondary roots (2) Tertiary roots
(3) (1) and (2) both (4) Adventitious roots

Q.10 Tap (primary) root develops from-
(1) Radicle (2) Hypocotyl
(3) Epicotyl (4) None

Q.11 Root hairs are absent in aquatic plants as-
(1) They do not absorb salts and water
(2) Absorption occurs by leaves
(3) Roots are profusely branched and have more surface area
(4) None

Q.12 Monocot plants are characterised by the presence of
(1) Moniliform roots (2) Fibrous roots
(3) Stilt roots (4) Annulated roots

Q.13 Root nodules (tubercles) are found on -
(1) Primary root (2) Branch
(3) Secondary roots
(4) Primary and secondary roots

Q.14 Rhizobium lives symbiotically with root nodules and fixes atmospheric nitrogen. It gives nitrogenous compound to host and inturn takes food from host. This food taken by bacterium is-
(1) Fats (2) proteins
(3) Carbohydrates (4) Any of these

Q.15 The factors which initiate development of respiratory roots in Avicenia and other mangroves are-
(1) Saline marshes
(2) Poor oxygen supply
(3) Soil is physiologically dry
(4) All the above are correct

Q.16 The lenticles in respiratory roots are called-
(1) Pneumatophores (2) Pneumathodes
(3) Stomata (4) Hydathodes

Q.17 Buttrus or Plank roots in Bombax, Ficus are metamorphosed tap roots for support. They arise from-
(1) Base of tap root
(2) Mid part
(3) Base of tap root and mid part both
(4) Base of adventititous roots

Q.18 Roots store food in-
(1) Cell elongation region
(2) Cell differentiation region
(3) Root cap (4) Meristemtic ozone

Q.19 Reproductive roots taking part in reproduction are found in-
(1) Dalbergia (shisham)
(2) Dahlia
(3) Sweet Potato (Ipomoea)
(4) All correct

Q.20 Assimilatory (Photosynthetic) roots are characteristic of-
(1) Trapa and Tinospora
(2) Taeniophyllum and Podostemon
(3) Trapa
(4) All of the above

Q.21 Prop roots are-
(1) Primary roots (2) Adventitious roots
(3) Branch roots (4) Tap roots

STEM

Q.22 Ginger is not a root but a stem, because-
(1) It stores the food material
(2) It has a pungent taste
(3) It has nodes and internodes
(4) It is not green in colour

Q.23 Potato tuber is a modified-
(1) Stem (2) Root
(3) Bulb (4) Stolon

Q.24 Buds typically are found-
(1) At the tips of branches and roots
(2) At the tips of branches and at the bases of leaves
(3) Along roots and at the bases of leaves
(4) Only on the bases of leaves

Q.25 Stem modified to perform the function of leaf and having many internodes is called-
(1) Phylloclade (2) Cladode
(3) Offset (4) Phyllode

Q.26 In which of the following stem is most reduced-
(1) Rhizome (2) Corn
(3) Phylloclode (4) Bulb

Q.27 Photosynthetic organ of Asparagus are-
(1) Leaf (2) Leaf stipule
(3) Phyllode (4) Cladode

Q.28 Cladode are common among-
(1) Liliaceae (2) Malvaceae
(3) Mimosoideae (4) Solanaceae

Q.29 Photosynthetic organs of opuntia are-
(1) Phyllode (2) Phylloclode
(3) Leaves (4) Leaflets

Q.30 Which of the following is a caudex plant-
(1) Cycas (2) Pinus
(3) Ficus (4) Mango

LEAF

Q.31 In opuntia the leaves are modified into-
(1) Scales (2) Spines
(3) Thorns (4) Phylloclades

Q.32 The stipules are modified into tendrils in-
(1) Smilax (2) Asphodelus
(3) Gloriossa (4) Asparagus

Q.33 The first few leaves after the cotyledons in the seedling of an Acacia are pinnately compound but the petioles of upper compound leaves are flattened and they bear fewer pinnae. The adult plant only has parallel veined leaves like the flattened petioles but without any pinnae. These observations lead us to the conclusion that-
(1) The leaves in the adult plant are reduced to phyllodes while seedling leaves are unreduced
(2) The green, parallel-veined structures in the adult plant are phylloclades
(3) The exhibits heterophilly bearing simple leaves in the adult plant and compound leaves in the seedling
(4) The adult plant leaves are a case of reversion where they become simple like the cotyledons

Q.34 The cladode among the following is-
(1) Parkinsonia (2) Acacia
(3) Opuntia (4) Asparagus

Q.35 The mode of arrangement of leaves on the stem and branch is knwon as-
(1) Vernalization (2) Vernation
(3) Venation (4) Phyllotaxy

Q.36 Which of the following plant has parallel venation-
(1) Castor (2) Grass
(3) Moss (4) Fern

Q.37 In Nepenthes, the pitcher is formed of-
(1) Peptide and stipules
(2) Lamina
(3) Leaf apex (4) Leaf base

Q.38 Main photosynthetic organs of lathyrus sativus plant-
(1) Leaves (2) Leaflets
(3) Stipules (4) Phyllodes

Q.39 An abnormal dicot leaf showing parallel venation is of-
(1) Smilex (2) Rananculus
(3) Calophyllum (4) Dioscorea

Q.40 An abnormal monocot with reticulate venation and tendrilar stipule is-
(1) Gloriosa (2) Pethos
(3) Smilax (4) Dracaena

Q.41 Tongue like out growth in the leaf base is the characteristic feature of-
(1) Fern leaf (2) Cycas leaf
(3) Grass leaf (4) Banana leaf

INFLORESCENCE

Q.42 The main axis of the inflorescence is elongated in a-
(1) Corymb (2) Capitulum
(3) Cyanthium (4) Catkin

Q.43 Cyathium is a type of-
(1) Fruit (2) Inflorescence
(3) Bacterium (4) Algae

Q.44 Verticillaster is a type of-
(1) Phyllotaxis (2) Placentation
(3) Inflorescence (4) Venation

Q.45 When inflorescence axis is branched, it is called-
(1) Panicle (2) Head
(3) Umbel (4) Cymose

Q.46 The axis of inflorescence is known as-
(1) Thalamus (2) Peduncle
(3) Pedicel (4) Petiole

Q.47 The inflorescence with acropetally arranged sessile flower is-
(1) Raceme (2) Spike
(3) Carymb (4) Panicle

Q.48 In onion the inflorescence is-
(1) Raceme (2) Corymb
(3) Umbel (4) Spike

Q.49 Inflorescence of Lycopersicon is-
(1) Raceme (2) Helicoid cyme
(3) Scorpoid cyme (4) Spike

Q.50 The name compositae is based on-
(1) Inflorescence (2) Corolla
(3) Gynoecium (4) Fruit

Q.51 Inflorescence of banana is-
(1) Raceme (2) Spike
(3) Spadix (4) Catkin

ANSWER KEY

EXERCISE – 2

Q.1	**3**	**Q.2**	**2**	**Q.3**	**2**	**Q.4**	**4**	**Q.5**	**3**	**Q.6**	**1**	**Q.7**	**1**
Q.8	**3**	**Q.9**	**3**	**Q.10**	**1**	**Q.11**	**3**	**Q.12**	**2**	**Q.13**	**3**	**Q.14**	**3**
Q.15	**2**	**Q.16**	**2**	**Q.17**	**4**	**Q.18**	**2**	**Q.19**	**4**	**Q.20**	**4**	**Q.21**	**2**
Q.22	**3**	**Q.23**	**1**	**Q.24**	**2**	**Q.25**	**1**	**Q.26**	**4**	**Q.27**	**4**	**Q.28**	**1**
Q.29	**2**	**Q.30**	**1**	**Q.31**	**2**	**Q.32**	**1**	**Q.33**	**1**	**Q.34**	**4**	**Q.35**	**4**
Q.36	**2**	**Q.37**	**2**	**Q.38**	**2**	**Q.39**	**3**	**Q.40**	**3**	**Q.41**	**3**	**Q.42**	**4**
Q.43	**2**	**Q.44**	**3**	**Q.45**	**1**	**Q.46**	**2**	**Q.47**	**2**	**Q.48**	**3**	**Q.49**	**3**
Q.50	**1**	**Q.51**	**3**										

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Pneumatophores occur in plants of **[CBSE PMT 2000]**

(1) Sandy soil
(2) Saline marshy soil
(3) Marshy soil (4) Water

Q.2 Assimilatory (Photosynthetic) roots a characteristic of **[Kerala 2000]**

(1) Trapa and Tinospora
(2) Taeniophyllum and Podostemon
(3) Both correct
(4) None of these

Q.3 Bacteria found in root nodules of legumes are **[DPMT 2002]**

(1) Nitrobacter (2) Nitrosomonas
(3) Rhizobium (4) Azotobacter

Q.4 In Ipomoea batatas/Sweet potato the food is stored in [**JKCMEE 2002]**

(1) Root tuber (2) Stem tuber
(3) Bud (4) Leaves

Q.5 Pneumatophores are characteristics of family **[Bih. PMT 2001**]

(1) Loranthaceae (2) Hydrocharitaceae
(3) Rhizophoraceae (4) Orchidaceae

Q.6 Root cap is absent in **[BHU 1994, 2000]**

(1) Hydrophytes (2) Lithophytes
(3) Xerophytes (4) Mesophytes

Q.7 Food is stored in one of the following **[Kerala 2001]**

(1) Respiratory root (2) Fibrous root
(3) Fasciculated root (4) Nodulated root

Q.8 Velamen is present in **[CPMT 2001]**

(1) Tuberous roots
(2) Epiphytic roots of orchids
(3) Breathing roots (4) Parasitic roots

Q.9 Epiphytes like Vanda develop special layer of absorptive tissue velamen consiting of 4 or 5 layers of long polygonal cells. Velamen is formed by **[AIIMS 2001]**

(1) Absorbing roots (2) Stem
(3) Clinging roots (4) Hanging roots

Q.10 Regions of root from base to root tip are **[AMU 2001]**

(1) Maturation zone - Cell division zone - Elongation zone
(2) Maturation zone - Elongation zone - Cell division zone
(3) Cell division zone - Elongation zone - Maturation zone
(4) Elongation zone - Cell division zone - Maturation zone

Q.11 A plant with epidermis specialised to absorb moisture from air is **[APMEE 2002]**

(1) Avicennia (2) Vanda
(3) Rhizophora (4) Jussiaea

Q.12 Hygroscopic roots occur in **[AMU 2002]**

(1) Vanda (2) Rhizophora
(3) Bryophyllum (4) All the above

Q.13 A root is adventitious when it is **[CPMT 2002]**

(1) Swollen
(2) Growing in marshy places
(3) Formed from plumule
(4) Modified for storage

Q.14 A fleshy root tapering at both ends is **[AMU 2001]**

(1) Fusiform (2) Conical
(3) Napiform (4) Tuberous

Q.15 A fibrous root system is better adapted than tap root system for **[BHU 2001; AMU 2001]**

(1) Storage of food
(2) Anchorage of plant to soil
(3) Absorption of water and minerals
(4) Transport of water and organic food

Q.16 An underground specialised shoot with reduced disc like stem covered by fleshy leaves is **[JKCMEE 2000]**

(1) Bulb (2) Bulbil
(3) Rhizome (4) Rhizophore

Q.17 Potato and sweet potato **[AIIMS 2004]**
(1) Have edible parts which are homologous organs
(2) Have edible parts which are analogous organs
(3) Have been introduced in India from the same place
(4) Are two species of the same genus

Q.18 Phylloclade is a modification of **[JKCMEE 2002]**
(1) Leaf (2) Root
(3) Flower (4) Stem

Q.19 Ginger plant has an underground stem which is **[MP PMT 2004]**
(1) Rhizome (2) Bulb
(3) Tuber (4) Corm

Q.20 Phylloclade is found in **[AMU 2001]**
(1) Chrysanthemum (2) Asparagus
(3) Ruscus (4) Opuntia

Q.21 Thorns with leaves and flowers are found in **[APMEE 2002]**
(1) Bougainvillea (2) Carissa
(3) Duranta (4) Artabotrys

Q.22 Thick underground stem growing parallel to soil surface is **[Tamil Nadu 2001]**
(1) Stolon (2) Rhizome
(3) Sucker (4) Offset

Q.23 Underground stem is rhizome in plant **[APMEE 2002]**
(1) Allium (2) Scilla
(3) Lilium (4) Gloriosa

Q.24 Green leaf-like one internode long stem branches are called **[KCET 2003]**
(1) Phylloclades (2) Phyllodes
(3) Bulbils (4) Cladodes

Q.25 Stem tendrils occur in **[Orissa 2000]**
(1) Smilax (2) Gloriosa
(3) Vitis (4) Lathyrus

Q.26 Which of the following is not related to corm **[Kerala 2001]**
(1) Tunic (2) Lateral buds
(3) Nodes (4) Scale leaves

Q.27 Eye of potato is **[CPMT 2001]**
(1) Apical bud (2) Axillary bud
(3) Accessory bud (4) Adventitious bud

Q.28 Swollen lower end of leaf stalk is **[Wardha 2000]**
(1) Petiole (2) Pulvinus
(3) Thalamus (4) Disc

Q.29 Phyllotaxis is **Kerala 2002]**
(1) Mode of leaf arrangement on stem
(2) Types of roots
(3) Arrangement of sepals and petals in a flower
(4) Type of ovary

Q.30 Petiole is modified into tendril in : **[Orissa 2000]**
(1) Passiflora (2) Gloriosa
(3) Pisum (4) Clematis

Q.31 On the margins of leaves of a plant called Bryophyllum tiny plants grow complete with roots. These tiny plants fall of and continue to grow. This is a form of **[AIEEE 2004]**
(1) Hermophroditism
(2) Vegetative reproduction
(3) Sexual reproduction
(4) Reproduction by fission

Q.32 Pinnately parallel venation is found in **[Tamil Nadu 2001]**
(1) Canna (2) Grass
(3) Zizyphus (4) Castor

Q.33 Ochreate stipules occur in leafy vegetable **[APMEE 2002]**
(1) Amaranthus (2) Mentha
(3) Platanus (4) Rumex

Q.34 Spiral phyllotaxy in which sixth leaf lies above the first one after completing two circles is **[APMEE 2002]**
(1) Distichous (2) Tristichous
(3) Pentastichous (4) Octastichous

Q.35 Match the columns **[AMU 2002]**

(i) Acicular	(1) Grass
(ii) Linear	(2) Nerium
(iii) Lanceolate	(3) Banana

(iv) Oblong (4) Pine

(1) (i) 4 (ii) 1 (iii) 2 (iv) 3

(2) (i) 4 (ii) 1 (iii) 3 (iv) 2

(3) (i) 4 (ii) 2 (iii) 3 (iv) 1

(4) (i) 4 (ii) 3 (iii) 2 (iv) 1

Q.36 Leaves develop from **[AFMC 2003]**

(1) Nodes (2) Internodes

(3) Epidermis (4) Endodermis

Q.37 Phyllode is found in **[CET Chd. 2003]**

(1) Clematis (2) Gloriosa

(3) Acacia (4) Dischidia

Q.38 Parallel venation occurs in **[BVP 2000; Tamil Nadu 2001]**

(1) Monocots (2) Dicots

(3) All angiosperms (4) Ferns

Q.39 Bombax leaf is **[Tamil Nadu 2001]**

(1) Tripinnate (2) Unipinnate

(3) Multifoliate (4) Quadrifoliate

(5) Trifoliate

Q.40 Name the plant having reticulate venation **[Wardha 2001; Tamil Nadu 2001]**

(1) Musa (2) Mangifera

(3) Oryza (4) Canna

Q.41 In Nepenthes the pitcher is modified **[Kerala 2001; CET Chd. 2003]**

(1) Whole leaf (2) Leaf apex

(3) Lamina (4) Petiole

Q.42 Santalum album/Sandal-wood Tree is **[Orissa 2007]**

(1) Partial root parasite

(2) Partial stem parasite

(3) Total stem parasite (4) Total root parasite

Q.43 Biggest flower belongs to a plant which is **[C.B.S.E. 1999, Manipur 2006]**

(1) Partial root parasite

(2) Partial stem parasite

(3) Total stem parasite (4) Total root parasite

Q.44 A plant growing on another plant without drawing any nourishment is **[A.F.M.C. 1986, 2005]**

(1) Ectoparasite (2) Epiphyte

(3) Symbiont (4) Saprophyte

Q.45 A rootless aquatic plant in which a portion of leaf is modified to form a blade for catching small aquatic animals is **[DPMT 2009]**

(1) Dionaea (2) Drosera

(3) Utricularia (4) Nepenthes

Q.46 Total root parasite is **[MPPMT 2009]**

(1) Rafflesia (2) Cassytha

(3) Viscum (4) Loranthus

Q.47 Insectivorous plants usually grow in soils which are deficient in **[CPMT2009]**

(1) Nitrogen/nitrate (2) Cassytha

(3) Organic matter (4) Ca/Mg

Q.48 Balanophora/Orobanche is a **[CPMT1990, 1992, Bih.PMT1994]**

(1) Total root parasite

(2) Partial root parasite

(3) Partial stem parasite

(4) Total stem parasite

Q.49 The tallest plant belongs to **[A.F.M.C. 2004, H.P.PMT2005]**

(1) Cedrus deodara (2) Eucalyptus ragnans

(3) Sequoia sempervirens

(4) Pinus roxburghii.

Q.50 Smallest flowering plant/flower is **[CPMT2009]**

(1) Polyalthia (2) Rafflesia

(3) Azadirachta (4) Wolffia

Q.51 One of the follwing is a saprophyte **[B.H.U. 1999, Manipur 2009]**

(1) Monotropa/Neottia (2) Utricularia

(3) Dionaea (4) Nepenthes

Q.52 Botanical name of Venus Fly Trap is **[B.H.U 1989, C.E.T. Chd. 2002]**

(1) Aldrovanda (2) Dionaea

(3) Utricularia (4) Napenthes

Q.53 Insects captured by carnivorous plants partially meet their requirement of **[B.H.U 2008]**

(1) Organic matter (2) Enzymes

(3) Water (4) Nitrogen

Q.54 Which one of the following is a partial root parasite **[D.PMT2002]**

(1) Balanophora (2) Santalum

(3) Viscum (4) Cuscuta

Q.55 Which one of the following is a total root parasite **[Bih. PMT 2002]**

(1) Balanophora/Orobanche

(2) Viscum

(3) Cassytha (4) Drosera

Q.56 The association between ants and members of family rubiaceae is **[A.M.U. 1997]**

(1) Ornithophily (2) Entomophily

(3) Myrmecophily (4) Anemophily

Q.57 Which is not an insectivorous plant **[Manipur 2009]**

(1) Dionaea

(2) Dischidia/Monotropa

(3) Sarracenia (4) Pinguicula

Q.58 Monocarpic plant is the one which **[Orissa 2009, MPPMT2009]**

(1) Flowers twice in a year

(2) Produces only one fruit

(3) Flowers once in life and then dies

(4) Bears only one type of flowers

Q.59 Which one is an insectivorous plant? **[Orissa 2009]**

(1) Vallisneria (2) Rafflesia

(3) Santalum (4) Nepenthes

Q.60 Which of the following is/are angiospermic hydrophyte? **[CPMT 2009]**

(1) Hydrilla (2) Vallisneria

(3) Zizyphus (4) Both 1 and 2

Q.61 Which one of the following is not insectivorous plant? **[JKCMEE 2010]**

(1) Monotropa (2) Drosera

(3) Utricularia (4) Nepenthes

ROOT

Q.62 Radish has **[JKCMEE 2005]**

(1) Napifom root (2) Conical root

(3) Fusiform root (4) Tuberous root

Q.63 Prop or pillar roots are **[Manipur 2010]**

(1) Fasciculated roots (2) Tap roots

(3) Adventitions roots (4) Secondary roots

Q.64 In Ipomoea batatas/Sweet Potato the food is stroed in **[JKCMEE 2008]**

(1) Root tuber (2) Stem tuber

(3) Bud (4) Leaves

Q.65 Haustoria or sucking roots occur in **[JKCMEE 2003, Kerala 2006]**

(1) Betel (2) Orchids

(3) Cuscuta (4) Tinospora

Q.66 Velamen is present in **[Bihar PMT2001, Manipur 2007]**

(1) Tuberous roots (2) Epiphytic roots

(3) Breathing roots (4) Parasitic roots

Q.67 Roots that hold horizontal branches of Banyan tree in the air are **[Bih. PMT1991, Orissa 2005]**

(1) Thumb roots (2) Prop roots

(3) Stilt roots (4) All the above

Q.68 Root cap is absent in **[B.H.U. 1993, R.PMT2005]**

(1) Hydrophytes (2) Lithophytes

(3) Xerophytes (4) Mesophytes

Q.69 Clinging roots occur in **[C.B.S.E. 1999, A.M.U.P.M.D.C. 2006]**

(1) Trapa (2) Orchid

(3) Screwpine (4) Podostemon

Q.70 Roots originating from parts other than radicle are **[C.M.C. 2003, Har. PMT2005]**

(1) Stilt roots (2) Adventitious roots

(3) Tap roots (4) Fibrous roots

Q.71 Outer covring of epiphytic root is **[Orissa 2005]**

(1) Osmophore (2) Rhizophore

(3) Pneumatophore (4) Velamen

Q.72 Identify the correct order **[EAMCET 2005]**

1. Mineral absorption zone.
2. Meristematic zone.
3. Maturation Zone
4. Water absorption zone

(1) 2, 1, 4, 3 (2) 4, 3, 2, 1

(3) 2, 4, 1, 3 (4) 1, 2, 3, 4

Q.73 Which of the following has succulent root? **[Pb. PMT20005]**

(1) Opuntia (2) Agave

(3) Aloe (4) Asparagus

Q.74 Pneumatophores are found **[B.V. 2006]**

(1) In deserts (2) Near river mouths

(3) On mountains (4) In grasslands

Q.75 Match the columns

	Column I	Column II
1.	Tubercular storage roots	a. Tinospora
2.	Pneumatophores	b. Heritiera
3.	Haustoria	c. Asparagus
4.	Prop roots	d. Viscum
5.	Assimilatory roots	e. Screwpine

[Kerala 2007]

(1) 1 – c, 2 – b, 3 – d, 4 – e, 5 – a

(2) 1 – b, 2 – c, 3 – d, 4 – e, 5 – a

(3) 1 – c, 2 – d, 3 – e, 4 – a, 5 – b

(4) 1 – c, 2 – a, 3 – b, 4 – e, 5 – d

(5) 1 – e, 2 – d, 3 – e, 4 – b, 5 – a

Q.76 Root modification is **[JKCMEE 2007]**

(1) Permanent internal changes in roots

(2) Temporary internal changes in roots

(3) Permanent structural changes in roots

(4) Temporary structural changes in roots

Q.77 Asafoetide is obtained from Ferula asafoetida from **[Ph. PMT2007]**

(1) Stem (2) Root

(3) Leaf (4) Flower

Q.78 Velamen occurs in **[B.H.U. 2008]**

(1) Epiphytes (2) Mesophytes

(3) Hydrophytes (4) Xerophytes

Q.79 Select the correct code

Primary root is -

1. Positively geotropic
2. Positivily hydrotropic
3. Negatively geotropic
4. Negatively hydrotropic **[BHU 2008]**

(1) 1, 2, 3 correct (2) 1, 2 correct

(3) 2, 4 correct (4) 1, 3 correct

Q.80 A fibrous root system is efficient in **[DPMT2009]**

(1) Food storage

(2) Nitrogen fixation

(3) Good anchorage

(4) Absorption from deep soil layers

Q.81 Primary root continues to grow and form root system called **[DPMT2009]**

(1) Tap (2) Stilt

(3) Secondary (4) Fibrous

Q.82 Pneumatophores are found in **[Orissa 2009]**

(1) Mesophytes (2) Sciophytes

(3) Halophytes (4) Helophytes

Q.83 Rhizophora possesses **[AMU 2009]**

(1) Pneumatophores (2) Prop roots

(3) Stilt roots (4) Modified roots

Q.84 Tall trees of what range of height have strong buttresses at their base **[Guj.CET 2009]**

(1) 15 m and above (2) 5 – 7 m

(3) 3 – 5 m (4) 7 – 10 m

Q.85 Root cap is absent in **[Guj. CET 2009]**

(1) Xerophytes (2) Mesophytes

(3) Epiphytes (4) hydrophytes

Q.86 Which is incorrect match? **[AMU 2010]**

(1) Tap root – Carrot

(2) Prop root – Banyan Tree

(3) Adventitious root – Sweet potato

(4) Stilt root – Turnip

Q.87 The stem of Maize and Sugarcane have support roots coming out of the lower nodes of stem. They are called **[HPPMT 2010]**

(1) Stilt roots (2) Prop roots

(3) pneumatophores (4) Adventitious roots

STEM

Q.88 Cladodes occur in **[JKCMEE 2008]**

(1) Parkinsonia (2) Asparagus

(3) Opuntia

(4) Euphorbia royleana

Q.89 In Amorphophallus, vegetative multiplication occurs through **[Pb. PMT 2005]**
(1) Bulbils (2) Rhizome
(3) Corm (4) Offset

Q.90 In passiflora, the tendrils are modified **[JKCMEE 2007]**
(1) Axillary buds (2) Upper leaflets
(3) Whole leaves (4) Stipules

Q.91 Potato tuber is modified/Edible part of Potato is **[Har, PMT 2005]**
(1) Stem (2) Bulb
(3) Stolon (4) Root

Q.92 Ginger is a stem which can be differentiated from root becaue it **[Bih. PMT 2002, MPPMT 2007]**
(1) Grows parallel to ground
(2) Stores food
(3) Lacks chlorophyll
(4) Has nodes and internodes

Q.93 In opuntia, the stem is modified into **[Orissa 2000]**
(1) Cladode (2) Phylloclade
(3) Phyllode (4) Staminode

Q.94 Ginger plant has an underground stem which is **[MPPMT2004, JKCMEE 2005]**
(1) Rhizome (2) Bulb
(3) Tuber (4) Corm

Q.95 Stem tendrils occur in **[Orissa 2000]**
(1) Smilax (2) Gloriosa
(3) Vitis (4) Lathyrus

Q.96 Thick undergound stem growing parallel to soil surface is **[DPMT2009]**
(1) Stolon (2) Rhizome
(3) Sucker (4) Offset

Q.97 A rhizome which grows vertically upwards is **[AFMC 2005]**
(1) Corm (2) Stolon
(3) Bulbil (4) Rootstock

Q.98 Underground stem that has contractile roots is **[EAMCET 2005]**
(1) Rhizome (2) Corm
(3) Stem tuber (4) Bulb

Q.99 Bamboo is **[RPMT2005]**
(1) Culm (2) Bulb
(3) Runner (4) Twiner

Q.100 Turmeric powder is obtained from **[RPMT2006]**
(1) Curuma longa (2) Curcuma amada
(3) Cucurbita sativa (4) Cassia tora

Q.101 Corm is modified **[Orissa 2006]**
(1) Root (2) Stem
(3) Leaf (4) Bud

Q.102 Which one is found only in aquatic plant **[Orissa 2006]**
(1) Runner (2) Stolon
(3) Tuber (4) Offset

Q.103 Uniparous, biparous and multiparous system of branching are found respectively in **[Kerala 2005]**
(1) Mirabilis, Datura and Vine
(2) Saraca, Mirabilis and Euphorbia
(3) Vine, Polyalthia and Saraca
(4) Casuarina, Saraca and Croton
(5) Euphorbia, Croton and Polyalthia

Q.104 Scaly bulb occurs in **[JKCMEE 2007]**
(1) Lilium (2) Allium
(3) Scilla (4) Ginger

Q.105 Black Pepper is **[MPPMT2007]**
(1) Herb (2) Shrub
(3) Tree (4) Climber

Q.106 Which statements are true
(a) Stem with joined solid nodes and hollow internodes is called caudex
(b) In Tridax, the stem is decumbent
(c) Corm is condensed form of rhizome growing more or less in vertical direction
(d) Sucker is an underground modification of stem
(e) Biparous type of cymose branching seen in Saraca. **[Kerala 2008]**
(1) a, d, e (2) b and c only
(3) c and d only (4) b, c, e only
(5) d, e only

Q.107 Identify plants which show modification of axillary buds into tendrils and hooks respectively

(a) Hugonia (b) Duranta

(c) Passiflora (d) Dioscorea

[EAMCET 2008]

(1) a and b (2) c and a

(3) b and c (4) d and a

Q.108 Stem may function in **[AMU 2008]**

(1) Protection

(2) Spread of branches

(3) Storage, support and vegetative propagation

(4) All of these

Q.109 Which one is example of sub aerial modification of stem **[Kerala 2009]**

(1) Asparagus (2) Polyalthia

(3) Tridax (4) Oxalis

(5) Agave

Q.110 Potato is

(1) Root (2) Rhizome

(3) Leaf (4) Stem

Q.111 In Duranta, vasculated defensive structure represent

(1) Axillary bud as in Bougainvillea

(2) Stipules as in Acacia

(3) Terminal bud as in Carissa

(4) Apical bud as in Artobotrys

Q.112 Suculent stem occurs in **[EAMCET 2009]**

(1) Pisum (2) Casuarina

(3) Euphorbia (4) Oxalis

Q.113 Stem modification having vascular bundle is

(1) Prickle (2) Thorn

(3) Bristle (4) All the above

LEAF

Q.114 Petiole is modified into green leafy structure called **[CET Chd. 2009]**

(1) Phyllode (2) Phylloclade

(3) Cladode

(4) Foliaceous petiole

Q.115 Occurrence of more than one type of leaves on the same plant is **[Kerala 2008]**

(1) Heterophylly (2) Phyllotaxy

(3) Venation (4) Vernation

Q.116 Spiny leaf margins are found in **[Manipal 2005]**

(1) Opuntia (2) Papaver

(3) Argemone (4) Polyalthia

Q.117 The largest leaf belongs to **[CPMT 1995, WB 2007]**

(1) Nerium (2) Tobacco

(3) Victoria/musa (4) Rafflesia

Q.118 In Nepenthes the pitcher is modified **[DPMT 2005, Orissa 2010]**

(1) Whole leaf (2) Leaf apex

(3) Lamina (4) Petiole

(5) Leaf base

Q.119 Identify the order where plants show alternate, opposite and whorled phyllotaxy. **Kerala 2005]**

(1) China Rose, Calotropis and Nerium

(2) China Rose, Nerium and Calotropis

(3) Nerium, China Rose and Calotropis

(4) Nerium, Calotropis and China Rose

(5) Calotropis, Nerium and China Rose

Q.120 Pulvinus is found in **[Kerala 2005]**

(1) Calotropis (2) Ocimum

(3) Legume plants (4) Alstonia

(5) Ficus

Q.121 Venation is generally reticulate in **[JKCMEE 2005]**

(1) Monocot plants (2) Bryophytes

(3) Thallophytes (4) Dicot plants

Q.122 Venation in monocots is **[Orissa 2005, AMU 2005]**

(1) Pinnate reticulate (2) Palmate reticulate

(3) Pinnate parallel (4) Parallel

Q.123 Stipules are modified into spines in **[EAMCET 2005]**

(1) Citrus and Euphorbia

(2) Euphorbia and Zizyphus

(3) Ziziphus and Bougainvillea

(4) Citrus and Bougainvillea

Q.124 A compound leaf which appears simple due to supression of 1 – 2 lateral leaflets is found in **[EAMCET 2005]**

(1) Hardwickia (2) Parkinsonia
(3) Citrus (4) Coriandrum

Q.125 In Utriularia, the leaves are modification to form **[JKCMEE 2005]**

(1) Bladders (2) Tendrils
(3) Hooks (4) Pitchers

Q.126 In Opunita, spines are modification of **[JKCMEE 2005]**

(1) Epidermal hair (2) Stem
(3) Flowers
(4) Leaves of axillary bud

Q.127 Leaves are modified into tendrils, hooks, pitchers and bladders in **[Kerala 2006]**

(1) Sweet Pea, Cat's Nail, Nepenthes, Utricularia
(2) Sweet Pea, Cat's Nail, Utricularia, Nepenthes
(3) Nepenthes, Sweet Pea, Cat's Nail, Utricularia
(4) Utricularia, Nepenthes, Cat's Nail, Sweet Pea
(5) Nepenthes, Cat's Nail, Sweet Pea, Utricularia

Q.128 In distichous condition **[Manipur 2005]**

(1) First leaf stands over the second
(2) Second leaf stands over the first
(3) Third leaf stands over the first
(4) Fourth leaf stands over the first

Q.129 Leaves of Nelumbo plant are **[WB 2007]**

(1) Epistomatic (2) Hypostomatic
(3) Amphistomatic (4) None of these

Q.130 Phyllotaxy is decussate in **[COMED-K's 2008]**

(1) Nerium indicum
(2) Pisum sativum
(3) Hibiscus rosa–sinensis
(4) Catharanthus roseus

Q.131 Which ones show stipular modifications

(a) Spines of Zizyphus
(b) Tendrils in Smilax
(c) Tendirls in Nepenthes
(d) Spines in Argemone
(e) Thorn in bougainvillea. **[EAMCET 2005]**

(1) a and b (2) a and c
(3) b and e (4) c and e

Q.132 Phyllotaxy in Calotropis is **[AMU 2005]**

(1) Alternate (2) Opposite
(3) Whorled (4) None of these

Q.133 Multicostate parallel venation occurs in **[Kerala 2009]**

(1) Banana and Canna
(2) Mango and Peepal
(3) Grasses and Palms
(4) Castor and Tapioca
(5) Castor and China Rose

Q.134 Leaves are modified into spines in **[Kerala 2009]**

(1) Nepenthes (2) Australian Acscia
(3) Opuntia (4) Utricularia
(5) Tamarix

Q.135 Find the correct match **[AMU 2010]**

(1) Mustard – Leaves opposite
(2) Mustard – Leaves alternate
(3) Guava – Leaves alternate
(4) Guava – Leaves whorled

Q.136 Whorled phyllotaxy occurs in **[Kerala 2010]**

(1) Alstonia (2) Guava
(3) Calotropis (4) Mustard
(5) China Rose

Q.137 Bladderwort is **[MPPMT 2010]**

(1) Drosera (2) Nepenthes
(3) Dionaea (4) Utricularia

INFLORESCENCE

Q.138 In cyathium, the ratio between female to male flowers is **[EAMCET 2002, Orissa 2010]**

(1) One : One (2) One : Many
(3) Many : One (4) Many : Many

Q.139 The flowers of a raceme are arranged **[Pb.PMT 2010]**

(1) Acropetally (2) Basipetally

(3) Centripetally (4) Centrifugally

Q.140 The inflorescence of Rice/family gramineae is **[Orissa 2010]**

(1) Spike (2) Thyrsus

(3) Spikelet (4) Pedicel

Q.141 Axis of the inflorescence is called **[Har PMT 2007]**

(1) Peduncle (2) Thalamus

(3) Petiole (4) Pedicel

Q.142 The inflorescence present in Euphorbia is **[KECT, 2000, Tamil Nadu 2001]**

(1) Cyathium (2) Capitulum

(3) Helicoid cyme (4) Verticillaster

Q.143 Inflorescence having a flattend axis, sessile flowers and a whorl of involucral bracts is **[Kerala 2010]**

(1) Umbel (2) Head

(3) Corymb (4) Raceme

Q.144 A biparous cyme ending in uniparous cymes constitutes **[JIPMER 2000]**

(1) Verticillaster (2) Panicle

(3) Thyrus (4)Paniculate cyme

Q.145 Spadix inflorescence occurs in **[Orissa 2007, JKCMEE 2010]**

(1) Mulberry (2) Banana

(3) Coriander (4) Delonix

Q.146 Number of female flowers in a cyathium is : **[Kerala 2005, CPMT 2007]**

(1) 1 (2) 2

(3) 3 (4) Several

Q.147 Edible part of Cauliflower is **[AFMC 1996, AIIMS 2000]**

(1) Bud (2) Bract

(3) Inflorescence (4) Leaves

Q.148 Capitulum inflorescence is found in **[MPPMT 2010, CET Chd. 2010]**

(1) Malvance (2) Papilionaceae

(3) Liliaceae (4) Compositae

Q.149 Whorl of small green structures present around Sunflower is **[Pb. PMT 2000]**

(1) Epicalyx (2) Calyx

(3) Leaves (4) Involucre

Q.150 Inflorescence of Jowar is **[Wardha 2010]**

(1) Spike of spikelets (2) Panicle of spikelts

(3) capitulum (4) Verticillaster

Q.151 The ratio of female to male flowers is $1 : \infty$. It is found in **[CMPT 2001]**

(1) Hypanthodium (2) Cyathium

(3) Catkin (4) verticillaster

Q.152 Vertiillaster inflorescence occurs in **[Har. PMT 2001]**

(1) Lamiaceae/Labiatae

(2) Brassicacaea/Cruciferae

(3) Compositae/Asteraceae

(4) Solanaceae

Q.153 All the florets are disc florets in **[Tamil Nadu 2001]**

(1) Launea (2) Vernonia

(3) Sunflower (4) Tridax

Q.154 Inflorescence having unisexual sessile flowers is **[JKCMEE 2002]**

(1) Spike (2) Spikelet

(3) Catkin (4) Spadix

Q.155 Inflorescence having unisexual sessile flowers is **[RPMT 2002]**

(1) Umbel Cyathium (2) Cyathium

(3) Hypanthodium (4) Capitulum

Q.156 Which is true

(1) Umbel is racemose inflorescence where stalked flowers aggregate on a flat receptacle

(2) In raceme the main axis is shortened and flowers are born acropetally

(3) Spadix is a pendulous spike with main axis much flattened

(4) Spike is a racemose inflorescence having sessile flowers.

Q.157 Select the correct combination of inflorescence

(1) Simple raceme, corymb, umbel, simple cyme

(2) Simple raceme, spadix, spike, catkin

(3) Cyathium, verticillaster, hypanthodium, catkin

(4) Capitulum, globose head, verticillaster, catkin

Q.158 Raceme inflorescence occurs in **[JIPMER 2003]**

(1) Cucurbita (2) Delonix

(3) Euphorbia (4) Begonia

Q.159 Which is nearest to corymb **[CMC 2003]**

(1) Umbel (2) Capitulum

(3) Cyathium (4) Hypanthodium

Q.160 Elongated peduncle bearing pedicellate flowers continuously in acropetal order is **[KJCMEE 2001]**

(1) Corymb (2) Umbel

(3) Raceme (4) Head

Q.161 Which is not a correct match **[JKCMEE 2003]**

(1) Catkin — Mulberry

(2) Capitulum — Sunflower

(3) Corymb — Candytuft

(4) Raceme — Candytuft

Q.162 Edible part of Cauliflower is **[CPMT 2004, AFMC 2005]**

(1) Cotyledons (2) Mesocarp

(3) Endocarp (4) Inflorescense

Q.163 Capitulum inflorescence occur in **[JKCMEE 2005]**

(1) Salvia (2) Euphorbia

(3) Marigold (4) Jasmine

Q.164 Compare the column and find out the correct combinatiion

Column I	**Column II**
(1) Gall flowers	(i) Spikelet
(2) Involucre	(ii) Hypanthodium
(3) Spathe	(iii) Cyathium
(4) Lemma	(iv) Umbel
	(v) Spadix

[EAMCET 2005]

(1) (1) – (ii), (2) – (iv), (3) – (v), (4) – (iii)

(2) (1) – (ii), (2) – (iii), (3) – (v), (4) – (i)

(3) (1) – (iii), (2) – (iv), (3) – (ii), (4) – (v)

(4) (1) – (iii), (2) – (iv), (3) – (ii), (4) – (i)

Q.165 Characteristic bracts associated with spikelet inflorescence of grasses are **[Manipur 2006]**

(1) Involucral bracts (2) Glumes

(3) Pappus (4) Spathes

Q.166 Spadix inflorescence is characteristic feature of **[CET Chd. 2006]**

(1) Colocasia (2) Palm

(3) Banana (4) All the above

Q.167 Scorpioid cyme occurs in **[JKCMEE 2007]**

(1) Hamelia (2) Nerium

(3) Heliotropium (4) Clerodendron

Q.168 Capitulum inflorescence does not occur in **[Manipur 2007]**

(1) Dahlia (2) Sunflower

(3) Marigold (4) China Rose

Q.169 Match the column and select the correct options

Column I	**Column II**
(a) Spike	(1) Bougainvillea
(b) Capitulum	(2) Coleus
(c) Dichasial cyme	(3) Adhatoda
(d) Multiparous cyme	(4) Zinnia
(e) Verticillaster	(5) Asclepias

[Kerala 2008]

(1) a – 3, b – 4, c – 1, d – 5, e – 2

(2) a – 3, b – 1, c – 4, d – 5, e – 2

(3) a – 2, b – 4, c – 1, d – 5, e – 3

(4) a – 4, b – 2, c – 5, d – 1, e – 3

(5) a – 5, b – 4, c – 1, d – 3, e – 2

Q.170 Study the following table and find the correct pair **[EAMCET 2008]**

(a) False whorl like inflorescence – many sessile bisexual flowers – Leonotis

(b) Single flower like inflorescence – Many stalked stminate and pistillate flowers – Poinsettia

(c) Fruit–like inflorescence – Many sessile, staminate flowers on top, pistillate flowers at base and sterile flower in between – Ficus

(d) Fleshy axis of inflorescence – Many stalked, staminate flowers at base, pistillate flowers on top and sterile flowers in between – Colocasia.

(1) a, c (2) a, d

(3) b, c (4) b, d

Q.171 Find the correct match

Column I	Column II
(a) Gall flowers	(1) Theobroma
(b) Sympodial axis	(2) Bougainvillea
(c) Achlamydeous	(3) Ficus
(d) Cauliflory	(4) Euphorbia
	(5) Hamelia

[EAMCET 2008]

(1) a – 3, b – 5, c – 1, d – 2
(2) a – 3, b – 4, c – 2, d – 1
(3) a – 3, b – 4, c – 1, d – 2
(4) a – 3, b – 5, c – 4, d – 1

Q.172 In an inflorescence two types of centripetally arranged sessile flowers with hair like sepals occurs. Which one is not associated with them
(a) Nectar glands at base of corolla
(b) Axile placentation
(c) Superior ovary
(d) Scaly bracts **[EAMCET 2008]**
(1) b and c (2) c and d
(3) a and b (4) a and d

Q.173 Verticillaster type of inflorescence occurs in **[JKCMEE 2008]**
(1) Cotton (2) Datura
(3) Leucas (4) Ocimum

Q.174 Glumes represent **[CPMT 2009]**
(1) Petals (2) Bracts
(3) Sepals (4) Stamens

Q.175 A student observed 34 inflorescence in Bougainvillea and 42 inflorescence in Poinsettia. Find out the number of flowers in Bougainvillea and the number of female of flowers in poinsettia respectively. **[EAMCET 2009]**
(1) 34, 126 (2) 204, 164
(3) 102, 42 (4) 68, indefinite

Q.176 Largest flower is that of **[BHU 1987, 1991]**
(1) Sunflower (2) Rafflesia
(3) Nelumbo (4) Drosera

Q.177 Arrangment of sepals and petals with respect to each other is **[COMED–K's 2006]**
(1) Venation (2) Vernation
(3) Aestivation (4) Phyllotaxy

Q.178 A flowers which can be divided into two exactly equal halves by any vertical division passing through centre is **[Har. PMT 2003, JKCMEE 2004]**
(1) Zygomorphic (2) Hypogynous
(3) Actinomorphic (4) Epigynous

Q.179 A typical flower with superior ovary and other floral parts inferior is **[JKCMEE 2005]**
(1) Polygamous (2) Hypogynous
(3) Periynous (4) Epigynous

Q.180 An apocarpous flower is found in **[BHU 1999, JIPMER 2000]**
(1) Caesalpinnia (2) Ranunculus
(3) Brassica (4) Datura

Q.181 Part of pistil which receives pollen is **[MPPMT 2000]**
(1) Ovary (2) Style
(3) Stigma (4) Ovule

Q.182 Gynobasic sytle is found in **[Har. PMT 2007]**
(1) Labiatae/Lamiaceae (2) Liliaceae
(3) Gramineae/Poaceae
(4) Composite/Asteracceae

Q.183 A plant with both male and female flowers/sex organs borne over it is **[DPMT 2009]**
(1) Monoecious (2) Dioecious
(3) Unisexual (4) Bisexual

Q.184 Marginal placentation is found in **[RPMT 2000]**
(1) Solanaceae (2) Cruciferae
(3) Fabaceae/Leguminosae
(4) Asteraceae/Compositae

Q.185 Pappus is modification of **[BHU 2005]**
(1) Bracts (2) Bracteoles
(3) Corolla (4) Sunflower

Q.186 Diadelphous (9) + 1 stamens occur in **[Manipal 2001, AIIMS 2001]**
(1) Gramineae (2) Cucurbitaceae
(3) Papilionate (4) Malvaceae

Q.187 Filament attachd along the whole length of anther is the condition called **[EAMCET 1996, AIIMS 2002]**
(1) Adnate (2) Dorsifixed
(3) Basifixed (4) Versatile

Q.188 Tetradynamous condition is characteristic of family **[Bihar PMT 2001, CBSC 2001]**

(1) Papilionaceae/Pea

(2) Cruciferae/Mustard

(3) Solanaceae/Tamato

(4) Malvaceae/Cotton

Q.189 Vexillary type of petal arrangement occurs in **[KCET 1998, 2001]**

(1) Maize (2) Cucurbita

(3) Mustard (4) Pea/Crotolaria

Q.190 Placentation type of petal arrangement in a syncarpous unilocular ovary where ovules occur on sutures is **[CPMT 2010]**

(1) Apical placentation

(2) Parietal placentation

(3) Marginal placentation

(4) Superficial placentation

Q.191 Monothecous anthers occur in **[RPMT 2000, Bih. PMT 2002]**

(1) Hibiscus rosa-sinensis/Malvaceae

(2) Allium cepa/Liliaceae

(3) Brassica oleracea/Cruiferae

(4) Solanum nigrum/Solanaceae

Q.192 Hair present on the cob of corn are **[CBSE 2000, 2006]**

(1) See hairs

(2) Modified hairs of bracts

(3) Styles

(4) Stigmas

Q.193 Pappus is characteristic of family **[JKCMEE 2000]**

(1) Asteraceae/Compositae

(2) Papaveraceae

(3) Papolionaceae/Fabaceae

(4) Malvaceae

Q.194 In many cultivated ornamental flowers, number of petal whorls is higher than the one in wild type. Extra petals are generally modified. **[JKMEE 2000]**

(1) Sepals (2) Petals

(3) Stamens (4) Pistils

Q.195 Ligulate corolla found in compositae is **[JIPMER 2000]**

(1) Wheel – shaped (2) Strap – shaped

(3) Masked (4) Two – lipped

Q.196 Butterfly shaped flower with one standard, two wing-like and two keeled petals belong to **[AIIMS 2000]**

(1) Compositae (2) Rubiaceae

(3) Malvaceae (4) Papilionaceae

Q.197 Transversely placed syncarpous ovary occurs in **[Pb. PMT 2000]**

(1) Compositae (2) Cruciferae

(3) Malvaceae (4) Cucurbitaceae

Q.198 When stamens are fused by their anthers and the filaments are free, the condition is called **[JIPMER 2000, Har. PMT 2003]**

(1) Monadelphous (2) Synandrous

(3) Syngenesious (4) Epipetalous

Q.199 Papilionaceous corolla occurs in **[Wardha 2001]**

(1) Brassicaceae (2) Asteraceae

(3) Fabaceae (4) Poaceae

Q.200 Stamens of Jower/Grass are **[Wardha 2001]**

(1) Dorsifixed (2) Versatile

(3) Basifixed (4) Adnate

Q.201 A flower without nonessential whorls is **[Kerala 2001]**

(1) Monoecious (2) Trioecious

(3) Dioecious (4) Achlamydeous

(5) Hermaphrodite

Q.202 The condition of free petals is called **[Kerala 2001]**

(1) Polypetalous (2) Gamopetalous

(3) Polyphyllous (4) Gamophyllous

(5) Apocarpous

Q.203 Anthers represents **[BHU 2001]**

(1) Male gametophytes (2) Male sporophylls

(3) Spermatogonia

(4) Female gametophytes

Q.204 Bicarpellary gynoecium with oblique ovary occurs in **[CBSE 2001]**

(1) Banana (2) Brinjal

(3) Pisum (4) Mustard

Q.205 Inividual flowers are attached to inflorescence axis by **[Tamil Nadu 2001]**

(1) Peduncle (2) Petiole

(3) Pedicel (4) Bract

Q.206 Trimerous flowers occur in **[Har. PMT 2001]**

(1) Monocots (2) Dicots

(3) Gymnosperms (4) All the above

Q.207 Which of the following is asymetrical flower **[Tamil Nadu 2001]**

(1) Clitroria (2) Canna

(3) Crotalaria (4) Hibiscus

Q.208 In obdiplostemonous androecium, stamens are arranged in **[EAMCET 2002]**

(1) One whorl alternating with petals

(2) Two whorls with outer whorl opposite the petals

(3) Two whorls with outer whorl alternating with petals

(4) One whorl opposite the petals

Q.209 In Bentham and Hooker's system of classification the arrangement of three series of polypetalae reflects evolution from **[EAMCET 2002]**

(1) Bisexuality to unisexuality

(2) Dichlamydeous to monochlamydeous condition

(3) Hypogyny to epigyny

(4) Apocarpy to syncarpy

Q.210 Petals of a flower are arranged in such a way that each overlaps a petal on one side and is overlapped by other petal on the other side. The aestivation is **[RPMT 2002]**

(1) Valvate (2) Quincuncial

(3) Imbricate (4) Twisted

Q.211 Out of 5 petals of a flower, two are completly internal, two completely external and remaining one is internal at one margin and external at the other margin. Aestivation is **[Orissa 2002]**

(1) Ascending imbricate

(2) Vaxillary

(3) Quincuncial (4) Valvate

Q.212 A flower which can be divided into two equal halves by only one plane is **[JKCMEE 2002, HPPMT 2007]**

(1) Zygomorphic (2) Actinomorphic

(3) Perfect (4) Regular

Q.213 Individual components of perianth are called **[Har. PMT 2003]**

(1) Sepals (2) Petals

(3) Tepals (4) Bracts

Q.214 Union of stamens with carpels from a complex called **[CMC 2003]**

(1) Gynandrous (2) Syngenesious

(3) Gynandrium (4) Synandrous

Q.215 The condition of fusion of filaments as well as anthers is **[Orissa 2004]**

(1) Gyandrous (2) Synandrous

(3) Syngenesious (4) Protandrous

Q.216 An ovule bent to come at right angles to funicle is **[CBSE 2004]**

(1) Anatropous (2) Orthotropous

(3) Campylotropous (4) Hemitropous

Q.217 Anthesis is **[CBSE 2004, CET Chd. 2010]**

(1) Opening of floral bud

(2) Development of anthers

(3) Maturation of anthers

(4) Reception of pollen by stigma

Q.218 Tetradynamous condition occurs in **[AFMC/CPMT 2004, RPMT 2005]**

(1) Petunia hybrida

(2) Helianthus annuus

(3) Brassica campestris

(4) Hibiscus rosa sinensis

Q.219 Flowers having only one set of essential organ are **[Kerala 2004]**

(1) Monoecious (2) Dioecious

(3) Bisexual (4) Unisexual

(5) Polygamous

Q.220 Trimerous unisexual flowers occur in **[KCET 2004]**

(1) Tamarind (2) Cocos

(3) Pea (4) Hibiscus

Q.221 Saffron is **[MPPMT 2004, Har. PMT 2007]**

(1) Stamens of Hibiscus

(2) Style and stigma of Crocus plant

(3) Roots of Indigofera

(4) Petals of Musa

Q.222 Gynoecium having three fused carpels with a single ovule containing chamber is **[JIPMER 2004]**

(1) Tricarpellary, syncarpous, unilocular

(2) Tricarpellary, polycarpellary unilocular

(3) Tricarpellary, syncarpous, trilocular

(4) Tricarpellary, polycarpellary, trilocular

Q.223 Clove used as spice represents **[Kerala 2005]**

(1) Seed (2) Leaves

(3) Flower buds (4) Stem tip

(5) Terminal bud

Q.224 Arrangement of ovules on the placentae developed from central axis of ovary is **[JKCMEE 2005]**

(1) Parietal placentation

(2) Basal placentation

(3) Marginal placentation

(4) Axile placentation

Q.225 The position of ovary is below sepals, petals and stamens. The flower is **[Orissa 2005]**

(1) Epigynous (2) Perigynous

(3) Mesogynous (4) Metagynous

Q.226 Indentify the wrong statement **[EAMCET 2005]**

(1) A plant that bears male, female and bisexual flowers is polygamous

(2) Actinomorphic flowers can be dissected into two equal halves from any plane

(3) Superior ovary is found in hypogynous flowers

(4) Side of the flower towards the bract is called posterior side.

Q.227 Compare the column and find out the correct combination **[EAMCET 2005]**

Column I	**Column II**
(1) Tridax	(i) Synandrous
(2) Dolichos	(ii) Monadelphous
(3) Ceiba	(iii) Syngenesious
(4) Cucurbita	(iv) Polyadephous
	(v) Diadelphous

(1) (1) – (iv), (2) – (v), (3) – (ii), (4) – (i)

(2) (1) – (iii), (2) – (v), (3) – (iv), (4) – (i)

(3) (1) – (iii), (2) – (v), (3) – (i), (4) – (iv)

(4) (1) – (v), (2) – (iii), (3) – (iv), (4) – (ii)

Q.228 A flower with five unequal petals has largest posterior petal, two lateral slighly small petals and two anterior petals partially fused to form a boat – shaped structure. Which is not correct for such a flower? **[EAMCET 2005]**

(1) Descending imbricate aestivation

(2) Odd sepal anterior

(3) Piston mechanism of pollination

(4) Many carpels.

Q.229 Staminal tube comes out of flower in **[RPMT 2005]**

(1) Pisum sativum (2) Cassia fistula

(3) Hibiscus (4) Iberis

Q.230 Colour of Bougainvillea flower is due to colour of its **[RPMT 2005]**

(1) Corolla (2) Bracts

(3) Calyx (4) Androrcium

Q.231 When pistillate and bisexual flowers develop on different plants. The condition is **[BV 2006]**

(1) Gynodioecious (2) Gymnomonoecius

(3) Polygamodiecius (4) Polygamonoecius

Q.232 Non-essential floral organs without differentiation of calyx and corolla are called **[MHTCET 2007]**

(1) Thalamus (2) Pedicel

(3) Perianth (4) Lodicules

Q.233 Epicalyx occurs in **[MHTCET 2007]**

(1) Cycas (2) Jower

(3) Nephrolepis (4) China Rose

Q.234 In Guava and Cucurbits the flowers are

(1) Hypogynous (2) Epigynous

(3) Perigynous (4) Both A and B

Q.235 Synandrous condition is found in **[WB 2008]**

(1) Sunflower (2) Gourd

(3) Pea (4) Lemon

Q.236 Floral bud is covered by **[Orissa 2008]**
(1) Petals (2) Anthers
(3) Sepals (4) Stigmas

Q.237 Ovarian parts are fused, styles and stigmas free but ovary part is unilocular with free central placentation. The plant is **[EAMCET 2008]**
(1) Michelia (2) Nymphaea
(3) Abutilon (4) Dianthus

Q.238 Replum occurs in the ovary of **[CBSE 2008]**
(1) Mustard (2) Pea
(3) Sunflower (4) Lemon

Q.239 In a plant, androecium has monadelphous stamens, monothecous reniform anthers and contorted corolla. It is **[KCET 2009]**
(1) Nerium (2) Rauwolfia
(3) Hibiscus (4) Lathyrus

Q.240 Pollinia occur in **[Orissa 2009]**
(1) Cruciferae (2) Asteraceae
(3) Poaceae (4) Asclepiadaceae

Q.241 Ochreate stipules occurs in **[Orissa 2009]**
(1) Leguminosae (2) Polygonaceae
(3) Acanthaceae (4) Malvaceae

Q.242 Ovules occur along the ventral suture over a ridge in two rows in placentation **[AMU 2009]**
(1) Marginal (2) Parietal
(3) Axile (4) Free central

Q.243 Placentation found in caryophyllaceae is **[Kerala 2009]**
(1) Axile (2) Basal
(3) Parietal (4) Free central
(5) Marginal

Q.244 Other florals develop below the base of ovary in a flower called **[WB 2009]**
(1) Epigynous (2) Hypogynous
(3) Agynous (4) Perigynous

Q.245 An example of axile placentation is **[CBSE 2009]**
(1) Marigold (2) Dianthus
(3) Lemon (4) Argemone

Q.246 Which one is monoecious **[CBSE 2009]**
(1) Marchantia (2) Pinus
(3) Cycas (4) Papaya

Q.247 Consider the following statements **[Kerala 2010]**
(a) In recemose inflorescence the flowers are borne in a basipetal order
(b) Epigynous floweers are seen in Rose plants
(c) In Brinjal the ovary is superior. Of these statements
(1) a and b are true but c is false
(2) a and c are true but b is false
(3) a and b are false but c is true
(4) b and c are true but a is false
(5) a and c are false but b is true

Q.248 The ovary in hypogynous flowers is said to be **[HPPMT 2010]**
(1) Half inferior (2) Inferior
(3) Superior (4) None of these

Q.249 Aestivation found in Pea flowers is **[HPPMT 2010]**
(1) Twisted (2) Valvate
(3) Imbricate (4) Vexillary

Q.250 In which of the following kinds of ovules, the emboryo sac is horse – shoe shaped **[MPPMT 2010]**
(1) Orthotropous ovule
(2) Hemitorpous ovule
(3) Amphitropous ovule
(4) Circinotropous ovule

Q.251 Which of these is an example for zygomorphic flower with inbricate aestivation **[Kerala 2010]**
(1) Canna (2) Cassia
(3) Cucumber (4) Catotropis
(5) Mustard

Q.252 Gynandrous condition means **[Orissa 2010]**
(1) Adhesion of stamens and carpels
(2) Cohesion of stamens
(3) Stamens united by filaments
(4) Free stamens

Q.253 Feathery stigma is called **[Orissa 2010]**
(1) Plumose (2) Spur
(3) Stylopodium (4) Calyculus

Q.254 The expression 'gynoecium is apocarpous' implies that **[DPMT 2010]**

(1) Gynoecium compries only one pistil which is fused with the stamens

(2) Gynoecium compries more than one carpel which are free

(3) Gynoecium compries more than one carpel which are fused

(4) Gynocium compries only one carpel which is free

Q.255 In unilocular ovary with a single ovule the placentation is **[CBSE 2010]**

(1) Basal (2) Free central

(3) Axile (4) Marginal

Q.256 The technical term used for the androecium in a flower of China Rose (Hibiscus rosa - sinensis) is **[CBSE 2010]**

(1) Diadelphous (2) Polyandrous

(3) Polyadelphous (4) Monadelphous

FRUIT

Q.257 Maize/Wheat/Rice grain is **[RPMT 2005, AFMC 2005]**

(1) Fruit (2) Seed

(3) Embryo (4) Dried bud

Q.258 Edible part in the fruit of Litchi is **[CBSE 2005, Wardha 2005]**

(1) Mesocarp (2) Aril

(3) Fleshy thalamus (4) Cotyledons

Q.259 In Asteraceae/Sunflower, the fruit is **[CPMT 2001]**

(1) Drupe (2) Cypsela

(3) Berry (4) Carcerules

Q.260 Wheat/Rice grain is a fruit of the type **[AMUPMDC 2006, AFMC 2009]**

(1) Cypsela (2) Samara

(3) Achene (4) Caryopsis

Q.261 Which one of the following is a nut **[Kerala 2003, BHU 2005, 2008]**

(1) Walnut (2) Cashewnut

(3) Groundnut/Areca (4) Both 1 and 2

Q.262 Which one of the following does not have a polycarpellary ovary **[CPMT 1989, JKCMEE 2009]**

(1) Guava (2) Coconut

(3) Apple (4) Fig.

Q.263 A simple one – seeded dry, indehiscent fruit in which pericarp and testa are fused is **[JKCMEE 2008, CET Chd. 2010]**

(1) nut (2) Achene

(3) Cypsela (4) Caryopsis

Q.264 Coir of commerce is obtained from **[AIIMS 2001, AMU 2005, CPMT 2009]**

(1) Endocarp of Coconut

(2) Mesocarp of Coconut

(3) Stem of Jute

(4) Leaves of Coconut

Q.265 Fruit of Calotropis is **[CPMT 1986, Pb. PMT 2000]**

(1) Nut (2) Follicle

(3) Berry (4) Siliqua

Q.266 Fruit growing from hypanthodium/fruit of Fig is **[CPMT 2001, CBSE 2009]**

(1) Sorosis (2) Siliqua

(3) Syconus (4) Samara

Q.267 Caryopsis is the fruit of **[AFMC 1986, MHTCET 2007]**

(1) Coconut (2) Brinjal

(3) Tomato (4) Maize/Sorghum

Q.268 A false fruit is that of **[CPMT 1988, 2009, AFMC 2010]**

(1) Mango (2) Cashewnut

(3) Apple (4) Brinjal

Q.269 The fruit of Annona squamosa (Custard Apple) is **[AFMC 2004]**

(1) Etaerio of berries (2) Etaerio of drupes

(3) Hypanthodium (4) Etaerio of achenes

Q.270 The edible part of Apple/Pear is **[BHU 2008, AMU 2005, Manipur 2007]**

(1) Cotyledons

(2) Thalamus/Receptacle

(3) Mesocarp

(4) Endocarp

Q.271 Endocarp is stony in the fruit of **[JKCEE 2005, KCET 2009]**

(1) Berry (2) Pome
(3) Drupe (4) Pepo

Q.272 Edible part of Mango is **[AFMC 2010, CBSE 2004]**

(1) Pericarp (2) Mesocarp
(3) Pome (4) Epicarp

Q.273 Edible part of Coconut is **[Bih. PMT 1991]**

(1) Endocarp (2) Mesocarp
(3) Aril (4)Seed/Endosperm

Q.274 Dry indehiscent single seeded fruit formed from bicarpellary syncarpous inferior ovary is **[CBSE 2008]**

(1) Cremocarp (2) Caryopsis
(3) Cypsela (4) Berry

Q.275 Pepo is a fruit of **[AMUPMDC 2006]**

(1) Crouciferae (2) Leguminosae
(3) Cucurbitaceae (4) Liliaceae

Q.276 Formation of fruit without fertilization is **[AFMC 2001, CPMT 2003, 2009]**

(1) Apogamy (2) Apospory
(3) Syngenesious (4) Parthenocarpy

Q.277 Edible part of Guava is **[Orissa 1995, AFMC 2002]**

(1) Thalamus and pericarp
(2) Entire fruit
(3) Endocarp (4) None of the above

Q.278 Aril represents edible part in **[CBSE 2006, AFMC 2009]**

(1) Litchi (2) Apple
(3) Mango (4) Banana

Q.279 Science and practice of fruit culture is **[Orissa 2010]**

(1) Spermology (2) Pomology
(3) Anthology (4) Dendrology

Q.280 Syconus fruit develops from **[AMUPMDC 2006]**

(1) Catkin (2) Varticillaster
(3) Hypanthodium (4) Cyathium

Q.281 Syconus is the name of **[Har. PMT 2010]**

(1) Inflorescence (2) Fruit
(3) Thalamus (4) Ovary

Q.282 Geocarpic fruit is **[CBSE 2000]**

(1) Mango (2) Orange
(3) Wtare Melon (4) Pea Nut

Q.283 Jack fruit is **[CET Chd. 2000]**

(1) Sorosis (2) Syconus
(3) Siliqua (4) Lomentum

Q.284 Fruit of Candytuft is **[Wardha 2000]**

(1) Capsule (2) Follicle
(3) Silicula (4) Pome

Q.285 Pome is false fruit as **[CPMT 2000]**

(1) Endocarp is cartilaginous
(2) Pericarp is inconspicuous
(3) Fruit is surrounded by fleshy thalamus
(4) All the above

Q.286 Schizocarpic fruit has **[JIPMER 2000]**

(1) Fleshy pericarp
(2) Origin from inflorescence
(3) Origin from apocarpous pistil
(4) Trait of breaking up into single seeded parts

Q.287 Select the correct combination of edible part **[Manipal 2000]**

(1) Coconut – Mesocarp
(2) Apple – Mesocarp
(3) Mango – Endocarp
(4) Banana – Mesocarp Endocarp

Q.288 Which one of the following is true match **[Manipal 2001]**

(1) Composite fruit – Pineapple
(2) Aggregate fruit – Pineapple
(3) True fruit – apple
(4) False fruit – Mango

Q.289 Single seeded fruit develops from **[CPMT 2001]**

(1) Tricarpellary ovary
(2) Bicarpellary syncarpous ovary
(3) Multicarpellary syncarpous ovary
(4) Pistil having single ovule

Q.290 Fruit of coconut is **[CPMT 2010]**

(1) Berry (2) Cypsela
(3) Drupe (4) Cremocarp

Q.291 A composite/sorosis fruit is **[HPPMT 2007]**

(1) Banana (2) Pineapple

(3) Pear (4) Coconut

Q.292 Which is correct match for edible part **[CBSC 2001]**

(1) Tomato – Thalamus

(2) Maize – Cotyledons

(3) Guava – Mesocarp

(4) Date – Mesocarp

Q.293 Edible part of Banana is **[CBSE 2001]**

(1) Epicarp

(2) Epicarp and mesocarp

(3) Mesocarp and less developed endocarp

(4) Endocarp and less developed mesocarp

Q.294 Coir is obtained from **[Har. PMT 2001]**

(1) Fruit of Cocos nucifera

(2) Seed of Cocos nucifera

(3) Stem of Cocos nucifera

(4) Leaves of Cocos nucifera

Q.295 Edible part of Mulberry is **[Uttarakhand 2001]**

(1) Thalamus (2) Perianth

(3) Rachis (4) Ripened ovary

Q.296 Spines on the rind of Jack – Fruit represent **[Tamil Nadu 2001]**

(1) Styles (2) Carpels

(3) Stigmas (4) Bracts

Q.297 Which one is a composite fruit **[DPMT 2002]**

(1) Pea (2) Strawberry

(3) Calotropis (4) Jack Fruit

Q.298 Fruit developed from bicarpelley syncarpous ovary having a false septum is **[DPMT 2002]**

(1) Achene (2) Siliqua

(3) Capsule (4) Berry

Q.299 Berries, drupes and pomes are **[JKCMEE 2002]**

(1) Aggregate fruits

(2) Composite fruits

(3) Simple dry fruits

(4) Simple succulent fruits

Q.300 Aril is **[JIPMER 2002]**

(1) Outgrowth of integument

(2) Persistent nucellus

(3) Outgrowth of funicle which grows around the ovule

(4) Outgrowth from micropyle

Q.301 Nature of fruit developing from a flower depends upon the type of **[KCET 2002]**

(1) Gynoecium (2) Androecium

(3) Pollination (4) Fertilisation

Q.302 Juicy hair like structures observed in lemon fruit develop from **[CBSE 2003]**

(1) Exocarp

(2) Mesocarp

(3) Endocarp

(4) Mesocarp and endocarp

Q.303 Fruit formed from an inflorescence is **[Wardha 2003]**

(1) Simple fruit (2) Pseudocarp

(3) Composite fruit (4) Aggregate fruit

Q.304 Most important edible plant food is **[AMU 2003]**

(1) Roots (2) Stems

(3) Leaves (4) Fruits

Q.305 Fruits have fructose for **[AMU 2003]**

(1) Attracting animals for seed dispersal

(2) Fruit ripening

(3) Maturation of seeds

(4) Nourishment of embryo

Q.306 Fruit of Elepkat Apple (Dillenia indica) **[AMU 2003]**

(1) Balausta (2) Pepo

(3) Amphisarca (4) Berry

Q.307 A dry indehiscent fruit is **[Kerala 2004]**

(1) Caryopsis (2) Follicle

(3) Capsule (4) Pod

Q.308 In sorosis type of composite fruits, the edible part is **[BHU 2005]**

(1) Cotyledons

(2) Fleshy thalamus

(3) Perianth and peduncle

(4) Endosperm

Q.309 The fruit developed from single ovary is **[JKCMEE 2005]**

(1) Composite (2) Simple fruit

(3) Aggregate fruit (4) None of the above

Q.310 Drupes are called stony fruits as they have **[Kerala 2005]**

(1) Hard endocarp

(2) Hard mesocarp

(3) Hard epicarp

(4) Hard epicarp and hard mesocarp

(5) Hard mesocarp and hard endocarp

Q.311 Dorsiventral dehiscence occurs in fruits **[EAMCET 2005]**

1. Legume 2. Follicle

3. Siliqua 4. Capsule

(1) 1 and 2 (2) 2 and 3

(3) 2 and 4 (4) 1 and 3

Q.312 Edible part of fleshy fruit is **[Manipur 2005]**

(1) Parenchymatous pulp

(2) Soft seeds

(3) Collenchymatous rind

(4) Sclerenchymatous endocarp

Q.313 Which is correct for Anacardium occidentale? **[Manipur 2005]**

(1) Upper part is edible

(2) Upper part is false fruit

(3) Seed is edible part of fruit

(4) Upper part is true fruit

Q.314 Which one is a true fruit? **[AMU 2005]**

(1) Walnut (2) Areca nut

(3) Cashew nut (4) Ground nut

Q.315 Edible part in sorosis fruit is **[AMU 2005]**

(1) Perianth (2) Parianth + sepals

(3) Placenta (4) Perianth + Placenta

Q.316 Pineapple (Ananas) fruit develops from **[CBSE 2006, DPMT 2009]**

(1) Cluster of flowers borne compactly on a common axis

(2) Multilocular monocarpellary flower

(3) Unilocular polycarpelley flower

(4) Mulitpistillate syncarpous flower

Q.317 Seedless fruit in Banana is produced by **[Bih. PMT 2006]**

(1) Parthenogenesis

(2) Asexual reproduction

(3) Triploidy

(4) Cross pollination

Q.318 Banana is **[COMED – K's 2006]**

(1) Cremocarp

(2) Parthenocarpic berry

(3) Drupe (4) Capsule

Q.319 A fruit that has fleshy mesocarp and stony endocarp is **[Manipur 2006]**

(1) Pome (2) Berry

(3) Pepo (4) Drupe

Q.320 Match the column **[Kerale 2006]**

Column I	**Column II**
(a) Apple	(1) Outer portion of receptacte
(b) Coconut	(2) Fleshy thalamus
(c) JAckfruit	(3) Thalamus and pericarp
(d) Guava	(4) Endosperm
(e) Pineapple	(5) Bract, perianth and seeds

(1) a – 5, b – 3, c – 1, d – 4, e – 2

(2) a – 2, b – 3, c – 1, d – 5, e – 4

(3) a – 2, b – 4, c – 5, d – 3, e – 1

(4) a – 2, b – 3, c – 4, d – 5, e – 1

(5) a – 5, b – 4, c – 3, d – 2, e – 1

Q.321 Lomentum is **[BHU 2007]**

(1) Achenial fruit (2) Schizocarpic fruit

(3) Composite fruit (4) Syconus fruit

Q.322 Pericarp and placenta are edible parts of simple fleshy berry fruit **[KCET 2007]**

(1) Tomato (2) Jack fruit

(3) Banana (4) Date Palm

Q.323 Edible part in the fruit of Hesperidium is **[JKMEE 2007]**

(1) Endocarp (2) Mesocarp

(3) Juicy hairs (4) Pericarp

Q.324 Dried fruit used in making a musical instrument is **[Har. PMT 2007]**
(1) Snake Gourd (2) Bitter Gourd
(3) Bottle Gourd (4) All the above

Q.325 Geocarpic fruits are formed in **[AMFC 2007]**
(1) Watermelon (2) Onion
(3) Carrot (4) Groundnut

Q.326 A single flower with multiple ovaries produces **[Orissa 2008]**
(1) Simple fruit (2) Aggregate fruit
(3) Composite fruit (4) False fruit

Q.327 Arrange the fruits in descending order of the chambers of the ovary they develop **[EAMCET 2008]**
(a) Carcerulus (b) Schizocarp
(c) Cremocarp (d) Regma
(1) b, a, d, c (2) a, d, c, b
(3) b, d, c, a (4) b, c, a, d

Q.328 The fruit is chambered, developed from inferior ovary and has seeds with succculent testa is **[CBSE 2008]**
(1) Orange (2) Cucumber
(3) Pomegranate (4) Guava

Q.329 Fleshy receptacle of syconus of Fig encloses a number of **[CBSE 2008]**
(1) Berries (2) Achenes
(3) Mericarps (4) Samras

Q.330 Find out the correct statements **[BHU 2008]**
(1) Seeds of Pea are exalbuminous
(2) Fruit of Peach is drupe
(3) Seeds of Tamoto are albuminous
(4) Fruit of Coconut is berry
(1) 1, 2, 3, correct (2) 1, 2 correct
(3) 2, 4 correct (4) 1, 3 correct

Q.331 In which plant the fruit is a drupe, seed coat is thin, embryo is inconspicuos and endosperm is edible? **[DPMT 2009]**
(1) Groundnut (2) Apple
(3) Wheat (4) Coconut

Q.332 In drupe of Coconut, mesocarp is **[AMU 2009]**
(1) Stony (2) Fleshy
(3) Fibrous (4) Watery

Q.333 Which statements are correct **[Kerala 2009]**
(a) A fruit developing from inflorescence composite fruit
(b) Mesocarp is edible in Apple
(c) Gynobasic style occurs in Ocimum
(d) hypanthodium occurs in Euphorbia species
(1) a, d correct (2) a, c correct
(3) a, b correct (4) b,d correct
(5) b, c, d corrct

Q.334 Cotyledons and testa are respectively edible in **[CBSE 2009]**
(1) Walnut and Tamarind
(2) French Bean and Coconut
(3) Cashew Nut and Litchi
(4) Groudnut and Pomegranate

Q.335 What is correct answer to assertion (1) and reason (r). Assertion a. In syconus type fruit, the achenes formed are fewer the total number of flowers in the inflorescence. Reason r. Upper and middle flowers do not develop into fruits **[EAMCET 2009]**
(1) Both a and r are correct with r being correct explanation of a
(2) Both a and r are correct with r is not correct explanation of a
(3) a is true but r is false
(4) a is false but r is true

Q.336 Which of the following fruit is parthenocarpic **[CET Chd. 2010]**
(1) Mango (2) Lemon
(3) Banana (4) Apple

Q.337 Which is multicellular and splits longitudinally along dorsal sutures **[Orissa 2010]**
(1) Septicidal (2) Capsular
(3) Loculicidal (4) Septifragal

Q.338 Bracts, perianth and seeds are edible parts of **[MPPMT 2010]**
(1) Cocos nucifera
(2) Mangifera indica
(3) Argemone maxicana
(4) Artocarpus heterophyllus

Q.339 In Coconut fruit, the hard shell is **[MPPMT 2010]**

(1) Endocarp
(2) Fused structure of mesocarp and endocarp
(3) Fused structure of epicarp anb mesocarp
(4) Epicarp

Q.340 Which one is not a false fruit **[HPPMT 2010]**

(1) Apple (2) Mango
(3) Strawberry (4) Cashewnut

Q.341 Scientific name of Banana is **[AFMC 2010]**

(1) Musa paradisica (2) Musa superba
(3) Musa textilis (4) Hibiscus mutabilis

SEEDS

Q.342 Mechanical injuring of seed coat to break dormancy is called **[DPMT 1999, 2003]**

(1) Scarification (2) Stratification
(3) Impaction (4) Compaction

Q.343 A seed which does not require oxygen for germination is **[BHU 2008]**

(1) Pea (2) Rice
(3) Typha (4) Both B and C

Q.344 Outermost layer of endosperm of Maize grain is **[Uttarakhand 2001, Har. PMT 2007]**

(1) Epidermis (2) Pericarp
(3) Tunica (4) Aleurone

Q.345 Oil is stored in the endosperm of **[WB 2007]**

(1) Groundnut (2) Soybean
(3) Coconut (4) Cashewnut

Q.346 Micropyle occurs in **[BHU 2008]**

(1) Ovary (2) Seeds
(3) Ovule (4) Both B and C

Q.347 Shield – shaped cotyledon/scutellum occurs in **[BHU 2008]**

(1) Maize/Sorghum (2) Gram
(3) Pea (4) Cucumber

Q.348 A method of breaking dormancy and allowing ample absorption of water is **[CBSE 2000]**

(1) Stratification (2) Scarification
(3) Vernalisation (4) Devernalisation

Q.349 During seed germination, seed coatrupture due to **[Har. PMT 2000]**

(1) Differentiation of cotyledons
(2) Massive glycolysis in endosperm cotyledons
(3) Maasive imbibition of water
(4) Sudden increase in cell division

Q.350 Hormone group responsible for breaking seed dormancy **[Manipur 2001]**

1. ABA 2. Cytokinin
3. Auxin 4. Gibberellin

(1) 1, 3 (2) 1, 2, 4
(3) 2, 3, 4 (4) 1, 2, 4

Q.351 In some halophytes, seeds germinate with fruits while attached to parent plant. **[Kerala 2001, Orissa 2009]**

(1) Vivipary (2) Halophytosis
(3) Monocarpic (4) Vernalisation
(5) Seismonasty

Q.352 Mitochondria produce more energy during **[AFMC 2001]**

(1) Formation of seed (2) Seed maturation
(3) Dormant seed (4) Seed germination

Q.353 Which one is endospermous **[Tamil Nadu 2001]**

(1) Cajanus cajan
(2) Helianthus annus
(3) Ricinus communis
(4) Ravenala madagascariensis

Q.354 Embryo of Sunflower has **[BHU 2002]**

(1) One cotyledon (2) Two cotyledon
(3) Many cotyledons (4) No cotyledon

Q.355 Nonalbuminuos seeds occur in **[DPMT 2002]**

(1) Maize (2) Wheat
(3) Rice (4) Vallisneria

Q.356 In pulses protein is stored in **[EAMCET 2002]**

(1) Cotyledons (2) Endosperm
(3) Pericarp (4) Seed coat

Q.357 Aleurone layer of maize grain is specially rich in **[CBSE 2003]**

(1) Proteins (2) Starch
(3) Lipid (4) Auxins

Q.358 Which of the following is an oil seed plant? **[AFMC 2003]**

(1) Sunflower (2) Hibiscus
(3) Marigold (4) Rose

Q.359 Which one is monocot albuminous seed **[Har. PMT 2003]**

(1) Maize (2) Wheat
(3) Rice (4) All the above

Q.360 In Groundnut, oil is stored in **[CPMT 2003]**

(1) Embryo axis (2) Endosperm
(3) Cotyledons (4) None of the above

Q.361 Assign the seeds to their respective categories **[JKCMEE 2003]**

(a) Maize (b) Mustard
(c) Pea (d) Endospermic
(e) Nonendospermic

(1) a – d, b – d, c – e (2) a – d, b – e, c – e
(3) a – e, b – e, c – d (4) a – e, b – d, c – e

Q.362 In Pea, Castor and Maize, the number of cotyledons are respectively **[JKCMEE 2004]**

(1) One, two and two (2) Two, two and one
(3) Two, one and two (4) One, two and one

Q.363 Which one does not exhibit seed dormancy? **[CPMT 2004]**

(1) Phaseolus (2) Rhizophora
(3) Cassia (4) Xanthium

Q.364 Which one yields castor oil? **[MPPMT 2004]**

(1) Sesamum indicum (2) Cocos nucifera
(3) Ricinus communis
(4) Brassica campesteris

Q.365 Dry fruit 'Chilgoza' is **[BHU 2005]**

(1) Fruit of Cycas
(2) Seed of Cycas
(3) Fruit of Pinus gerardiana
(4) Seed of Pinus gerardiana

Q.366 Why is vivipary an undesirable character for annual crop plants? **[CBSE 2005]**

(1) It reduces vigour of the plant
(2) It adversely affects the fertility of the plant
(3) The seeds exhibit long dormancy
(4) The seeds cannot be stored under normal conditions for next season.

Q.367 A dicot plant lacking cotyledons is **[AMU 2005]**

(1) Cuscuta (2) Santalum
(3) Lodoicea (4) None of the above

Q.368 Seed of Castor is **[AMU 2005]**

(1) Nonendospermic exalbuminous
(2) Endospermic ablbuminous
(3) Endospermic exalbuminous
(4) Nonendospermic ablbuminous

Q.369 In cereal grain, single cotyledon is represented by **[CBSE 2006]**

(1) Coleoptile (2) Coleorhiza
(3) Scutellum (4) Prophyll

Q.370 Edible part of Paddy is **[Orissas 2006]**

(1) Endosperm (2) Cotylendons
(3) Fruit
(4) Endosperm and embryo

Q.371 The point of attachment of the stalk with the seed is **[HPPMT 2007]**

(1) Hilum (2) Micropyle
(3) Tegmen (4) Plumule

Q.372 In Maiza grain, plumule is covered by protective sheath called **[HPPMT 2007]**

(1) Scutellum (2) Coleorrhiza
(3) Coleoptile (4) Tegmen

Q.373 Match the columns **[Kerala 2007]**

	Column I	**Column II**
(1)	Coleorrhiza	(1) Grapes
(2)	Food storing tissue	(2) Mango
(3)	Parthenocarpic fruit	(3) Maize
(4)	Single seeded fruit from monocarpellary superior ovary	(4) Radicle
(5)	Membranous seed coat	(5) Endosperm

(1) a – 1, b – 3, c – 2, d – 5, e – 4
(2) a – 4, b – 5, c – 1, d – 2, e – 3
(3) a – 3, b – 1, c – 4, d – 2, e – 5
(4) a – 4, b – 2, c – 5, d – 1, e – 3
(5) a – 5, b – 1, c – 3, d – 4, e – 2

Q.374 In monocotyledonous seeds, endosperm is separated from embryo by a distinct layer of **[Kerala 2008]**

(1) Testa (2) Tegmen
(3) Aleurone layer (4) Scutellum
(5) Coleoptile

Q.375 Scutellum of Maize is **[COMED–K's 2008, CBSE 2010]**

(1) Cotyledon (2) Endosperm
(3) Tegmen (4) Testa

Q.376 Identify the characters of plant where 8–nucleate embryo sac was first studied by Strasburger **[EAMCET 2007]**

(a) Micropyle, chalaza and funiculus in same vertical line
(b) Both unisexual and bisexual flowers on same plant
(c) Filiform apparatus conducts food from endosperm to egg apparatus
(d) Long funiculus coils like watch spring around the ovule.

(1) a, b and c (2) a and b
(3) b and d (4) a and c

Q.377 Find the correct answers : Seeds have separate endosperm **[BHU 2008]**

(a) Mazie (b) Onion
(c) Rice (d) Bean
(1) a, b and c (2) a and b
(3) b and d (4) a and c

Q.378 Find the correct answer : For germination of angiospermic seeds **[BHU 2008]**

(a) On hydraytion the seed germinates showing increased enzyme activily
(b) Respiration rate of germinating seed increases alongwith increase enzymatic activity
(c) Increase in respiratory rate continue still senescence
(d) Rate of enzymatic activity increases

(1) 1, 2, 3 (2) 1 and 2
(3) 2, 4 (4) 1 and 3

Q.379 Prechilling treatment to break seed dormancy is **[JKCMEE 2008]**

(1) Scarification (2) Vernalisation
(3) Impaction (4) Stratification

Q.380 Endosperm is consumed by the developing embryo in **[CBSE 2008]**

(1) Coconut (2) Pea
(3) Maize (4) Castor

Q.381 Embryo axis above the cotyledon is known as **[Orissa 2009]**

(1) Hypocotyl (2) Funicle
(3) Epicotyl (4) Raphe

Q.382 Scutellum is seed leaf of **[CET Chd 2009]**

(1) Gymnosperms (2) Dicots
(3) Pteridophytes (4) Monocots

Q.383 An example of a seed with endosperm, perisperm and caruncle is **[CBSE 2009]**

(1) Castor (2) Coffee
(3) Lily (4) Cotton

Q.384 Match the follwing **[EAMCET 2009]**

	Column I		**Column II**
a	Coleorhiza	i	Development of sporophyte directly from gametophyte without intervention of gametes
b	Apogamy	ii	Development of gametophyte directly from sporophyte without the
c	Indusium	iii	An unbranched columnar stem with a crown of leaves
d	Caudex	iv	Protective covering of radicle
		v	Protective structure of a sorus

(1) a – v, b – ii, c – iv, d – i
(2) a – iii, b – v, c – ii, d – iv
(3) a – iv, b – i, c – v, d – iii
(4) a – ii, b – iii, c – i, d – v

Q.385 Residual perisistent nucellus is known as **[AMU 2010]**

(1) Perisperm (2) Integument
(3) Pericarp (4) None of the above

Q.386 Non – endospermic seeds are found in **[Orissa 2010]**

(1) Barley (2) Castor
(3) Bean (4) Wheat

Q.387 In hypogeal germination plumule comes out of ground due to elongation of **[Orissa 2010]**

(1) Hypocotyl (2) Epicotyl
(3) Cotyledons (4) Both A and B

Q.388 A large shield – shaped cotyledon found in some moncotyledonous seeds is **[MPPMT 2010]**

(1) Aleurone layer (2) Coleorhiza
(3) Scutellum (4) Hilum
(5) Coleoptile

Q.389 Seed develops from **[MPPMT 2010]**

(1) Embryo (2) Ovule
(3) Embyo sac (4) Ovary

Q.390 Keel is characteristic of the flower of **[CBSC 2010]**

(1) Cassia (2) Calotropis
(3) Bean (4) Gulmohur

FRUIT & SEED DISPERSAL

Q.391 Seeds of Ruellia tuberosa are disseminated by **[Har. PMT 2007]**

(1) Censer mechanism
(2) Parachute mechanism
(3) Jaculator mechanism
(4) Explosive mechanism

Q.392 Clematis and Narvelia are dispersed by air with the help of **[BHU 2008]**

(1) Persistent inflated calyx
(2) Perisistent hairy styles
(3) Hair (4) Wings

Q.393 Censer mechanism of seed dispersal is found in **[CPMT 2000, BHU 2007]**

(1) Papaveraceae (2) Liliaceae
(3) Leguminosae (4) Rosaceae

Q.394 In which plant only two curved hooks are formed on seeds **[EAMCET 2002]**

(1) Xanthium (2) Martynia
(3) Tribulus (4) Ricinus

Q.395 Birds disseminate seeds by **[AMU 2003]**

(1) Eating fruit and passing the seeds unharmed through excreta at places
(2) Their feathers
(3) Carrying seeds in their beaks
(4) Eating fruits and digesting fruit contents in their alimentary canal.

Q.396 Pappus occurs in compositae for **[CPMT 2007]**

(1) Air pollination (2) Air dispersal
(3) Insect pollination (4) Animal dispersal

Q.397 Bright coloured fleshy fruits are dispersed by **[Orissa 2007]**

(1) Air (2) Insects
(3) Water (4) Birds

Q.398 Which one of the following statements is correct? **[CPMT 2011]**

(1) In tomato, fruit is a capsule
(2) Seeds of orchids have oil-rich endosperm
(3) Placentation in primose is basal
(4) Flower of tulip is a modified shoot

Q.399 The correct floral formula of chilli is **[CPMT 2011]**

(1) $\oplus \, ♀ ♂ \, K_{(5)}C_5A_5\underline{G_{(2)}}$ (2) $\oplus \, ♀ ♂ \, K_{(5)}C_{(5)}A_5\underline{G_{(2)}}$

(3) $\oplus \, ♀ ♂ \, K_{(5)}C_{(5)}A_{(5)}\underline{G_2}$ (4) $\oplus \, ♀ ♂ \, K_{(5)}C_5A_{(5)}\underline{G_2}$

Q.400 Flowers are zygomorphic in **[CPMT 2011]**

(1) Mustard (2) Gulmohur
(3) Tomato (4) Darura

Q.401 The ovary is half inferior in flower of **[CPMT 2011]**

(1) Peach (2) Cucumber
(3) Cotton (4) Guava

Q.402 A drupe develops in **[CPMT 2011]**

(1) Mango (2) Wheat
(3) Pea (4) Tomato

Q.403 Placentation in tomato and lemon is : **[AIPMT Pre 2012]**

(1) Free central (2) Marginal
(3) Axile (4) Parietal

Q.404 How many plants in the list given below have composite fruits that develop form an inflorescence ? **[AIPMT Pre 2012]**

(1) Five (2) Two

(3) Three (4) Four

Q.405 Phyllode is present in : **[AIPMT Pre 2012]**

(1) *Euphorbia* (2) Australian Acacia

(3) *Opuntia* (4) *Asparagus*

Q.406 The coconut water and the edible part of coconut are equivalent to : **[AIPMT Pre 2012]**

(1) Endocarp (2) Mesocarp

(3) Embryo (4) Endosperm

Q.407 Cymose inflorescence is present in : **[AIPMT Pre 2012]**

(1) *Sesbania* (2) *Trifolium*

(3) *Brassica* (4) *Solanum*

Q.408 Vixillary aestivation is characteristic of the family: **[AIPMT Pre 2012]**

(1) Asteraceae (2) Solanaceae

(3) Brassicaceae (4) Fabaceae

Q.409 The gynoecium consists of many free pistils in flowers of : **[AIPMT Pre 2012]**

(1) Tomato (2) *Papaver*

(3) *Michelia* (4) *Aloe*

Q.410 How many plants in the list given below have marginal placentation ?

Mustard, Gram, Tulip, Asparagus, Arhar, Sun hemp, Chilli, Colchicine, Onion, Moong, Pea, Tobacco, Lupin

[AIPMT Mains 2012]

(1) Four (2) Five

(3) Six (4) Three

Q.411 *Cuscuta* is an example of : **[AIPMT Mains 2012]**

(1) Ectoparasitism (2) Brood parasitism

(3) Predation (4) Endoparasitism

ANSWER KEY

EXERCISE – 3

Q.1	**2**	**Q.2**	**3**	**Q.3**	**3**	**Q.4**	**1**	**Q.5**	**3**	**Q.6**	**1**	**Q.7**	**3**
Q.8	**2**	**Q.9**	**4**	**Q.10**	**2**	**Q.11**	**2**	**Q.12**	**1**	**Q.13**	**3**	**Q.14**	**1**
Q.15	**3**	**Q.16**	**1**	**Q.17**	**2**	**Q.18**	**4**	**Q.19**	**1**	**Q.20**	**4**	**Q.21**	**3**
Q.22	**2**	**Q.23**	**4**	**Q.24**	**4**	**Q.25**	**3**	**Q.26**	**1**	**Q.27**	**2**	**Q.28**	**2**
Q.29	**1**	**Q.30**	**4**	**Q.31**	**2**	**Q.32**	**1**	**Q.33**	**4**	**Q.34**	**3**	**Q.35**	**1**
Q.36	**1**	**Q.37**	**3**	**Q.38**	**1**	**Q.39**	**3**	**Q.40**	**2**	**Q.41**	**3**	**Q.42**	**1**
Q.43	**4**	**Q.44**	**2**	**Q.45**	**3**	**Q.46**	**1**	**Q.47**	**1**	**Q.48**	**1**	**Q.49**	**2**
Q.50	**4**	**Q.51**	**1**	**Q.52**	**2**	**Q.53**	**4**	**Q.54**	**2**	**Q.55**	**1**	**Q.56**	**3**
Q.57	**2**	**Q.58**	**3**	**Q.59**	**4**	**Q.60**	**4**	**Q.61**	**1**	**Q.62**	**3**	**Q.63**	**3**
Q.64	**1**	**Q.65**	**3**	**Q.66**	**4**	**Q.67**	**2**	**Q.68**	**1**	**Q.69**	**2**	**Q.70**	**2**
Q.71	**4**	**Q.72**	**1**	**Q.73**	**4**	**Q.74**	**2**	**Q.75**	**1**	**Q.76**	**3**	**Q.77**	**2**
Q.78	**1**	**Q.79**	**2**	**Q.80**	**3**	**Q.81**	**1**	**Q.82**	**3**	**Q.83**	**2**	**Q.84**	**1**
Q.85	**4**	**Q.86**	**4**	**Q.87**	**1**	**Q.88**	**2**	**Q.89**	**3**	**Q.90**	**1**	**Q.91**	**1**
Q.92	**4**	**Q.93**	**2**	**Q.94**	**1**	**Q.95**	**3**	**Q.96**	**2**	**Q.97**	**4**	**Q.98**	**4**
Q.99	**1**	**Q.100**	**1**	**Q.101**	**2**	**Q.102**	**4**	**Q.103**	**2**	**Q.104**	**1**	**Q.105**	**4**
Q.106	**2**	**Q.107**	**2**	**Q.108**	**4**	**Q.109**	**4**	**Q.110**	**4**	**Q.111**	**1**	**Q.112**	**3**

Q.113 2	**Q.114 1**	**Q.115 1**	**Q.116 3**	**Q.117 3**	**Q.118 3**	**Q.119 1**
Q.120 3	**Q.121 4**	**Q.122 4**	**Q.123 2**	**Q.124 3**	**Q.125 1**	**Q.126 4**
Q.127 1	**Q.128 3**	**Q.129 1**	**Q.130 4**	**Q.131 1**	**Q.132 2**	**Q.133 3**
Q.134 3	**Q.135 2**	**Q.136 1**	**Q.137 4**	**Q.138 2**	**Q.139 1**	**Q.140 3**
Q.141 1	**Q.142 1**	**Q.143 2**	**Q.144 1**	**Q.145 2**	**Q.146 1**	**Q.147 3**
Q.148 4	**Q.149 4**	**Q.150 2**	**Q.151 2**	**Q.152 1**	**Q.153 2**	**Q.154 3**
Q.155 4	**Q.156 4**	**Q.157 2**	**Q.158 2**	**Q.159 1**	**Q.160 3**	**Q.161 4**
Q.162 4	**Q.163 3**	**Q.164 2**	**Q.165 2**	**Q.166 4**	**Q.167 3**	**Q.168 4**
Q.169 1	**Q.170 1**	**Q.171 4**	**Q.172 1**	**Q.173 4**	**Q.174 2**	**Q.175 3**
Q.176 2	**Q.177 3**	**Q.178 3**	**Q.179 2**	**Q.180 2**	**Q.181 3**	**Q.182 1**
Q.183 1	**Q.184 3**	**Q.185 4**	**Q.186 3**	**Q.187 1**	**Q.188 2**	**Q.189 4**
Q.190 2	**Q.191 1**	**Q.192 3**	**Q.193 1**	**Q.194 3**	**Q.195 2**	**Q.196 4**
Q.197 2	**Q.198 3**	**Q.199 3**	**Q.200 2**	**Q.201 4**	**Q.202 1**	**Q.203 2**
Q.204 2	**Q.205 3**	**Q.206 1**	**Q.207 2**	**Q.208 2**	**Q.209 3**	**Q.210 4**
Q.211 3	**Q.212 1**	**Q.213 3**	**Q.214 1**	**Q.215 2**	**Q.216 4**	**Q.217 1**
Q.218 3	**Q.219 4**	**Q.220 2**	**Q.221 2**	**Q.222 1**	**Q.223 3**	**Q.224 4**
Q.225 1	**Q.226 4**	**Q.227 2**	**Q.228 4**	**Q.229 3**	**Q.230 2**	**Q.231 1**
Q.232 3	**Q.233 4**	**Q.234 2**	**Q.235 2**	**Q.236 3**	**Q.237 4**	**Q.238 1**
Q.239 3	**Q.240 4**	**Q.241 2**	**Q.242 1**	**Q.243 4**	**Q.244 2**	**Q.245 3**
Q.246 2	**Q.247 3**	**Q.248 3**	**Q.249 4**	**Q.250 3**	**Q.251 2**	**Q.252 1**
Q.253 1	**Q.254 2**	**Q.255 1**	**Q.256 4**	**Q.257 1**	**Q.258 2**	**Q.259 2**
Q.260 4	**Q.261 4**	**Q.262 1**	**Q.263 4**	**Q.264 1**	**Q.265 2**	**Q.266 3**
Q.267 4	**Q.268 3**	**Q.269 1**	**Q.270 2**	**Q.271 3**	**Q.272 2**	**Q.273 4**
Q.274 3	**Q.275 3**	**Q.276 4**	**Q.277 1**	**Q.278 1**	**Q.279 2**	**Q.280 3**
Q.281 2	**Q.282 4**	**Q.283 1**	**Q.284 3**	**Q.285 3**	**Q.286 4**	**Q.287 4**
Q.288 1	**Q.289 4**	**Q.290 3**	**Q.291 2**	**Q.292 4**	**Q.293 3**	**Q.294 1**
Q.295 2	**Q.296 3**	**Q.297 4**	**Q.298 2**	**Q.299 4**	**Q.300 3**	**Q.301 1**
Q.302 3	**Q.303 2**	**Q.304 4**	**Q.305 1**	**Q.306 3**	**Q.307 1**	**Q.308 3**
Q.309 2	**Q.310 1**	**Q.311 4**	**Q.312 1**	**Q.313 3**	**Q.314 3**	**Q.315 4**
Q.316 1	**Q.317 2**	**Q.318 2**	**Q.319 4**	**Q.320 3**	**Q.321 2**	**Q.322 1**
Q.323 3	**Q.324 3**	**Q.325 4**	**Q.326 2**	**Q.327 1**	**Q.328 3**	**Q.329 2**
Q.330 2	**Q.331 4**	**Q.332 3**	**Q.333 2**	**Q.334 4**	**Q.335 1**	**Q.336 3**
Q.337 3	**Q.338 4**	**Q.339 1**	**Q.340 2**	**Q.341 1**	**Q.342 1**	**Q.343 4**
Q.344 4	**Q.345 3**	**Q.346 4**	**Q.347 1**	**Q.348 2**	**Q.349 3**	**Q.350 3**
Q.351 1	**Q.352 4**	**Q.353 3**	**Q.354 2**	**Q.355 4**	**Q.356 1**	**Q.357 1**
Q.358 1	**Q.359 4**	**Q.360 3**	**Q.361 2**	**Q.362 2**	**Q.363 2**	**Q.364 3**
Q.365 4	**Q.366 4**	**Q.367 1**	**Q.368 2**	**Q.369 3**	**Q.370 4**	**Q.371 1**
Q.372 3	**Q.373 2**	**Q.374 4**	**Q.375 1**	**Q.376 2**	**Q.377 1**	**Q.378 2**
Q.379 4	**Q.380 2**	**Q.381 3**	**Q.382 4**	**Q.383 1**	**Q.384 3**	**Q.385 1**
Q.386 3	**Q.387 2**	**Q.388 3**	**Q.389 2**	**Q.390 3**	**Q.391 3**	**Q.392 2**
Q.393 1	**Q.394 2**	**Q.395 1**	**Q.396 2**	**Q.397 4**	**Q.398 4**	**Q.399 2**
Q.400 2	**Q.401 1**	**Q.402 1**	**Q.403 3**	**Q.404 3**	**Q.405 2**	**Q.406 4**
Q.407 4	**Q.408 4**	**Q.409 3**	**Q.410 3**	**Q.411 1**		

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) **If both Assertion & Reason are True & the reason is correct explanation of the Assertion.**

(2) **If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.**

(3) **If Assertion is True but the Reason is False.**

(4) **If both Assertion & Reason are false.**

Q.1 **A :** In angiosperms, seeds are present inside fruit.

R : The ripended ovary forms fruit and ripened ovules form seeds.

Q.2 **A :** Binnials complete their life cycle in two growing seasons.

R : They complete their vegetative phase in first season and reproductive phase in second season.

Q.3 **A :** The plants producing flowers and fruits single time in life are called monocarpic.

R : Agave americana and Bambusa are monocarpic plants.

Q.4 **A :** Onion is a tunicated bulb.

R : characteristic smell of onion is due to presence of allyl sulphide.

Q.5 **A :** Banana plant is a herb.

R : Herbaceous pseudostem is found in banana.

Q.6 **A :** Arrangement of main vein and its branches in leaf is called vernation.

R : Parallel venation is characteristic of dicotyledons.

Q.7 **A :** A specific outgrowth present over hilum in castor seed is called strophiole.

R : Strophiole helps in gaseous exchange.

Q.8 **A :** Censer mechanism of seed dispersal occurs in Papaver (poppy)

R : Seeds of poppy are scattered after dehiscence of fruit when shaken by wind.

Q.9 **A :** Roots of trapa are photosynthetic.

R : Trapa consist of spiny calyx.

Q.10 **A :** Seeds should be heavy and smooth so that they can travel large distances for dispersal.

R : For dispersal by wind fruits and seeds should be light.

Q.11 **A :** Flower are arranged in acropetal Manner in cymose inflorescence.

R : All flower are at same level is cymose inflorescence.

Q.12 **A :** Fruit is caryopsis in poaceae.

R : Placentation is parietal type in poaceae.

Q.13 **A :** Ovary is unilocular in parietal placentation.

R : Number of placenta is equal to number of ovaries.

Q.14 **A :** Reticulate venation is found in dicots.

R : Veinlets are absent in reticulate venation.

Q.15 **A :** Parietal placentation is found in cruciferae.

R : Ovary is bilocular in cruciferae.

Q.16 **A :** Pentamerous condition is found in cruciferae.

R : 5 sepals and 5 petals are found in cruciferae.

Q.17 **A :** Ovary of Brassicaceae is unilocular in the beginning but becomes bilocular.

R : Ovary of Brassicaceae become bilocular due to formations of a false septum.

Q.18 **A :** Custard apple is a aggregate fruit.

R : It is formed by many flowers.

Q.19 **A :** Ovules are situated at central axis in parietal placentation.

R : Ovary in bilocular in parietal placentation.

Q.20 **A :** The banyan trees are able to extand over large areas.

R : Banyan trees have prop roots.

Q.21 **A :** Stem is exogenous in origin.

R : Stem originates from cortex.

Q.22 **A :** It is possible to identify nodes on a stem.

R : Leaves arise from the nodes of a stem.

Q.23 **A :** Carrot is a root.

R : It occurs underground and have unicellular root hairs.

Q.24 **A :** Radish is a fusiform fleshy root.

R : Base at radish root is hypocotyl.

Q.25 **A :** Root are geotropic.

R : Root are more hydrotropic than geotropic.

Q.26 **A :** Cladodes are stems of unlimited growth.

R : Only the main stems is modified as cladodes.

Q.27 **A :** Mangroves show breathing root.

R : Soil air is almost negligible in swamps.

Q.28 **A :** Onion leaves are centric and green.

R : Aerial leaves of anion store food.

Q.29 **A :** Scale leaves are small and non-green.

R : They do not photosynthesis.

Q.30 **A :** Lithci is an aril.

R : It is dry fruit.

ANSWER KEY

EXERCISE – 4

Q.1	**2**	**Q.2**	**1**	**Q.3**	**2**	**Q.4**	**2**	**Q.5**	**2**	**Q.6**	**4**	**Q.7**	**3**
Q.8	**1**	**Q.9**	**2**	**Q.10**	**3**	**Q.11**	**4**	**Q.12**	**2**	**Q.13**	**2**	**Q.14**	**3**
Q.15	**2**	**Q.16**	**4**	**Q.17**	**1**	**Q.18**	**3**	**Q.19**	**4**	**Q.20**	**1**	**Q.21**	**1**
Q.22	**1**	**Q.23**	**1**	**Q.24**	**2**	**Q.25**	**2**	**Q.26**	**4**	**Q.27**	**1**	**Q.28**	**3**
Q.29	**1**	**Q.30**	**2**										

Bansal Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

FAMILIES OF ANGIOSPERM PLANTS

SEMI-TECHNICAL DESCRIPTION

Bracteate	=	Br
Ebracteate	=	Ebr
Actinomorphic	=	⊕
Zygomorphic	=	% or ↿
Bisexual	=	☿
Unisexual male (staminate)	=	♂
Unisexual female (Pistillate)	=	♀
Epicalyx	=	Epi
Calyx	=	K or if joined = $K_{( )}$
Corolla	=	C or if joined = $C_{( )}$
Perianth	=	P or if joined = $P_{( )}$
Androecium	=	A or if joined = $A_{( )}$
Gynoecium	=	G or if joined = $G_{( )}$
Superior ovary / Hypogynous flower	=	$\underline{G}$
Inferior ovary / Epigynous flower	=	$\overline{G}$
Ovary half inferior or half superior / Perigynous flower	=	G –

- **Adhesion**

Epiphyllous	=	$\overset{\frown}{P\ A}$
Epipetalous	=	$\overset{\frown}{C\ A}$

CRUCIFERAE (BRASSICACEAE)

- **Systematic Position -**

Class	=	Dicotyledonae	
Sub-Class	=	Polypetalae	Petals - Free
Series	=	Thalamiflorae	Flower - Hypogynous
Order	=	Parietales	Placentation - Parietal

- **Distinguishing Features of Cruciferae -**
  - The plant organs have pungent odour. This odour is due to presence of sulphur containing glucosides compound. Myrosin enzyme (present in secondary cells) hydrolyse then into glucose & different isothiocyanates (Various oils).
  - Inflorescence – Typical raceme.

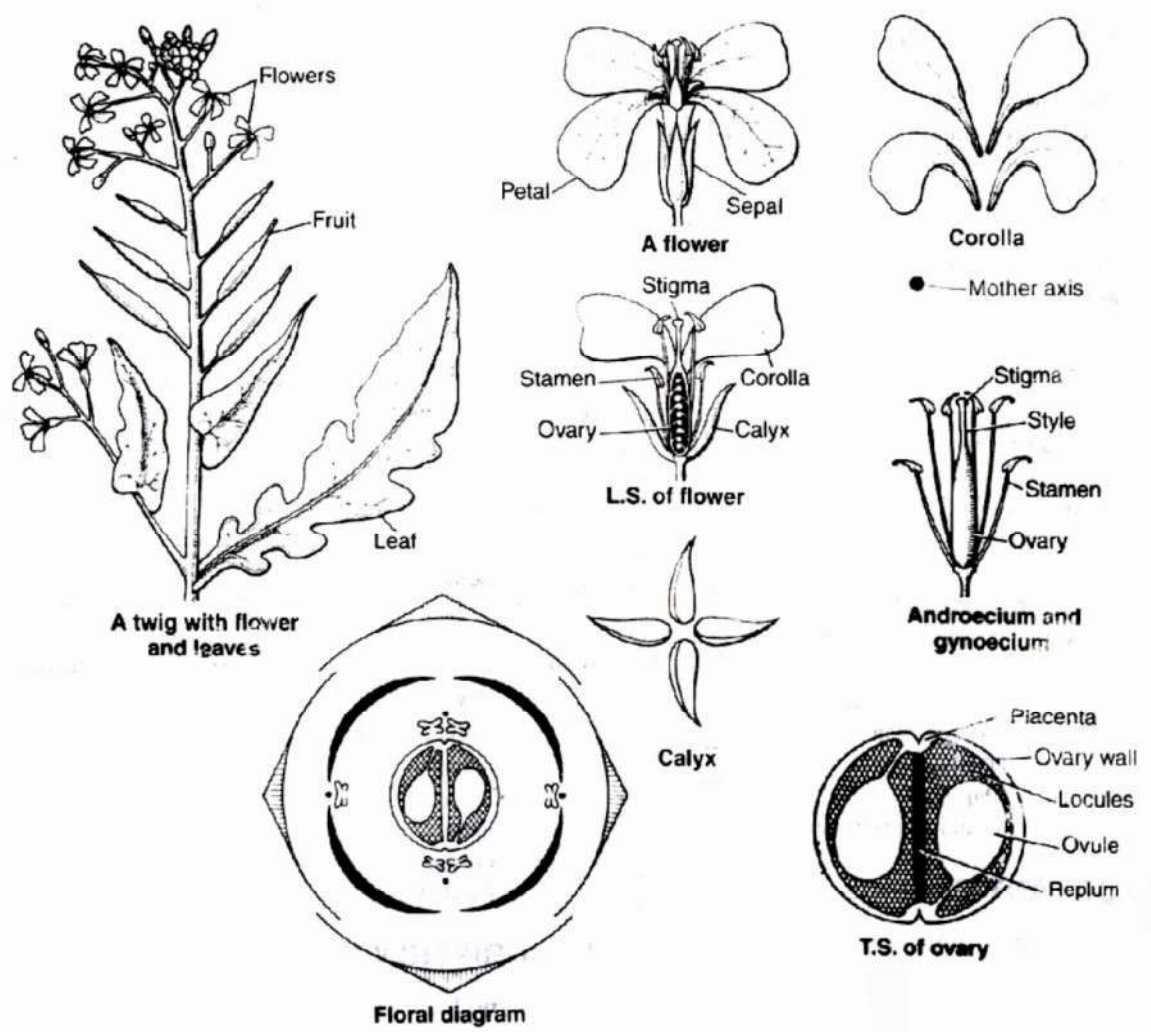
  Exception :-
  - ***Iberis amara*** = Candytuft (chandni) has corymb type of inflorescence.
  - The compound corymb inflorescence is present in cauliflower.
  - Corymbose raceme inflorescence is present in mustard.
- **The common Characteristics of flower -**
  - **Flower** Ebracteate
  - Bisexual or hermaphrodite
  - Actinomorphic but some time zygomorphic e.g. ***Iberis amara***
  - Hypogynous and tetramerous,
  - **Calyx-** Sepals 4, polysepalous, sepals arranged in two whorls 2 outer and 2 inner. Imbricate or valvate or quincuncial aestivation.
  - Out of their four sepals two lower sepals are small and upper two are big in size
  - **Corolla-** Petals 4, polypetalous, valvate aestivation and cruciform.
  - The each petal in cruciferae is divided into two parts-long **claw** and broader lamina-**limb.**
  - The corolla is absent in ***Lepidium*** and ***Coronopus.***
  - The corolla is transformed into stamens in **Capsella.**
  - **Androecium :-** Stamens 6 (2 + 4), arranged in two whorls in which two outer small stamens antisepalous and inner four stamens are long and anti petalous. This condition is known as **tetradynamous.** Nactaries are present at the base of the anthers
  - Anther is dithecous
  - Stamens introse and basifixed.

  Exception :- 2 stamens in *Coronopus*, 4 stamens in *Lepidium* and *Cardamine*, and 16 stamens in *Megacarpea.*
  - **Gynoecium :-** Bicarpellary, syncarpous.
  - The ovary is unilocular in the beginning but it becomes bilocular due to the formation of a false septum (replum),
    - Placentation is parietal.
    - Both the carpels arranged transversely.
    - Ovule is campylotropous.
    - •• Gynoecium is tricarpellary in ***Lepidium***, and tetracarpellary gynoecium in ***Nasturtium***
  - **Fruit -** Usually siliqua which is solitary dry and dehiscent.

    Silicula fruit is found in ***Capsella, Iberis, Lepidium*** and ***Alyssum*.**
  - **Seed -** Non endospermic
- **Floral Formula -**

Ebr ⊕ ♀♂ $K_{2+2}\ C_{4x}\ A_{2+4}\ \underline{G}_{(2)}$

- **Diagram –**



Flowering twig, parts of a flower and floral diagram of ***Brassica comprestris*** (Yellow mustard)

- **Economic Importance -**
  - **Food Stuff**

Radish	=	***Raphanus sativus***-fusiform root and unripe fruit
Turnip	=	***Brassica rapa***-Napiform root
Cauliflower	=	***Brassica oleracea*** var. botrytis inflorescence
Cabbage	=	***Brassica oleracea*** var. capitata-Fleshy leaves./condensed bud
Knol-Khol	=	***Brassica oleracea*** var. caulorapa/gongilodes-thickened stem.
Mustard	=	***Brassica campestris*** (yellow).
Black Mustard	=	***Brassica napus***
Black Rai	=	***Brassica nigra***
Local Rai	=	***Brassica juncea***
Taramira	=	***Eruca sativa***
White Rai	=	***Brassica Alba***
Armoracia lapathifolia	=	obtains sweet materials form roots.

- **Medicinal uses :-**

Halima	=	***Lepidium sativum* –** garden cress-its seeds are used in liver diseases, asthma, cough and bleeding piles
Khoob Kalan	=	***Sisymbrium irio* -** Its leaves are used in scurvy disease
Wall flower	=	***Cheiranthus cheiri*-**Its seeds are used in fever, cough, paralysis, bronchits.
Tarha	=	***Nasturtium indica* –** Its seed are very useful in asthma disease.
Chandni (Candy tuft)	=	***Iberis amara* –** It is used in rheumatism.

- **Ornamental :-**

Chandni (Candy tuft)	=	***Iberis amara***
Wall Flower	=	***Cheiranthus cheiri***
Shepherd's purse	=	***Capsella bursa-pestoris***
Basket of gold	=	***Alyssum sexatile***
Honesty	=	***Luneria annue***
Stock	=	***Mathiola incana***

MALVACEAE

Systematic position :-

Class	=	Dicotyledonae
Sub class	=	Polypetalae
Series	=	Thalamiflorae
Order	=	Malvales
Family	=	Malvaceae

Diagnostic feature of malvaceae :-

- The mucilage is present in various plant organs like flower, fruit etc. in this family. Stellate (star shaped) hairs present on the shoot.
- **Inflorescence :-** Cymose or solitary axillary (***Hibiscus, Gossypium***) or solitary terminal (***Abutilon***).
- **Exception :-** The raceme inflorescence is present in ***Althaea*** (holly hock). Penicle inflorescence is present in **kydia**

General characters of flower :-

- **Flower :-** Bracteate-Bracts are big and green in colour. Flowers are bisexual, actinomorphic, hypogynous and pentamerous.
  Polygamous flower are present in ***Kydia*** and unisexual flower is present in ***Napaea***.
- **Epicalyx :-** Epicalyx are 3-7; free and green in colour. Valvate aestivation.
  Epicalyx is absent in some genera of the malvaceae such as ***Abutilon, sida*** and ***Bombax***.
- **Calyx :-** sepals-5 gamosepalous valvate aestivation but in some of the plants **persistant** calyx are present, it means present on fruit also as in ***Abelmoschus*** and ***Gossypium*.**
  The odd sepal is posterior in malvaceae.
  * odd sepal in **Malvastrum** are anterior
- **Corolla :-** Petal 5, polypetalous twisted aestivation mucilaginous and attractive.
- **Andorecium :-** Stamens indefinite, monoadelphous The filament are united together to form a long **staminal canal** or tube around styles, epipetalous.

– The stamens are monothecous, kidney shaped, anther dorsifixed.
– The stamens are **extrose.**

– **Exception :** ***Julostylis*** contains 10 stamens in which 5 stamens are sterile and remaining 5 are normal.

- **Gynoecium :-** Penta carpellary or poly carpellary syncarpus.

  The number of locules are equal to the number of carpels so ovary is penta locular or multilcular.

  The ovary and style are enclosed by staminal tube but stigma remains out side. Axile placentation

  Exception :- Three carpels are present in the flower of ***kydia.***

- **Fruit :-** Loculicidal capsule, which is solitary, dry dehiscent multilocular and multi seeded fruit each locules breaks from the wall of the locule during the dehiscence eg. Lady's finger, cotton

  Exception :- The carcerulus fruit is found in ***Althaea***, ***Abutilon, Sida***. Hooked-schizocarpic in ***Urena*** & ***Pavonia***

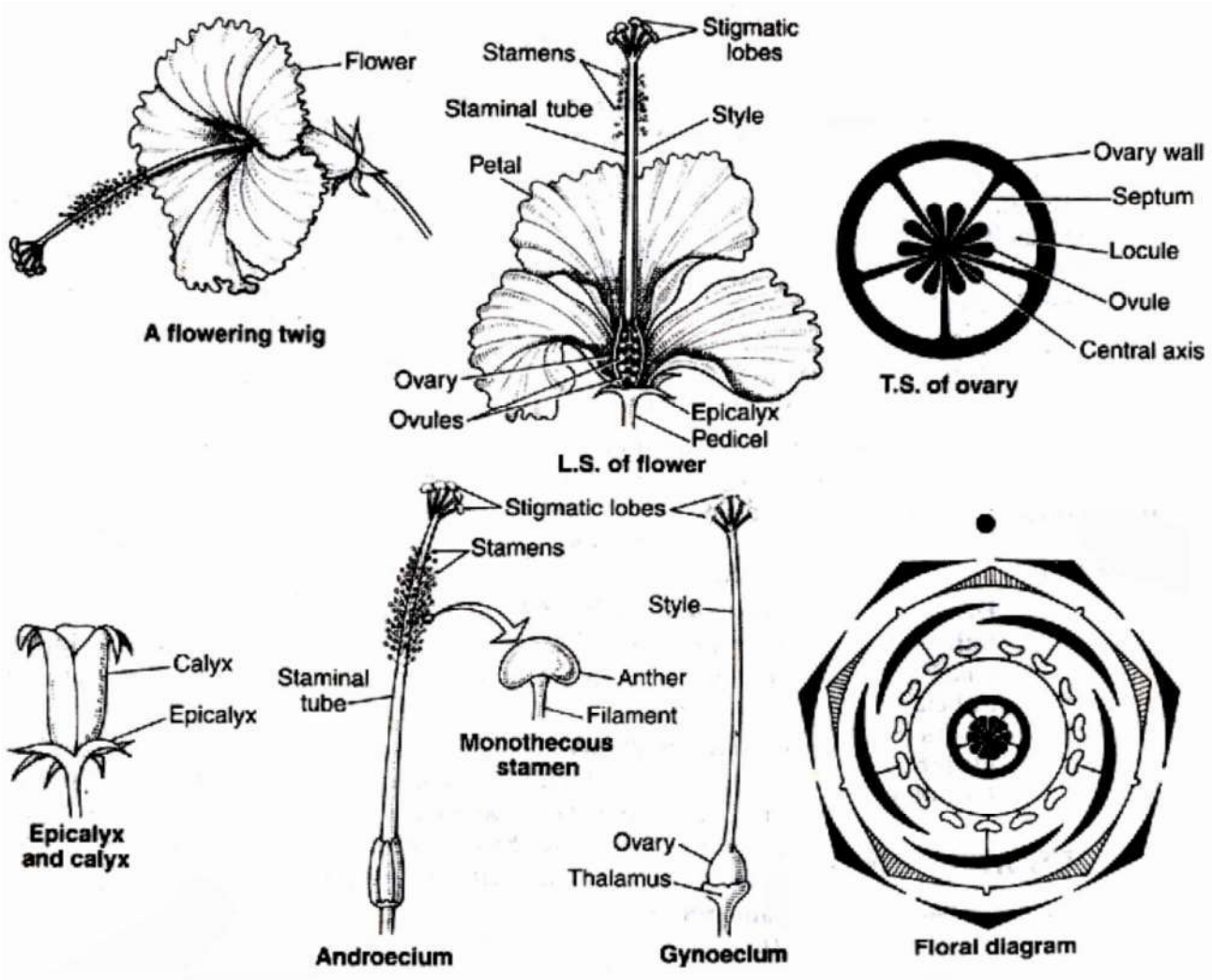
  Some times berry is present e.g. ***Malva Viscus.***

- **Seed :-** Non endospermic. A dense hairy seed coat is present on cotton seed **[*Gossypium*]**

- **Floral formula -**

$$\boxed{\text{Br} \oplus \male\!\!\female \; \text{Epi}_{3-7}\text{K}_{(5)}\,\overset{\frown}{\text{C}_5\,\text{A}_{(\infty)}}\underline{\text{G}}_{(5-\infty)}}$$

- **Diagram –**



Flowering twig, parts of a flower and floral diagram of *Hibiscus rosa-sinensis* (Gurhal)

- **Economic importance -**
  - **Food** - Okra (Lady's finger) = ***Abelmoschus esculentus*** or ***Hibiscus esculentus*** used as vegetable.
  - **Oils**- Cotton seeds – ***Gossypium*** genera. The seed of ***Gossypium*** are used for obtaining oils which is hydrogenated to prepare vegetable ghee.
  - Volatile oil known as Musk seed oil used in perfumery is obtained from ***Hibiscus abelmoschus*** seeds.
  - **Fibres -**
  - **Cotton = *Gossypium*.**

    The seeds of ***Gossypium*** are used for obtaining cotton fibres -

    Gossypium arboreum and ***G.herbaceum*** are known as old world cotton while ***Gossypium hirsutum*** and ***G.barbedense*** is called as new world cotton.

    Gossypium hirsutum = Upland cotton

    G. arboreum = Egyptian cotton

    G. herbaceum = Asiatic cotton

    G. barbedense = Long fibre

    Salmalia malabaricum = Red Silk cotton

    Eriodendron or ***Ceiba*** = White Silk cotton [Kapok]
  - **Soft fibre or Bast fibers :-**

    Hibiscus sabdariffa = Patua/Roma (Rosella hemp)

    Sida rhombifolia = Queen's land hemp

    Abutilon asiaticum = China Jute **(**Indian mallow)

    Hibiscus cannabinus = Pastsan [Deccan hemp]

    Hibiscus elatus = Cuba bast

    Urena lobata = Vilayati Sunn/Foreign hemp
  - **Timber :-**

    Ochroma lagopus = Balsa wood, lightest wood

    Malva sylvestrils = Mallow wood

    Hibiscus elatus =
  - **Medicine :-**

    Urena repanda = These roots are useful in hydrophobia

    Adansonia digitata = Monkey bread tree-Quinine like medicine is obtained from its **roots.**

    Abelmoschus moschatus = Musk mallow- Its root is used for abdominal pain.

    Abutilon indicum = Luxative seed – Their seeds are used in constipation and root are used for fever.

    Thespesia populnea = It is used as purgative.

    Sida acuta = Its roots are used in neural and urinal diseases.

    Sida rhombifolia = It is used in rheumatism diseases.
  - **Ornamental : -**

    China rose [Shoeflower] = ***Hibiscus rosasinensis*** **–** Red shoes polish is obtained form the petals of this flower.

    Holly hock [Gul-e-khera] = ***Althaea rosea*** (Blue colour is obtained from its leaves)

Pula = ***Kydia calycina***

Cotton rose = ***Hibiscus mutabilis*** (Changeable rose - It change its colour)

Mallow [Khatmi] = ***Malva sylvestris***

Umbrella tree = ***Thespesia populnea***

Pavonia odorata **-** from roots hina perfume is manufactured.

- **Vitamins:-*Gossypium*** seeds are rich in vitamin A,D,E and B- complex.

SOLANACEAE

- **Systematic position :-**

Class - Dicotyledonae

Subclass - Gamopetalae

Series - Bicarpellatae

Order - Polymoniales

Family - Solanaceae

- Many ovules are present in the ovary so many seed are formed as in tomato, Brinjal etc.
- Most of plants of this family are herbs, some of them are shrubs, rarely trees.
- The tap root system is present in these plants.
- Leaves are simple and exstipulate. Bicollateral vascular bundles are present in stem

Inflorescence :- Solitary axillary or cymose inflorescence.

Monochasical cyme is of two types :-

- **Helicoid cyme : *Solanum*.**
- **Scorpioid Cyme : *Atropa***

Exception :- Solitary terminal inflorescence is found in **Datura,** Rhipidium inflorescence is present in ***Solanum nigrum***

- **Flower :-** Flowers are bracteate or ebracteate, bisexual, complete, hypogynous, pentamerous and actinomorphic but in few of them is zygomorphic such as in Henbane (***Hyoscyamus***) and ***Salpiglossis***, ***Schizanthus***.
- **Calyx -** Sepals 5, gamosepalous, valvate aestivation and persistent.
  - The sepals in some of the plants changed into membranous balloon like structure which help in dispersal of fruits. e.g. **Physalis** (Raspberry). The sepal grows with the growth of the fruit and becomes thickened and elongated. They are known as **accrescent** such as in Brinjal.
  - The odd sepal in solanaceae is in posterior condition.
- **Corolla -** Petals-5 gamopetalous, aestivation valvate or imbricate with various shapes of corolla.
- **Androecium** - Stamens-5, polyandrous, epipetalous, intorse, filaments basifixed and anthers dithecous.
  - The dehiscence of anther is longitudinal but in ***Solanum*** dehiscence through the apical pores.
  - **Exceptions:-** 4-Stamens are present in ***Salpiglossis*** in which two are elongated means didynamous in condition. 2-Stamens are present in ***Schizanthus*.**
- **Gynoecium :-** Bicarpellary, syncarpous, bilocular and axile placentation, superior.
  - **Special features :-** Swollen placenta is present. Ovaries arranged obliquely on thalamus carpels move at ∠45° in clock wise direction. posterior carpal turns on right side and anterior carpal turns on left side.
  - Multilocular ovary is formed in tomato and Datura due to formation of false septum.

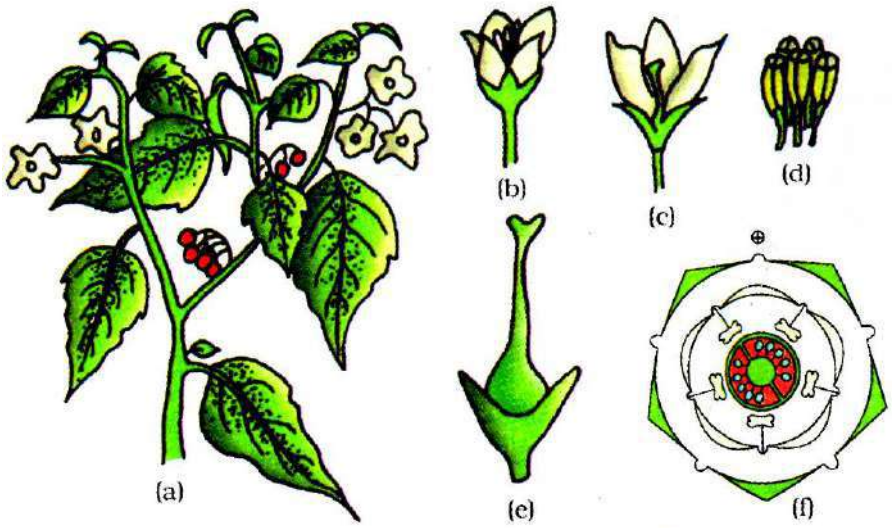
  * Unilocular is present in ***Henoonia***.

* The ovary is bilocular at the base and unilocular on the upper side in ***Capsicum*** (chilli)

- **Fruit :-** Fleshy fruits – berry such as Tomato, Brinjal, chilli, Physalis etc.
  The fruit of the Datura is septifragal capsule in which dehiscence takes place through the septa.
- **Seed :-** Endospermic
- **Floral formula :**

  Br or Ebr ⊕ ♀ $K_{(5)}\ \overset{\frown}{C_{(5)}}\ A_5\ \underline{G}_{(2)}$

- **Diagram :**



Solanum nigrum (makoi) plant : (a) Flowering twig (b) Flower (c) L.S. of flower (d) Stamens (e) Carpel (f) Floral diagram

- **Economic Importance :-**
  - **Food (Vegetable) :-**

Potato	=	***Solanum tuberosum*** – edible part = under ground stem-**tuber**
Tomato	=	**(loveapple)** ***Lycopersicon esculentum / Solanum lycoperscium***
Brinjal (Egg plant)	=	***Solanum melongena***
Makoi	=	***Solanum nigrum***
Chilli	=	***Capsicum annuum***
Shimala Mirch	=	***Capsicum frutescence***
Raspberry (Goose berry)	=	***Physalis peruviana*** (fruit are eaten)
Physalis ixocarpa		
Cyphomandra betacea [tree tomato]		

  - **Medicines :-**

– ***Atropa belladona*** (Deadly night shade) The roots are used in the manufacture of belladonna. Atropine alkaloids is obtained from the roots. Atropine is used to dialate the pupil of the eye.
– ***Withania somnifera*** = Asvagandh/Ashwagandha-Its root used as nerve tonic, leaves used in fever
– **Stramonium** is obtained form the seeds of Datura (Thorn apple) in which **Scopolamine alkaloid** is present. It is pain reliever and sedative.
– **Henbane** medicine (containing hyoscyamine alkaloid) obtained from the leaves of ***Hyscyamus niger.*** It is used in the treatment of asthama and whooping cough.

– **Nicotine** & anabasin alkaloid obtain from the leaves of ***Nicotiana tabacum*** **(Tobacco)** & ***N. rustica*** It is nerve stimulant and are also used as insecticide. Its leaves are used as fumigatory.
– ***Solanum xanthocarpum*** **=** (Nelee Kanteli) the juice of its used in rheumatism and cough.
– ***Solanum nigrum*** = (Makoi) = The fruit are laxative.

• **Ornamental Plants –** Many plants of the family are cultivated for their beautiful flower and fragrance as follows-

– ***Petunia alba*** and ***petunia hybrida.***

Cestrum nocturnum	=	Rat-Ki-Rani
Cestrum diurnum	=	Din-ka-Raja
Schizanthus	=	Poor man's orchids
Brunfelsia hopeana	=	Kal-Aaj-Kal
Salpiglossis sinvata		
Solanum dulcamara	**=**	**Jangli-lata**
Solanum grandiflorum		
Nicandra physaloides		

LEGUMINOSAE OR FABACEAE

• **Systematic position**

Class	-	Dicotyledonae
Sub class	-	Polypetalae
Series	-	Calyciflorae
Order	-	Rosales
Family	-	Leguminosae [Fabaceae]

• **Main characteristics**

Flower	-	Perigynous G-/Hypogynous G
Gynoecium	-	Monocarpellary
Ovary	-	Unilocular
Placentation	-	Marginal

Dissimilarities are found in the remaining characters. On the basis of dissimilarities, (inflorescence and floral characters) Leguminosae family is divided into **3 subfamilies**

(i) Papilionatae (ii) Caesalpinoideae (iii) Mimosoideae

PAPILIONATAE/LOTOIDEAE (SUB FAMILY)

• **Important features**

Sleeping movements commonly occurs in this family.

• **Roots :-** Roots are branched and tap root system is present. Root nodules are present. In root nodules N_2 fixing becterium ***Rhizobium leguminosarum*** is present.

• **Leaves :-** Stipulate, unipinnate, imparipinnate.

Many modification are found in leaves as follows -

– Some of the leaflets of compound leaves of Pea are modified into tendrils for climbing.
– All the leaflets of ***Lathyrus odoratus*** are transformed into the tendrils.
– The stipules of leaves in both Pea and ***Lathyrus odoratus*** become foliaceous.

• **Inflorescence :-** Typical raceme or sometimes solitary axillary as-***Lathyrus aphaca***

- **General features of Flower :-** Bracteate, bisexual, Perigynous/hypogynous, penta merous and Zygomorphic symmetry. The zygomorphic symmetry is due to presence of different (odd) petals (dissimilar petals & androecium) - **Cleistogamous flower**
- **Calyx :-** Sepals 5, gamosepalous, aestivation valvate or imbricate and anterior sepals is odd.
- **Corolla :-** Petals 5, papilionaceous (main feature) polypetalous, one petal is odd out of 5-petals.

  Exception

  Petals are absent in *Lespedeza*.
- **Androecium**

  Stamens – 10; diadelphous-1 + (9) ;

  Exception →

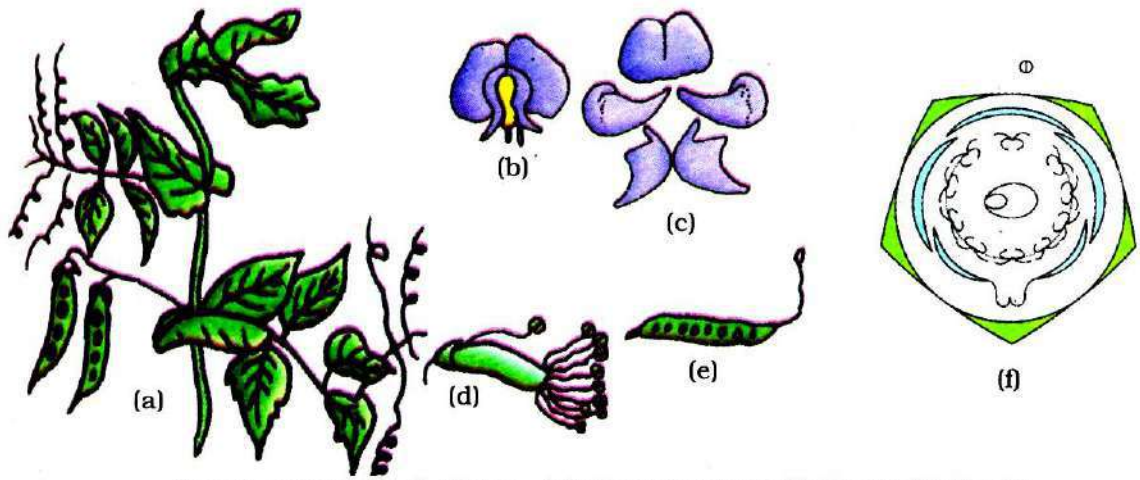
  10 – stamens are free in ***Sophora***

  10 – stamens are monoadelphous in ***Pongamia, Crotalaria, Lupinus cymopsis***. (10)

  The posterior stamen is absent in ***Arachis, Dalbergia*** and ***Abrus***. 9-stamens are present in them in monoadelphous condition. (9)
- **Gynoecium :-** Gynoecium is monocarpellary, unilocular, Half inferior/superior and marginal placentation.
- **Fruit -** Legume or pod, dry, dehiscent, one chambered fruit.

  Sometimes lomentum is also found as in ***Arachis***
- **Seed -** Nonendospermic
- **Floral formula -**

  $$\text{Br}\ \%\ \female\ K_{(5)}\ C_{1+2+(2)}\ A_{(9)+1}\ \underline{G}_{1}$$
- **Diagram -**



Pisum sativum (pea) plant : (a) Flowering twig (b) Flower (c) Petals (d) Reproductive parts (e) L.S.carpel (f) Floral diagram

- **Economic importance**
  - **Food plant**

    Arhar (Pigeon pea) = ***Cajanus cajan* (Indicus)**

    Chana (Gram) = ***Cicer arietinum***

    Mattar (Pea) = ***Pisum sativum***

    Urad (Black gram) = ***Phaseolus mungo* or *vigna mungo***

    Mung (green gram) = ***Pheseolus radiatus* or *vigna radiatus***

Masoor = ***Lens esculenta* or L. culinaris**

French been = ***Vigna/Phaseolus vulgaris***
or kidney bean (Rajma)

Soyabean = ***Glycine max (G. soja)***

Gwar (cluster bean) = ***Cymopsis tetragonoloba***

Methi = ***Trigonella foenum graecum***

Mungphali (Ground nut) = ***Arachis hypogea*.**

Sem = ***Dolichos lablab***

Horse gram = ***Dolichos bifolras***

Agast tree = ***Sesbania grandiflora* (**Flower are edible)

Kasoori Methi = ***Medicago flacata***

Moth = ***Phaseolus aconitifolia* or *vigna aconitifolia***

Cowpea (chowla) = ***Vigna sinensis***

Asparagous bean = ***Vigna catiang***

Khaseri dal = ***Lathyrus sativus***
The lathyrism disease is occurred by the use of this dal.

Lima beam (Lobia) = ***Phaseolus lunatus***

- **Fooder**

Alfalfa = ***Medicago sativa***

Van Methi (Sweet colver) = ***Meliolotus indicus***

Sanji (Indian colver) = ***Meliolotus alba***

Berseem = ***Trifolium alexandrium*.** Used as green mannure

Bankla = ***Vicia faba***

- **Fibres**

Sunnhemp = ***Crotalaria juncea***

Dhaincha = ***Sesbania cannabinus*** used as green mannure **Hard** fibres

Ratti = ***Abrus precatorius*** Hard fibre

Ougenia dalbergiodes

Erythrina suberosa

- **Timber**

Shisham = ***Dalbergia sissoo* (Indian Red Wood)**

Kala shisham = ***Dalbergia latifolia*** = Indian rose wood

African black wood = ***Dalbergia melanoxylon***

Red sandal wood = ***Pterocarpus santalinus***

Indian kino tree = ***Pterocarpus marsupium***

Hard sola = ***Aeschynoment aspara***

- **Dyes**

Red colour = ***Pterocarpus santalinus***

Neel (Blue dye) = ***Indigofera tinctoria*** (dye is obtained from leaves)

Yellow dye = ***Butea monosperma*** orange, yellow dye is obtained from the flower

Black dye = ***Crotalaria striata***

Yellow dye = ***Psoralia plicata***

- **Medicinal plants**

  Glycyrrhiza glabra = Mulathi (Liquoric)
  Its roots are used in coughs & cold.

  Krameria traindra = The medicine for diarrhoea → **"krameria"** is obtained.

  Pongamia pinnata = Oil of the seed is used for rheumatism.

  Abrus precatoris = Ointment made from leaves is used for Treatment of leucoderma
- **Ornamental**

  Clitoria ternatea = Butterfly pea

  Cannavalia gladiata = Sword bean

  Erythrina indica = Indian coral tree

  Desmodium gyrans = Indian telegraph plant

  Clianthus = Glory pea

  Lathyrus odoratus = Phool matar (sweet pea)

  Sophora japonica = Japanese pagoda tree

  Lupinus albus

  Pongamia pinnata

  Butea monosperma
- **Insecticides**

  Derris elliptica = Rotenone insecticide
- **Gum**

  Bengal kino = It is obtained from the **butea** (dhak).

  Balsam of Peru = ***Myroxylon balsemum***

  Gwar Gum = Edible gum obtained from the Gwar (***cyamopsis tetragonoloba***)

  Indian gum = ***Pterocarpous marsupium*.**
- **Other uses :-**

  Abrus precatorius = Ratti = Jeweller's weight – jeweller's use it's seeds as weight

  Aeschynomeni indica **"Omfosm pith Plant"** ➡ Its wood is spongy. Toys are made from this.

  Dalbergia latifolia – Its bark is used in tanning.

  Aschynomeni aspara = Indian cork plant. It's wood used as cork.

  Silk worm lives on the stem of Butea.

  Alhagi pseudoalhagi = Camel's fodder. From its twigs screens (chiks) are manufactured

CAESALPINOIDEAE (SUB FAMILY)

- **Root -** Tap root system.
- **Leaves -**

  Usually compound, unipinnate, paripinnate. Palvinus leaf base present

  Bipinnate in ***Delonix*** Phyllode is found in ***Parkinsonia***.
- **Inflorescence –** Panicle or raceme of racemes or compound raceme

  * In *Bauhinia* cymose inflorescence is present
- **General character of flower -**

  Bracteate, bisexual, perigynous/ hypogynous, pentamerous and zygomorphic symmetry of the flower is due to the presence of sterile stamens.

- **Calyx -**
  Sepals 5, polysepalous imbricate aestivation, odd sepal is anterior one.
- **Corolla -**
  Petals 5, all alike, polypetalous, ascending imbricate aestivation (posterior petal is the innermost.)

***Exception➡**

Petals are absent in Ashok (***Saraca***)

Only 3-petals are present in Imli (***Tamarindus***), two petals are modified scales

- **Androecium -**
  Stamens 10, free, arranged in two whorls/(Circles) 5 + 5, some of them are sterile called as staminodes. Most of the genera have 3 staminodes.

– 7 Stamens are present in ***Tamarindus,*** monoadelphous, out of them 4 are staminodes.
– 5-8 normal stamens are present in ***Saraca*** (Ashok)
– 5- normal stamens are found in ***Bauhinia variegata*** (Kachnar).
All 10 stamens are fertile in parkinsonia,

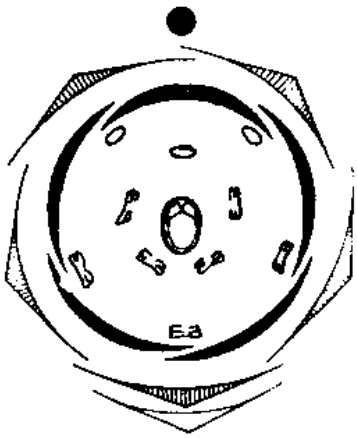
- **Gynoecium -**
  Monocarpellary, ovary half inferior/superior, unilocular, style long, stigma is simple and marginal placentation.
- **Fruit-**
  Legume or pod is present.

– Lomentum is present in ***Tamarindus.***

- **Seed** :- Nonendospermic
- **Floral formula**

$$\text{Br} \oplus \overset{\male}{\underset{+}{\bigcirc}} \; K_5\, C_5\, A_{5+5} \text{ or } A_{7+3} \text{ (Staminodes) } \underline{G}_1$$

- **Floral diagram**



- **Economic importance**
  - **Food**

Tamarindus indica	=	Imli
Bauhinia variegata	=	Kachnar (Camel's foot tree)
Bauhinia purpurea	=	Rawal
Ceratonia siliqua	=	Seeds are rich in protein

- **Ornamental**

Cassia fistula	=	Amaltas
Delonix regia	=	Gulmohar
Bauhinia anguinia	=	Nagput (Snake climber)
Saraca indica	=	Ashok
Caesalpinia pulcherima	=	Peacock flower
Parkinsonia aculeata	=	Vilayti kikar (Jeruselam Thorn)
Bauhinia variegata	=	Kachnar
Ambrestia nobilis		

- **Timber**

Caesalpinia sappan	**=**	**Brazil wood**
Haematoxylon compechianum	**=**	**Log wood**
		It yields a dye haematoxylin.
Copaifera pubiflora	**=**	**Purple heart wood**
Hymaenia-carbaryl	**=**	**West Indian locust wood**
Hardwickia binata	**=**	Hardest wood
Tamarindus indica	=	Imli
Kingiodendron pinnatum	**=**	It is used in agricultural implements.
Acroscarpus fraxinifolia	=	It produces primitive type of wood.

- **Medicines**

– The raw fruits of amaltas **(*Cassia fistula*)** are used as luxative.
– **Ashokarist** is obtained from the bark of ashok tree (ayurvedic medicine)
– The leaves and seed *Cassia occidentails* and *Cassia obtusifolia* (also purgative) are used in **skin diseases.**
– The bark and leaves of *Cassia glauca* are used in **diabetes** and **gonorrhoea.**
– A tonic is prepared from the bark ***Bauhinia variegata***.

- **Other uses**

– ***Phanera vahlii*** – It yields a commercial gum and bark fibres are used for making **ropes** and **baskets.**
– ***Caesalpinia sappan* – 'Gulal'** is obtained from its heart wood.
– ***Bauhinia purpurea*** and ***Ceratonia silqua*** are used as fodder.
– The oil of ***Kingiodendron pinnatum*** is used for making **soap** and **paints.**

- **Tanning :**

– **Bark of *Bauhinia purpurea***
– ***Bauhinia malabarica***
– ***Caesalpinia digyna***

MIMOSOIDEAE (SUB FAMILY)

- **Root -**

  Tap root system and branched.

- **Leaves -**

  Usually bipinnate paripinnate-pulvinus leaf base

  The stipule is modified into thorn as in ***Acacia.***

  Phyllode is found in Australian **Acacia**

- **Inflorescence -**

  Two types of inflorescences are found in Mimosoidae family -

(i) Capitate (Cymose Capitulum) - Acacia.

(ii) Spike – *Prosopis*

- **General floral character -**

  Bracteate, bisexual, Actinomorphic symmetry, perigynous/hypogynous, tetramerous or pentamerous

- **Calyx -**

  Sepals 4 or 5, gamosepalous, valvate aestivation

- **Corolla -**

  Petals 4 or 5, polypetalous

  gamopetalous corolla is present in ***Acacia*** & ***Albizzia***.

- **Androecium -**

  Many stamens, free, polyandrous

– Monoadelphous stamens are present in ***Albizzia.***

– 4 stamens which are free-found in ***Mimosa.***

– In prosopis 10 stamens are free

- **Gynoecium -**

  Monocarpellary, unilocular, half inferior/superior, marginal placentation

- **Fruit -**

  Lomentum

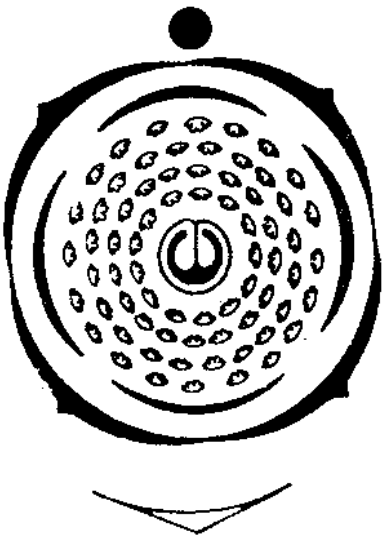
- **Seed** –

  Non endospermic

- **Floral formula -**

$$\text{Br} \oplus \male\!\!\female \; K_{(4-5)} \; C_{4-5} \; A_{\infty} \; \underline{G}_{1}$$

- **Floral diagram -**



- **Economic importance**
  - **Timber & fuel : -**

Acacia arabica	=	Desi Babool. (Black wood)
Prosopis juliflora	=	**Australian Babool**
Xylia dolabini formis	=	**Iron wood** (Jamboo)
Prosopis cineraria	=	Khejari (state tree of Rajasthan)
Albizzia lebbek	=	Siris
Acacia sundra	=	Heaviest wood in India
Xylia xylocarpa	=	Indian ironwood. Wood is used for making sleepers
Acacia julibrissin	=	Mimosa tree

  - **Food & fodder**

Pithecolobium dulce	=	**Jungle Jalebi (Aril)**
Albizzia lebbek	=	**Siris –** Pods are edible and used as fodder.
Neptunia oleracea	=	**Lajalu** – Fruits are edible
Parkia roxburghii	=	**Khurail**
Entada phaseliodes		

  - **Ornamental**

Mimosa pudica	=	Sensitive plant = "Touch me not"
Neptunia oleracea	=	Lajwanti "Kiss me quick"
Pithecolobium dulce	=	Hedge plant
Leucaena leucopholea		

  - **Other uses :-**

Adenanthera pavonia	=	seed-"Glodsmith's weight"
Acacia fornesiana	=	Cassie perfume is obtained from the flowers.
Acacia concinna	=	Shikakai-Its pods are used for head bath.
Acacia catechu	=	**Kattha** is obtained from its heart wood.
Prosopis spicigera	=	It is grown in Rajasthan as wind breaker.

    Many species of ***Acacia*** yield gum.
    Albizzia (Siris) produces special type of gum called **''Sresh''**
    The pods of shikakai are also used as insecticides.
    Gum arabic is obtained from the ***Acacia senegal*.**

CUCURBITACEAE

- **Systematic position**

Class	-	Dicotyledonae
Subclass	-	Polypetalae (but most of plants are gamopetalous, it is an exception)
Series	-	Calyciflorae
Order	-	Passiflorales
Family	-	Cucurbitaceae

- **Special character -**

– Stem Pentangular, branched, usually fistular, with bicollateral vascular bundle. They are arranged in two circles

– Inflorescence-Solitary axillary, most of the plants of this family are monoecious.

- Flowers are ebracteate, pedicellate, incomplete, unisexual, Actinomorphic symmetry, pentamerous and epigynous.
- 5 Sepals, gamosepalous, valvate aestivation.
- Petals 5, gamopetalous, valvate or imbricate aestivation.
- Tricarpellary, syncarpous, inferior ovary, unilocular, parietal placentation but it looks like axile placentation due to swelling of placenta, style one, stigma three and branched.
- 5 Stamens, usually cohesion in three groups (2) + (2) + 1. It means four stamens present in two pairs and fifth one is free, synandrous condition,
- Fruit is pepo
- The **bitter taste** of the fruit is due to presence of tetracyclic triterpenes.

- **Floral formula -**

Male flower – $\text{Ebr} \oplus \male\ K_{(5)}\, C_{(5)}\, A_{(2)+(2)+1} G_0$

Female flower - $\text{Ebr} \oplus \female\ K_{(5)}\, C_{(5)}\, A_0\, \underline{G}_{(3)}$

- **Floral diagram -**

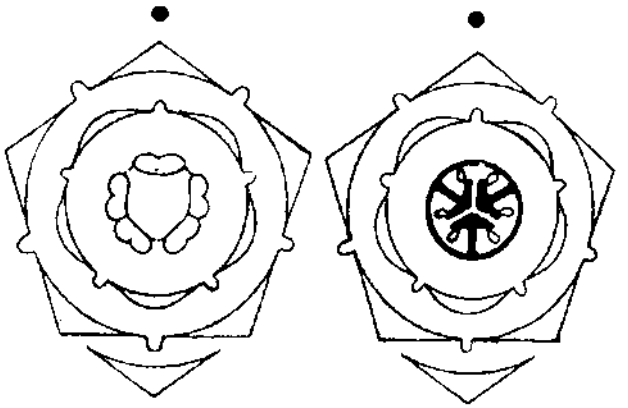


FIG. MALE FLOWER FEMALE FLOWER

- **Economic importance :**
- **Vegetables and Fruits**

Cucurbita pepo or ***Cucurbita maxima***	=	**Kadoo**
Lagenaria vulgaris	=	**Lauki**
Luffa acutangula	=	**Ridge Gourd**
Cucumis melo	=	**Muskmelon (Kharbooza)**
Luffa cylindrica	=	**Ghia tore**
***Cucumis melo* var. utilissimus**	=	**Kakari**
Citrullus vulgaris	=	Tarbooj (water melon)
Cucumis sativas	=	Kheera
Momordica charantia	=	Karela
Citrullus vulgaris *var.* ***fistulosus***	=	Tinda
Benincasa hispida	=	**Ash Gourd** or White Gourd
Trichosanthes dioeca	=	Parval (pointed gourd)
Trichosanthes anguina	=	Snake gourd

T. cucumeriana.	=	Ram bel
Cucumis momordica	=	Kachari
Coccinia cordifolia	=	Kundru (lvygourd)
Sechium edule	=	Lanku

- **Medicinal plants :**
  - ***Ecballium eleterium* = Eleterium** medicine is obtained, which is very useful in malaria and hydrophobia.
  - ***Bryonia rostrata* –** It is used in asthama and piles
  - ***Coccinia indica* –** extract of root leaf and fruit are used in treatment of diabetes
- **Other uses :**
  - ***Careya arborea* :-** Used in bidi

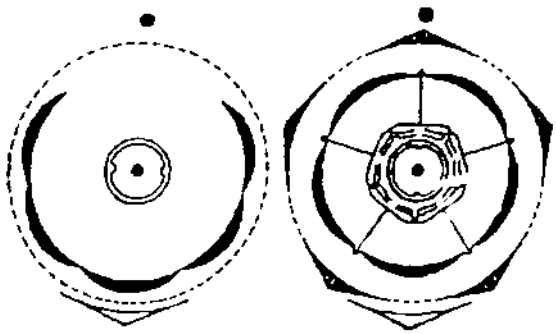
ASTERACEAE OR COMPOSITAE

- **Systematic position -**

Class	-	Dicotyledonae
Sub class	-	Gamopetalae
Series	-	Inferae
Order	-	Asterales
Family	-	Compositae or Asteraceae

Special character : Inflorescence mostly head or capitulum.

- Calyx usually represented by hairy structure called **pappus** or represented by minute **scales.** It is persistant & attached on fruit & helps in its dispersal.
- Petals 5, gamopetalous, valvate aestivation.
- Stamens-5 epipetalous, syngenesious.
- Bicarpellary, syncarpous, inferior ovary, unilocular basal placentation, one style and two stigma or bifurcated stigma
- Fruit is **cypsela** with hairy pappus.
- In Dehlia fasciculated roots are present.
- **Floral formula -**
  - Ray florets → Br % $\underset{+}{\bigcirc}$ $K_P\, C_{(5)}\, A_0\, \overline{G}_{(2)}$
  - Disc florets → Br ⊕ $\underset{+}{\bigcirc\!\!\!\!\bigcirc}$ $K_P\, \overset{\frown}{C_{(5)}\, A_{(5)}}\, \overline{G}_{(2)}$
  - Sterile florets → Br ⓘ $K_P\, C_{(5)}\, A_0\, G_0$
- **Floral diagram –**



- **Economic importance -**
  - **Food -**

    ***Lactuca sativa* =** Salad (Garden lettuce).

Cichorium intybus* (Kasni) = *Cichorium – chicory powder is prepared from roots which mixed in coffee powder.

Helianthus tuberosus – Their tubers are eaten which contain inulin.

Helianthus annus = Sunflower (Suraj mukhi) – The seeds of this yields valuable oil which is used for cooking purposes.

Carthamus thinctorius = Kusum (Safflower) – Oil obtaining from seeds reduced the level of cholesterol.

- **Medicinal plants -**

***Artemisia obsinthium* –** Santonin medicine obtains from *Artemisia* which is useful for removal of worms.

***Arnica montana* –** Arnica medicine is obtained which is used in healing of wound and as hair oil.

***Eclipta alba* –** (Bhring Raj) – Juice is used as hair tonic.

***Anthemis nobilis* –** Camomile named medicine is obtained from the inflorescence.

Species of blumea produce **''Kapoor''** which is a useful medicine.

***Taraxacum officinale* –** "Taraxacum" medicine is obtained which is purgative and diuretic.

- **Ornamental -**

Helianthus annus = Surajmukhi

Chrysanthemum = Gul-Daudi

***Tagetes* =** Genda (marigold)

***Calendula officinalis* =** (Pot marigold)

- **Other Values -**

Ambrosia artemissifolia = **Ring weed** – Hay fever is due to its pollen grains.

Parthenium hysterophorus = Congress grass-skin allergy develops from its pollen grains.

***Chrysanthemum cinerariefolium* =** Guldaudi-Pyrethrum named insecticide is obtained.

LILIACEAE

- **Systematic position**

Class - Monocotyledonae

Series - Coronarieae

Family - Liliaceae

* Perianth is present in this family,

- **Diagnostic features**
  - **Habit -**

Mostly Herbs some climbers

sometimes abnormal secondary growth is found in trees such as – ***Dracaena, Yucca*.**

  - **Root -**

Usually adventitous/fibrous. Fasciculated root is found in ***Asparagus*** (satawar)

  - **Stem**

The aerial stem is present in few plants.

Majority of the plants have underground stem. It is of two type-

(i) **Bulbs**

Example – **Onion, Garlic.**

(ii) **Corm**

Example – **Colchicum**

Modification of aerial stem -

Cladode – in ***Asparagus, Ruscus***

- **Leaves -**

  Some of the plants bear cauline leaves (present on aerial stem.)

  Radical leaves are present in few plants such as in ***Asphodelus*****.**

  The leaves are sessile with sheathing leaf bases i.e. clasping round the stem.

  *In ***Allium*** three different type of leaves are found scale, Foliar and Fleshy.

- **Venation-**

  Perallel venation

  *Reticulate venation is found in ***Smilax, Paris***

  The stipule of ***Smilax*** and leaf tip of ***Gloriosa*** are modified into tendrils.

- **Inflorescence -**

  It is of many types as follows :-

  Panicle *:-* Compound raceme e.g. ***Yucca*** and ***Dracaena***

  Scorpioid cyme – e.g. ***Haemorcoalis***

  Spadix – e.g. ***Aloe***

  Scapigerous umbel or Cymose umbel – e.g. **Onion** and **Garlic**

  Solitory terminal → ***Tulipa***

  Solitary axiliary – ***Gloriosa***

- **General characters of flower -**

  Bracteate, bisexual, complete, actinomorphic symmetry, Hypogynous and Trimerous, epiphyllous and in some plants may be epipetalous

  *The flowers in ***Ruscus*** and ***Smilax*** are unisexual and incomplete.

  *Zygomorphic flower present in ***Lilium***

  ****Aspidiastra***, ***Paris*** and ***Mianthimum*** contain tetramerous flowers.

- **Perianth-**

  Tapals 6 (perianth), polyphyllous, arranged in two whorls 3 + 3, Valvate or imbricate aestivation, tepal of outer whorl-anterior. May be polytepalous. Gamotepalous flower → ***Aloe, Asparagous***

  *Eight (8) tepals are present in ***Paris*** and ***Mianthimum*** and arranged in two whorls 4 + 4.

- **Andoroecium -**

  6 stamens, arranged in two whorls 3 + 3, free polyandrous, basifixed or versatile & introrse.

  *Only 3 stamens are found in ruscus. 8 stemens are found in Paris arranged in 4 + 4.

- **Gynoecium -**

  Tricarpellary, syncarpous, trilocular, stigma trifid, axile placentation, superior ovary.

- **Fruit -**

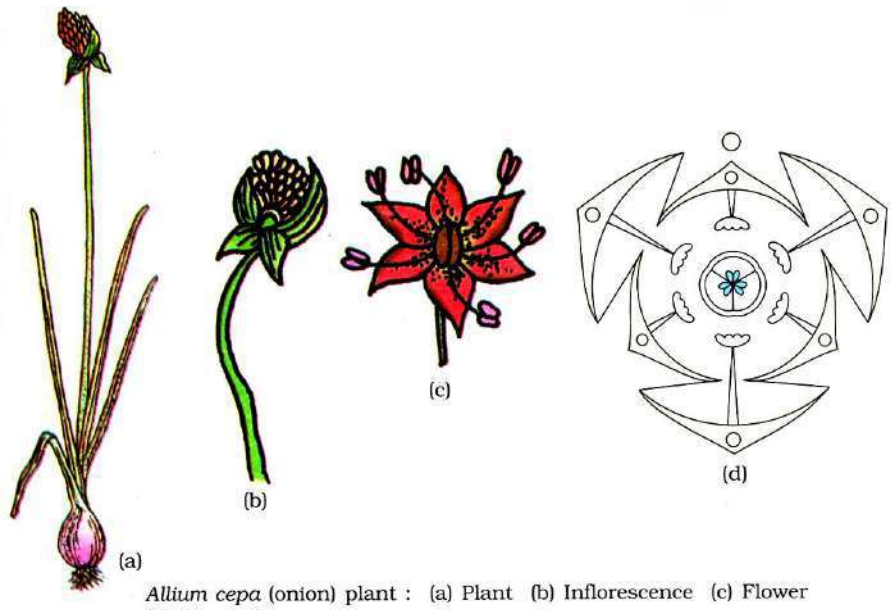
  Some have berry as in **Lily and** normally capsule as in **onion.**

- **Seed -** Endospermic

- **Floral formula -**

$$\text{Br} \oplus \; \overset{+}{\circlearrowleft} \; P_{3+3 \text{ or } (3+3)} \, A_{3+3} \, \underline{G}_{(3)} \quad \text{or} \quad \text{Br} \oplus \; \overset{+}{\circlearrowleft} \; \overset{\frown}{P_{3+3 \text{ or } (3+3)}} \, A_{3+3} \, \underline{G}_{(3)}$$

- **Diagram -**



Allium cepa (onion) plant : (a) Plant (b) Inflorescence (c) Flower (d) Floral diagram

- **Economic importance -**
  - **Food -**

    Allium cepa = Onion

    ***A. sativum* =** Garlic

    Asparagus = Satawar - Fasciculated roots

    Leprogeria rosea – Fruits are eaten.
  - **Ornamental plants -**

    ***Lilium bulbiferum* =** Lily

    ***Gloriosa superba* =** Glory lily

    Tulipa = **Tulip**

    ***Convalaria majlis* =** Lily of the valley

    Sensiviera trifasiata – "Mother in Law's tongue"

    Ruscus aculeatus – Butcher's boom"

    Fritillaria tenella* ; *F. melagris = snakes head

    Agapanthus americans = African lily
  - **Medicinal uses -**

    Sarasprilla = *Smilax zeylamicum* – roots yield sarasaprilla which is used in veneral disease dysentery and skin disease

    Sudarshan = ***Crinum asiaticum***

    The juice of leaves is used in rheumatism and ear pain.

    Gvar patha = ***Aloe vera*** – the juice of the leaves is used as skin tonic and increase the eye sight.

    Asphodelus tennuifolius – Its seeds are used in peptic ulcer.

    Urginea (wild onion) and Scilla rat killer medicine is prepared from their bulb.

    Lahasun = ***Allium sativum* =** It is very useful in heart disease, rheumatism & diabetes.

    ***Gloriosa superba* –** It is used in leprosy and piles, it is also very useful in biting of snake or scorpion.

- **Other uses :-**

– Dragon plant = ***Dracenena draca*** **–** Red colour resin is obtained from the stem, Thus it is known as "Dragon's blood"

– **Dragger plant =** ***Yucca alolifolia, Y. filamentosa*****-** Fibres are ontained from the stem.

– ***Colchicum automnale*****-**Colchicine is obtained from this plant which is used to induce polyploids in plants.

– ***C. luteum*** = corm is laxative

– ***lphigenia indica*** **–** Red colour is obtained from the flowers.

– ***Phormium tenax*** – It is used for preparing oil paints and varnishes.

– ***Sansevieria roxburghiana*** **=** "Indian Bowstring hemp" Bowstring hemp" and ***Sansevieria trifasciana*** = "African Bowstring hemp" – fibers are obtained which are used for making ropes and nets.

– ***Veratrum album*** = moth killer is prepared

POACEAE OR GRAMINEAE

- **Systematic position -**

  Class = Monocotyledonae

  Series = Glumaceae

  Family = Gramineae or Poaceae

- **Special character :**

– This is the largest family of the Indian flora.

– Inflorescence spike of spikelets. Main axis is called rachilla.

– Flowers sessile, bracteate, bracteolate. Two sterile or empty scales called glumes occur at the base of the main axis. A series of florets are present above the glumes with superieor and inferior palea. Inferior palea is fertile bract which is also known as fertile glume lemma. They can produce hair or awn. Superior palea is morphologically act as a bracteole.

– Flowers zygomorphic, bisexual, but in Zea and coix flowers are unisexual. Flowers are hypogynous and trimerous.

– Tepals 2, free polytapelous, membranous and situated in antereo lateral position. They are called lodicules.

– Stamens 3, polyandrous,

– Monocarpellary or Tricarpellary, syncarpous, superior ovary, unilocular, placentation is basal, two style are present and stigma is **feathery**

– Fruit is **caryopsis.**

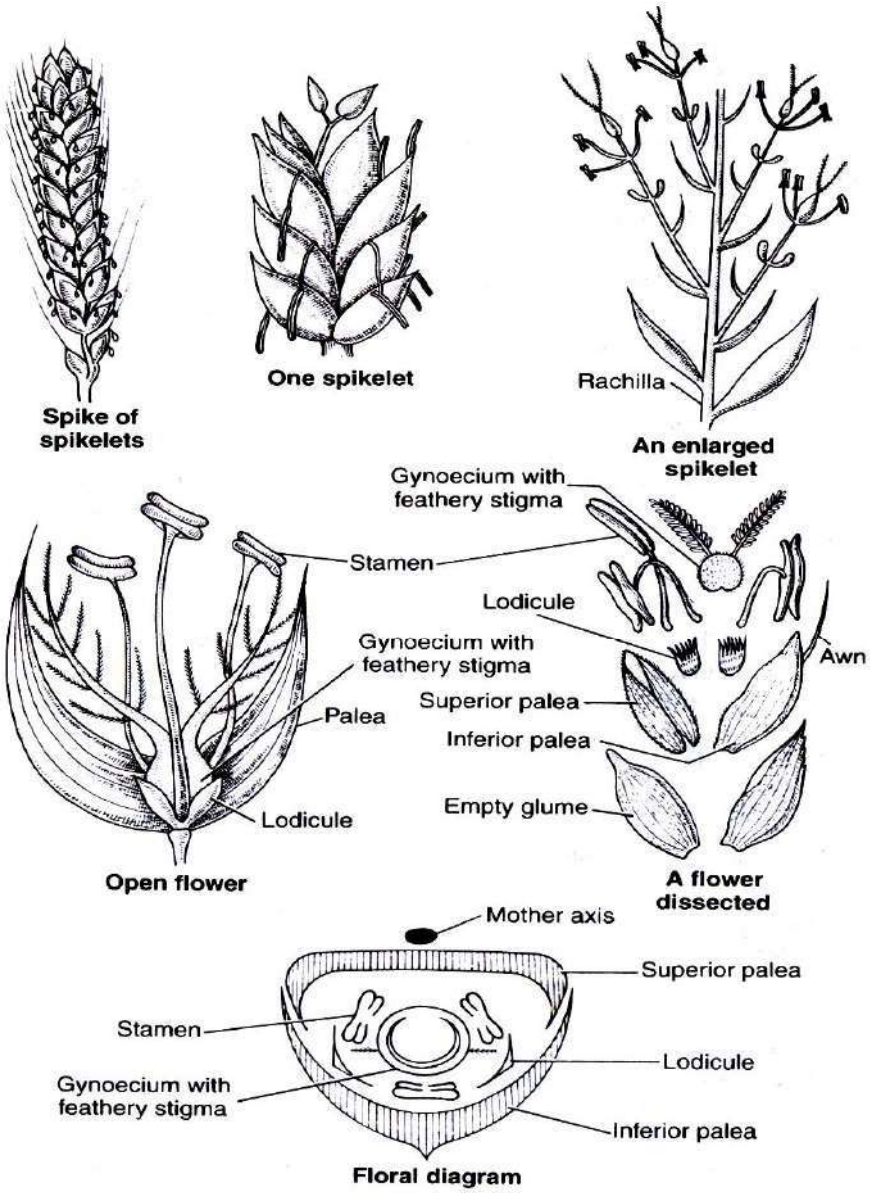
– Culm stem is present.

– Seed → Endospermic

- **Floral formula -**

$$Br \oplus \delta\!\!\!

- **Diagram -**



Triticum aestivum **(Wheat) : A spike of spikelets, one spikelet, an enlarged spikelet, an open flower, a dissected flower and floral diagram**

- **Economic importance -**
  - **Ornamental Plants :-**

    ***Cynodon dactylon* = Doob**
  - **Cereals :-**

Avena sativa	=	Jai/oat
Eleusine coracena	=	Ragi
Hordeum vulgare	=	Barely/jau – It is the oldest ancient crop.
Oryza sativa	=	Rice
Pennisetum typhoides	=	Bajra
Secale cereale	=	Europen rye
Sorghum vulgare	=	Jawar

Triticum aestivum = Wheat

Zea mays = Maize

- **Sugar :-**

Saccharum officinarum = Sugar cane

- **Oil Yielding Plants :-**

Cymbopogon caesius = ginger grass oil is obtained from their leaves & is used in soap industry.

C.flexnosus = Lemon grass oil is obtained from their leaves & is used for making scented materials.

Vetiveria zizanoides = Khus
Oil obtained from their root which is used in perfumery.

- **Fibre Yielding Plants :-**

– ***Erianthus arundinaceus*** = Sarkanda is used in making ropes.

– ***E.munja*** = Moonj–Fibres obtained from stem is used for making ropes, mats and baskets etc.

- **Timber Yielding Plants :-**

– ***Bambusa balcooa*** = Bamboo

– ***Dendrocalamus giganteus*****.**

- **Other uses :-**

– ***Hordeum vulgare*** is used for making **beer.**

– ***Thysanolaena mexima*** – It is used from making brooms

– ***Zea mays*** is used in alcohol industry.

– ***Vetiveria zizanoides* –** (Khus) – It is used for preparation of on alcoholic drinks. Its root are also used in perfumery.

– ***Arundinaria falcata*** **(Bansi) :** Used for making fishing rod.

SPECIAL POINTS

- Fabaceae is the alternative name of the **Leguminosae.**
- Compositae = **Asteraceae** is the largest family of angiosperms.
- ***Desmodium latifolium*** the member of papilionateae family which is halophyte.
- J.C. Bose conducted experiment of plant movement on ***Desmodium gyrans***.
- Pollen grains in Mimosoidae are usually present in the form of packets.
- Soyabean contains more protein than meat.
- Aloin alkaloides are obtained from ***Aloe*** plant of Liliaceae.
- ***Smilax*** is a monocot, having, reticulate venation.
- The flowers enter into the soil after fertilization in ground nut (Geocarpic fruit).
- Pulses are rich source of proteins.

EXERCISE - 1

Q.1 Edible part of coconut is-
(1) Endocarp (2) Embryo
(3) Endosperm (4) Mesocarp

Q.2 The characteristic fruit of family cruciferae is-
(1) legume (2) Capsule
(3) Berry (4) Siliqua

Q.3 The morphological nature of edible part of apple is-
(1) Mesocarp (2) Fleshy thalamus
(3) Endocarp (4) Cotyledons

Q.4 A caryopsis is a fruit-
(1) That does not have fruit wall
(2) Fruit wall, which is fleshy and contains many seeds
(3) In which fruit wall and seed coat are fused
(4) That dehiscence to expose seeds

Q.5 The fruit of coconut is a-
(1) Capsule (2) Drupe
(3) Nut (4) Berry

Q.6 The edible part of ripe mango is morphologically-
(1) Epicarp (2) Mesocarp
(3) Endocarp (4) Pericarp

Q.7 The fruit of apple (pome) is said to be false fruit because-
(1) Its pericarp is inconspicuous
(2) Its endocarp is cartilagenous
(3) Its actual fruit is located within an edible fleshy thalamus
(4) It develops from an inferior ovary

Q.8 Which of the following is not fruit-
(1) Tomato (2) Cucumber
(3) Mango (4) Potato

Q.9 The pair which is not correctly matched-
(1) Mango-drupe (2) Sunflower-cypsela
(3) Tomato-berry (4) fig-sorosis

Q.10 Drupe is one seeded succulent fruit with a three layered pericap, which of the following is not that fruit-
(1) Plum (2) Peach
(3) Lemon (4) Cherry

Q.11 Type of fruit in groundnut (Arachis hypogea) is-
(1) Nut (2) Legume
(3) Lomentum (4) Caryopsis

Q.12 The type of dehiscence in the capsule of cotton is-
(1) Loculicidal (2) Septifragal
(3) Septicidal (4) Poricidal

Q.13 Rice grains are fruits known as-
(1) Caryopsis (2) Achene
(3) Cypsela (4) Samara

Q.14 A true fruit develops from-
(1) Ovary (2) Thalamus
(3) Petals (4) Receptacle

Q.15 A cypsela is a fruit-
(1) That does not have a fruit wall
(2) In which fruit wall is fused with seed coat
(3) Which develops from a syncarpous, inferior single seeded ovary
(4) In which the pericarp is fleshy

Q.16 Which one of the following is a fruit-
(1) Potato (2) Radish
(3) Ginger (4) Lady's finger

Q.17 The fruit developing from an apocarpous condition of a gynoecium in a flower is known as-
(1) Multiple (2) Simple
(3) Aggregate (4) Composite

Q.18 The edible part of litchi is-
(1) Mesocarp (2) Fleshy thalamus
(3) Succulent testa (4) Fleshy aril

Q.19 Mulberry is a-
(1) Simple fruit (2) Composite fruit
(3) Aggregate fruit (4) None of these

Q.20 Parthenocarpic fruit develops from-
(1) Unpolinated ovary
(2) Unfertilized ovary
(3) Thalamus and ovary
(4) Unfertilized ovule

Q.21 The fruit that develops from hypanthodium inflorescence is called-
(1) Syconus (2) Siliqua
(3) Samara (4) Sorosis

Q.22 Siliqua fruit develops from-
(1) Bicarpellary ovary
(2) Polycarpellary unilocular ovary
(3) Monocarpellary ovary
(4) Polycarpellary and multilocular ovary

Q.23 Stony endocarp is found in-
(1) Berry (2) Nut
(3) Drupe (4) Amphisaraca

Q.24 Betel nut is a-
(1) Drupe (2) Berry
(3) Nut (4) Sorosis

Q.25 The plant which buries its own seeds in the soil is-
(1) Sweet potato (2) Arachis hypogea
(3) Potato (4) Onion

Q.26 When the pericarp is fused with testa and the fruit contains a single seed, it is called-
(1) Caryopsis (2) Achene
(3) Utricle (4) Nut

Q.27 Coir is obtained from which part of coconut-
(1) Epicarp (2) Mesocarp
(3) Endocarp (4) Seed

Q.28 Tomato is a-
(1) Pome (2) Berry
(3) Drupe (4) Nut

Q.29 The most important foods are derived from-
(1) Roots (2) Fruits
(3) Stems (4) Leaves

Q.30 The unilocular, single seeded fruit developing from a bicarpellary, inferior ovary, often with persistent pappus is called-
(1) Caryopsis (2) Achene
(3) Cypsela (4) Capsule

Q.31 Pine apple is an example of-
(1) An etaerio of berries
(2) A sorosis
(3) An aggregate of drupes
(4) A simple fleshy fruit

Q.32 Anona squamosa is-
(1) Etaerio of achenes (2) Etaerio of drupes
(3) Etaerio of berries (4) Hypanthodiuim

Q.33 Berry is a fruit which is commonly-
(1) Dry and multiseeded
(2) Fleshy and single seeded
(3) Flehsy and multiseeded
(4) Fleshy and single or multiseeded

Q.34 Immature gular fruit is a-
(1) Berry fruit (2) Pome fruit
(3) Hypanthodium inflorescence
(4) Swollen tip of a twig

Q.35 A fruit that has a fleshy mesocarp and stony endocarp is called-
(1) Pome (2) Drupe
(3) Berry (4) pepo

Q.36 The survival of the flowering plants can best be attributed to-
(1) Absence of vascular system
(2) Development of fruit
(3) Development of an extensive root system
(4) Ability to carry on vegetative propogation

Q.37 The dry dehiscent (schizocarpic) fruit which develops from tricarpellary, synacarpous, superior ovary with axile placentation is-
(1) Regma (2) Carcerulus
(3) Septicedal capsule (4) Septifragal capsule

Q.38 The fleshy indehiscent fruit which develops from tricarpellary synacarpous gynoecium, inferior ovary with parietal placentation is-
(1) Hesperidium (2) Pome
(3) Pepo (4) Syconus

Q.39 The fruits of which plants are dispersed by grazing animals such as goats and cows-
(1) Sunflower (2) Xanthium
(3) Mustard (4) Cucurbita

Q.40 Which of the following plants are likely to have wider range of distribution-
(1) Those distributed by seeds
(2) Those distributed by spores
(3) Those distributed by vegetative means
(4) Those distributed by fruits

Q.41 Dispersal of coconut fruit takes place by-
(1) Air (2) Water
(3) Animals (4) Splitting

Q.42 Parachute mechanism of fruit and seed dispersal is due to the structure called-
(1) Pappus (2) Thorns
(3) Corolla (4) Bracts

Q.43 Orchid seeds are-
(1) Very large and heavy
(2) Light and dry
(3) Small and sticky
(4) None of the above

Q.44 The following bear winged fruits-
(1) Oroxylon (2) Cinchona
(3) Dioscorea (4) Moringa

Q.45 Among the following whose seeds are dispersed by wind-
(1) Calotropis (2) Cycas
(3) Petunia (4) Rice

Q.46 The dispersal of seeds in opium takes place by-
(1) Parachute mechanism
(2) Censor mechanism
(3) Explosive mechanism
(4) None of the above

Q.47 Winged seeds are present in-
(1) Moringa (2) Shorea
(3) Hiptage (4) Calotropis

Q.48 Fruits dispersed by persistent styles in-
(1) Clematis (2) Solanum
(3) Papaver (4) Phyasalis

Q.49 Parachute mechanism of fruit and seed dispersal is due to structure called-
(1) Pappus (2) Thorns
(3) Corolla (4) Bracts

Q.50 The ovary showing ovules borne on three parietal placenta is-
(1) Bilocular (2) Trilocular
(3) Pentalocular (4) Unilocular

ANSWER KEY

EXERCISE – 1

Q.1	3	Q.2	4	Q.3	2	Q.4	3	Q.5	2	Q.6	2	Q.7	3
Q.8	4	Q.9	43	Q.10	3	Q.11	3	Q.12	1	Q.13	1	Q.14	1
Q.15	3	Q.16	4	Q.17	3	Q.18	4	Q.19	2	Q.20	2	Q.21	1
Q.22	1	Q.23	3	Q.24	1	Q.25	2	Q.26	1	Q.27	2	Q.28	2
Q.29	2	Q.30	3	Q.31	2	Q.32	3	Q.33	3	Q.34	3	Q.35	2
Q.36	2	Q.37	1	Q.38	3	Q.39	2	Q.40	4	Q.41	2	Q.42	1
Q.43	2	Q.44	3	Q.45	1	Q.46	2	Q.47	1	Q.48	1	Q.49	1
Q.50	4												

EXERCISE - 2

Q.1 For higher plant flowers are chiefly used as a basis of classification, because-
(1) These show a great variety in colour
(2) It can be preserved easily
(3) Reproductive parts are more conservative than vegetative
(4) None of these

Q.2 The part of cauliflower which is eaten is-
(1) Bud (2) Inflorescence
(3) Flower (4) Fruit

Q.3 Tetradynamous androecium is characterized by-
(1) Outer two long and inner two short stamens
(2) Outer two short and inner four long stamens
(3) Outer four long and inner two short stamens
(4) Outer four short and inner two long stamens

Q.4 Cruciform corolla is present in-
(1) Sunflower (2) China rose
(3) Raddish (4) Pea

Q.5 The aestivation of corolla of pea flower is called-
(1) Valvate (2) Twisted
(3) Imbricate (4) Vexillary

Q.6 Ochreate stipules occur in-
(1) Cotton (2) Rose
(3) Polygonum (4) Pea

Q.7 Maturation of stamens and pistils at different times in the same flower is called-
(1) Heterospory (2) Heterostyly
(3) Dichogamy (4) Dichotomy

Q.8 Monoadelphous stamens are formed by the fusion of
(1) Anther lobes of all the stamens
(2) Anther lobes of two stamens
(3) Filaments of all stamens
(4) Filaments of two stamens

Q.9 In bisexual flowers when the gynoecium matures earlier than the androecium it is called-
(1) Protandry (2) Protogyny
(3) Heterogamy (4) Autogamy

Q.10 A bisexual flower which never opens in its life span is called-
(1) Homogamous (2) Heterogamous
(3) Dichogamy (4) Cleistogamy

Q.11 Hydrophily is best demonstrated by-
(1) Nelumbium (2) Vallisneria
(3) Eichornia (4) Nymphaea

Q.12 A modification of a bud that can bear leaves, flowers and fruits and may also become branched is called-
(1) Prickle (2) Spine
(3) Thorn (4) Trichome

Q.13 The placentation in a multilocular ovary where the ovules are borne over the entire inner surface is called
(1) Pendulous (2) Marginal
(3) Superficial (4) Parietal

Q.14 When the filaments are united into a number of bundles, but the anthers are free, the conditions is called-
(1) Diadelphous (2) Monoadelphou
(3) Syngenesius (4) Polyadelphous

Q.15 Gynobasic style is found in-
(1) Labiatae (2) Gramineae
(3) Liliaceae (4) Compositae

Q.16 Perianth is-
(1) Outer part of flower in which calyx and corolla are not always distinguishable
(2) When stamens and gynoecium are not distinguishable
(3) When only calyx is present
(4) None of the above

Q.17 Arrangement of sepals or petals with respect to each other in floral bud is called-
(1) Vernation (2) Venation
(3) Aestivation (4) Phyllotaxy

Q.18 Ligulate/strap-shaped corolla occurs in sunflower in-
(1) Disc florets
(2) Immature florets
(3) Ray florets
(4) Both ray and disc florets

Q.19 The long silky hair coming out of cob of maize are-
(1) Meant for fruit dispersal
(2) Meant for attracting insects
(3) Meant for protecting seeds
(4) Long styles and stigmas

Q.20 Stamens with free anthers but filaments fused into a number of groups are-
(1) Polyadelphous (2) Diadelphous
(3) Monadelphous (4) Syngenesious

Q.21 Structure equivalent to perianth is-
(1) Superior palea (2) Inferior palea
(3) Glumes (4) Lodicules

Q.22 Which is not correctly matched in respect to edible part-
(1) Mango-mesocarp
(2) Litchi-fleshy aril
(3) Groundnut-embryo and cotyledons
(4) Coconut-endocarp

Q.23 An albuminous seed showing hypogeal germination is-
(1) Castor (2) Bean
(3) Gram (4) Maize

Q.24 Oil is stored in the endosperm of-
(1) Groundnut (2) Soyabean
(3) Coconut (4) Cashewnut

Q.25 Germination of seed within fruit is-
(1) Ovipary (2) Vivipary
(3) Hypogeal (4) Epigeal

Q.26 Dispersal of seed in opium Poppy/Argemone occurs by-
(1) Explosive mechanism
(2) Parachute mechanism
(3) Censer mechanism
(4) Jaculator mechanism

Q.27 Seeds are beset with tiger's claw in-
(1) Martynia (2) Xanthium
(3) Spear grass (4) Puncture vine

Q.28 Tetradynamous condition is related to-
(1) Androecium (2) Inflorescence
(3) Perianth (4) Gynaecium

Q.29 In the fruit of pomegranate, the edible part is-
(1) Mesocarp (2) Pericarp
(3) Seed coat (4) Endocarp

Q.30 Which is not correctly matched-
(1) Fig – Sorosis (2) Sunflower – Cypsela
(3) Mango – Drupe (4) Tomato – Berry

Q.31 Perisperm is-
(1) Remnant of endosperm
(2) Persistent nucellus
(3) Peripheral part of endosperm
(4) Disintegrated secondary nucleus

Q.32 Outermost layer of endosperm of maize grain is-
(1) Epidermis (2) Pericarp
(3) Tunica (4) Aleurone

Q.33 Fruit bearing plants are-
(1) Gymnosperms (2) Dicotyledons
(3) Angiosperms (4) Spermatophytes

Q.34 Tetradynamous condition has-
(1) Six stamens, two short and four long
(2) Six stamens, two long and four short
(3) Six stamens, two short in outer whorl and four long in inner whorl
(4) Four stamens, two short and two long in outer and inner whorls respectively

Q.35 Synandrous condition is fusion of-
(1) Filaments only
(2) Both filaments and anthers
(3) Anthers only
(4) Petals

Q.36 Maize/Wheat/Rice grain is-
(1) Fruit (2) Seed
(3) Embryo (4) Dried bud

Q.37 In pineapple, the edible part is-
(1) Pericarp and thalamus
(2) Rachis/penducle, bracts, perianth and pericarps
(3) Mesocarp and endocarp
(4) Pericarp and placenta

Q.38 Aleurone layer helps in-
(1) Storage of food in endosperm
(2) Protection of embryo
(3) Utilization of stored food
(4) All the above

Q.39 In the legume seed, food is stored in-
(1) Cotyledons (2) Endosperm
(3) Perisperm (4) Seed coats

Q.40 Epithelial layer of maize scutellum secretes the hormone-
(1) Auxin (2) Cytokinin
(3) Gibberellin (4) Ethylene

Q.41 Fruit of Cruciferae is-
(1) Legume/pod (2) Siliqua
(3) Berry (4) Cypsela

Q.42 Edible part of groundnut buried is soil is morphologically-
(1) Root (2) Stem
(3) Fruit (4) Leaf

Q.43 Fruit of Ficus is-
(1) Sorosis (2) Syconium
(3) Aggregate (4) Dry

Q.44 Aggregate fruit occurs in-
(1) Artocarpus (2)Annona squamosa
(3) Ananas (4) Both (2) and (3)

Q.45 Shield-shaped cotyledon/scutellum occurs in-
(1) Maize (2) Gram
(3) Pea (4) Cucumber

Q.46 Parachute type dispersal occurs in-
(1) Tomato (2) Mustard
(3) Pea (4) Cotton

Q.47 A characteristic of drupe is-
(1) Fleshy seed coat (2) Stony pericarp
(3) Stony mesocarp (4) Stony endocarp

Q.48 Which is active in maize-
(1) Maltase (2) Zymase
(3) Diastase (4) Urease

Q.49 Winged seeds are-
(1) Rough and sticky (2) Smooth and sticky
(3) Dry and spinning (4) None of the above

ANSWER KEY

EXERCISE – 2

Q.1	3	Q.2	2	Q.3	2	Q.4	3	Q.5	4	Q.6	3	Q.7	3
Q.8	3	Q.9	2	Q.10	4	Q.11	2	Q.12	3	Q.13	3	Q.14	4
Q.15	1	Q.16	1	Q.17	3	Q.18	3	Q.19	4	Q.20	1	Q.21	4
Q.22	4	Q.23	1	Q.24	3	Q.25	2	Q.26	3	Q.27	1	Q.28	1
Q.29	3	Q.30	1	Q.31	2	Q.32	4	Q.33	3	Q.34	3	Q.35	2
Q.36	1	Q.37	2	Q.38	4	Q.39	1	Q.40	3	Q.41	2	Q.42	3
Q.43	2	Q.44	2	Q.45	1	Q.46	4	Q.47	4	Q.48	3	Q.49	3

EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Pappus is characteristic of family **[JKCMEE 2000]**

(1) Asteraceae/Compositae
(2) Papaveraceae
(3) Papilionaceae/Fabaceae
(4) Malvaceae

Q.2 An apocarpous flower is found in **[JIPMER 2000]**

(1) *Caesalpinnia* (2) *Ranunculus*
(3) *Brassica* (4) *Datura*

Q.3 Ligulate corolla found in compositae is **[JIPMER 2000]**

(1) Wheel-shaped (2) Strap-shaped
(3) Masked (4) Two-lipped

Q.4 Butterfly shaped flower with one stranded, two wing-like and two keeled petal belong to **[AIIMS 2000]**

(1) Compositae (2) Rubiaceae
(3) Malvaceae (4) Papilionaceae

Q.5 Hair present on the cob of corn are **[CBSE PMT 2000]**

(1) Seed hairs
(2) Modified hairs of bracts
(3) Styles
(4) Stigmas and styles

Q.6 Transversely placed syncarpous ovary occurs in **[Pb. PMT 2000]**

(1) Compositae (2) Cruciferae
(3) Malvaceae (4) Cucurbitaceae

Q.7 Part of pistil which receives pollen is **[MP PMT 2004]**

(1) Ovary (2) Style
(3) Stigma (4) Ovule

Q.8 Tetradynamous condition is characteristics of [**CPMT 2001; Bih. PMT 2001]**

(1) *Liliaceae/Allium/Asphodelus*
(2) Cruciferae/Mustard/Iberis
(3) Malvaceae/*Althea/Hibiscus*
(4) Solanaceae/*Nicotiana/Petunia*

Q.9 The term Anthesis is used for **[AIEEE 2004]**

(1) Cluster of anthers
(2) Opening of flowers
(3) Dehiscence of anthers
(4) Falling of flowers

Q.10 Bilocular oblique ovary with numerous shining ovule on swollen axile placenta is the characteristics of **[AMU 2002]**

(1) Cruciferae (2) Solanaceae
(3) Liliaceae (4) Malvaceae

Q.11 In many cultivated ornamental flowers, number of petal whorls is higher than the one in wild type. Extra petals are generally modified **[JKCMEE 2000]**

(1) Sepals (2) Petals
(3) Stamens (4) Pistils

Q.12 Name the plant from seeds of which oil is obtained **[MP PMT 2001]**

(1) *Cicer arietinum*
(2) *Saccharum officinarum*
(3) *Saccharum munja*
(4) *Arachis hypogea*

Q.13 Chief features of family Brassicaceae/ Cruciferae is presence of **[BHU 2002]**

(1) Latex (2) Pectin
(3) Alkaloids (4) Myrosin enzyme

Q.14 Flower of Fabaceae is **[JIPMER 2002]**

(1) Complete, zygomorphic, pentamerous
(2) Complete, actinomorphic, trimerous
(3) Incomplete, zygomorphic, trimerous
(4) Incomplete, actinomorphic, pentamerous

Q.15 Ovary having basal placentation is **[JIPMER 2002]**

(1) Monocarpellary bilocular
(2) Bicarpellary, syncarpous and unilocular
(3) Multicarpellary, syncarpous and unilocular
(4) Syncarpous with two or more carpels

Q.16 Most important character of Brassica campesteris is **[RPMT 2002]**

(1) False septum (2) Parietal placentation
(3) Ebracteate (4) Imbricate aestivation

Q.17 In fabaceae, one of the following immediately encloses the essential organs **[APMEE 2002]**
(1) Anterior petals (2) Posterior petal
(3) Lateral petals (4) Sepals

Q.18 Choose the correct description depicted by floral diagram **[KCET 2002]**
(1) United valvate sepals, free twisted petals, free stamens, unilocular ovary with marginal placenta
(2) United valvate sepale, free imbricate petals, free stamens, unilocular ovary with axile placenta
(3) United valvate sepals, free imbricate petals, epipetalous stamens, unilocular ovary with marginal placenta
(4) United valvate sepals, free imbricate petals, free stamens, unilocular ovary with marginal placentation

Q.19 Compositae is also known as **[DPMT 2001]**
(1) Fabaceae (2) Asteraceae
(3) Liliaceae (4) Poaceae

Q.20 Four sepals arranged in two whorls is characteristic of family **[Manipal 2001, BHU 2002]**
(1) Solanaceae (2) Fabaceae
(3) Brassicaceae (4) Liliaceae

Q.21 Name the family having (9)+1 arrangement of stamens **[AIIMS 2001]**
(1) Solanaceae (2) Asteraceae
(3) Liliaceae (4) Fabaceae

Q.22 Largest family of flowering plants is **[Tamil Nadu 2001]**
(1) Fabaceae (2) Liliaceae
(3) Poaceae (4) Asteraceae

Q.23 Russian Millet, Digitaria, is grown in **[Har PMT 2000]**
(1) Bihar (2) Karnataka
(3) Rajasthan (4) Meghalaya

Q.24 Bicarpellary, syncarpous, unilocular ovary with basal placentation occurs in **[Tamil Nadu 2001]**
(1) Liliaceae (2) Solanaceae
(3) Asteraceae (4) Fabaceae

Q.25 Pulses are obtained from **[MPPMT 2002]**
(1) Fabaceae (2) Asteraceae
(3) Poaceae (4) Solanaceae

FAMILIES OF FLOWERING PLANTS

Q.26 Edible oil is obtined from seeds of **[BHU 2008]**
(1) Helianthus tuberosus
(2) Helianthus annus
(3) Carthamus tinctorius
(4) Both B and C

Q.27 Raticide poisons are obtained from **[BHU 2008, JKCMEE 2010]**
(1) Scilla (2) Urginea
(3) Both A and B (4) Gloriosa

Q.28 Botanical names of Jower and Rice are respectively **[JIPMER 2004]**
(1) Oryza sativa and Pennisetum typhoides
(2) Sorghum vulgare and Oryza sativa
(3) Triticum aestivum and Pennisetum typhoides
(4) Oryza sativa and Sorghum vugare

Q.29 Floral formula of Brassicaceae (Mustard) is **[Kerala 2010]**
(1) $\oplus\ K_{2+2}\ C_{X\ 4}\ A_{2+4}\ \underline{G_{(2)}}$
(2) $K_5C_5\ A_{5+5}\underline{G_1}$
(3) $\oplus\ \underline{G_{(3)}}$
(4) $\oplus\ K_5\ \underline{G_{(2)}}$ .....

Q.30 Scientific name of Sunflower is **[WB 2009]**
(1) Brassica campestris
(2) Pisum sativum
(3) Helianthus annuus
(4) Gossypium herbaceum

Q.31 Pulses are obtained from **[MPPMT 2002]**
(1) Fabaceae (2) Asteraceae
(3) Poaceae (4) Solanaceae

Q.32 Indian Mustard or Rai is **[CPMT 2010]**
(1) Brassica juncea (2) Brassica nigra
(3) Brassica rapa (4) Brassica campestris

Q.33 $\oplus\ \underline{G_{(3)}}$ is floral formula of **[RPMT 2006]**
(1) Liliaceae (2) Brassicaceae
(3) Asteraceae (4) Poaceae

Q.34 Floral formula of family solanaceae is **[Bih. PMT 2006]**

(1) Br Ebral $\oplus$ K_5 $G_{(\underline{2})}$

(2) Br Ebrl $\oplus$ $K_{(5)}$ $C_{1+2+(2)}$ A_{5+5} $G_{\underline{1}}$

(3) Ebe Ebrl $\oplus$ K_4 $C_{X\ 4}$ A_{2+4} $G_{(\underline{2})}$

(4) None of the above

Q.35 Russian Millet, Digitaria, is grown in **[PMT 2000]**

(1) Bihar (2) Kerala

(3) Rajasthan (4) Meghalaya

Q.36 An oil seed crop is **[MPPMT 2004]**

(1) Paddy (2) Sunflower

(3) Chrysanthemum (4) Gram

Q.37 Lycopersicum esculentum belongs to family **[Pb. PMT 2000]**

(1) Brassicaceae (2) Solanaceae

(3) Liliaceae (4) Poaceae

Q.38 Red dye for dyeing silk is got from petals of **[JIPMER 2000]**

(1) Tagetes erecta

(2) Zinnia elegans

(3) Carthamus tinctorius

(4) Eclipta prostrata

Q.39 Scientific name of Ragi is **[HPPMT 2001]**

(1) Avena sativa

(2) Sorghum vulgare

(3) Eleusine coracana

(4) Pennisetum typhoides

Q.40 Belladona is obtained from **[MPPMT 2001]**

(1) Atropa (2) Hyoscyamus

(3) Calendula (4) Aconitum

Q.41 Name the plant from seeds of which oil is obtained **[MPPMT 2001]**

(1) Cicer arietinum

(2) Saccharum officinarum

(3) Saccharum munja

(4) Arachis hypogea

Q.42 Replum is characteristic of family **[Manipal 2001, BHU 2008]**

(1) Brassicaceae (2) Asteraceae

(3) Liliaceae (4) Solanaceae

Q.43 Tetradynamous condition occurs in family **[CBSE 2001]**

(1) Asteraceae (2) Solanaceae

(3) Brassicaceae (4) Liliaceae

Q.44 Gram belongs to family **[MPPMT 2001]**

(1) Papilionaceae (2) Asteraceae

(3) Poaceae (4) Solanaceae

Q.45 Compositee is also known as **[DPMT 2001]**

(1) Fabaceae (2) Asteraceae

(3) Poaceae (4) Solanaceae

Q.46 Four sepals arranged in two whorls is characteristic of family **[Manipal 2001, BHU 2002]**

(1) Solanaceae (2) Fabaceae

(3) Brassicaceae (4) Liliaceae

Q.47 Name the family having (9) + 1 arrangement of stamens **[AIIMS 2001]**

(1) Solanaceae (2) Asteraceae

(3) Liliaceae (4) Fabaceae

Q.48 The number of ovules present in ovary of Asteraceae is **[Tamil Nadu 2001]**

(1) 1 (2) 2

(3) 4 (4) Many

Q.49 Largest family of flowering plants is **[Tamil Nadu 2001]**

(1) Fabaceae (2) Liliaceae

(3) Poaceae (4) Asteraceae

Q.50 Diadelphous condition cocurs in **[CPMT 2004]**

(1) Solanaceae (2) Fabaceae

(3) Asteraceae (4) Liliaceae

Q.51 Chief features of family Brassicaceae / Cruciferae is presence of **[BHU 2002]**

(1) Latex (2) Pectin

(3) Alkaloids (4) Myrosin enzyme

Q.52 Oblique ovary is found in **[DPMT 2002]**

(1) Liliaceae (2) Solanaceae

(3) Asteraceae (4) Poaceae

Q.53 Flower of Fabaceae is **[JIPMER 2002]**

(1) Complete, zygomorphic, pentamerous

(2) Complete, actinomorphic, trimerous

(3) Inomplete, zygomorphic, trimerous

(4) Incomplete, actinomorphic, pentamerous

Q.54 Ovary having basal placentation is **[JIPMER 2002]**

(1) Monocarpellary bilocular
(2) Bicarpellary, syncarpous and unilocular
(3) Multicarpellary, syncarpous and unilocular
(4) Syncarpous with two or more carpels

Q.55 Most important character of Brassica compestris is **[RPMT 2002]**

(1) False septum
(2) Parietal placentation
(3) Ebracteate
(4) Imbricate aestivation

Q.56 Swollen placentae, oblique septum and conniving anthers are characteristics of family **[AMU 2002]**

(1) Brassicaceae (2) Asteraceae
(3) Poaceae (4) Solanaceae

Q.57 In fabaceae, one of the following immediately encloses the essential organs **[EAMCET 2002]**

(1) Anterrior petals (2) Posterior petal
(3) lateral petals (4) Sepals

Q.58 Which one of the following is oil seed **[AFMC 2003]**

(1) Marigold (2) Sunflower
(3) Rose (4) Hibiscus

Q.59 Plants which are used as green manure in crop fields and in sandy soil **[CBSE 2003]**

(1) Crotalaria juncea and Alhagi camelorum
(2) Calotropis procera and Phyllanthus niruri
(3) Saccharum munja and Lantana camara
(4) Dichanthium annulatum and Azolla nilotica

Q.60 Which of the following is correct with reference to flowers of family Solanaceae **[KCET 2003]**

(1) Pentamerous, actinomorphic, unisexual, hypogynous
(2) Pentamerous, zygomorphic, bisexual, epigynous
(3) Pentamerous, bisexual, actinomorphic, hypogynous
(4) Trimerous, actinomorphic, bisexual, hypogynous

Q.61 Bract of jower flower is called **[Wardha 2003]**

(1) Palea (2) Lemma
(3) Lodicule (4) Spikelet

Q.62 Flowers are exclusively bisexual in **[CMC 2003]**

(1) Cucurbits (2) Euphorbias
(3) Malvaceae (4) Asteraceae

Q.63 In Gramineae / Poaceae, the inflorescence is **[Orissa 2003]**

(1) Spikelet (2) Spadix
(3) Cyathium (4) Corymb

Q.64 Inflorescence of Compositae / Asteraceae is **[Orissa 2004]**

(1) Capitulum (2) Hypanthodium
(3) Umbel (4) Corymb

Q.65 Most diversified monocot family is **[Orissa 2004]**

(1) Liliaceae (2) Poaceae
(3) Orchidaceae (4) Palmae

Q.66 Green Gram is **[Orissa 2004]**

(1) Vigna radiata (2) Vigna mungo
(3) Phaseolus vulgaris (4) Phaseolus coccineus

Q.67 Oil found in Groundnut accumulates in **[JIPMER 2004]**

(1) Embryo (2) Cotyledons
(3) Endosperm (4) None of the above

Q.68 Trimerrous flower, superior ovary with axile placentation are characteristic of **[BHU 2005, 2008]**

(1) Liliaceae (2) Cucurbitaceae
(3) Solanaceae (4) Asteraceae

Q.69 Which of the following members of family solanaceae is rich in vitamin C? **[AFMC 2005]**

(1) Guava (2) Gooseberry
(3) Strawberry (4) Tomato

Q.70 Identify the family containing mustard and its main characteristics **[AIIMS 2005]**

(1) Brassicaceae – Pentamerous flowers, many stamens, pentacarpellary gynoecium, capsule fruit
(2) Solanaceae – Pentamerous flowers, five stamens, bicarpellary gynoecium, berry fruit
(3) Brassicaceae – Tetramerous flowers, six stamens, bicarpellary gynoecium, siliqua fruit
(4) Poaceae – Trimerous flowers, three stamens, monocarpellary gynoecium, caryopsis fruit

Q.71 Three crops that contribute maximum to global food production are **[CBSE 2005]**
(1) Wheat, Rice and Maize
(2) Wheat, Rice and Barley
(3) Wheat, Maize and Sorghum
(4) Rice, Maize and Sorghum

Q.72 Which is not the characteristic feature of fabaceae? **[Kerala 2005]**
(1) Taproot system, compound leaves, raceme inflorescence
(2) Flowers actinomorphic, aestivation twisted and gamopetalous
(3) Stamens 10, introrse, basifixed, bithecous
(4) Monocarpellary, ovary superior and bent stigma
(5) Fruit is legume

Q.73 Match the columns and find out correct combination **[Kerala 2005]**

Column I	**Column II**
(A) Hibiscus rosa – sinensis	(p) Poaceae
(B) Oryza sativa	(q) Malvaceae
(C) Tridax procumbans	(r) Fabaceae
(D) Crotalaria juncea	(s) Liliaceae
(E) Gloriosa superba	(t)Asteraceae

(1) (A)–(q),(B)–(t),(C)–(p),(D)–(s),(E)–(r)
(2) (A)–(t),(B)–(p),(C)–(s),(D)–(q),(E)–(r)
(3) (A)–(r),(B)–(s),(C)–(p),(D)–(t),(E)–(q)
(4) (A)–(s),(B)–(p),(C)–(q),(D)–(t),(E)–(r)

Q.74 Which is absent in Asteraceae? **[Kerala 2005]**
(1) Cypsela fruit
(2) Capitulum inflorescence
(3) Hypogynous flowers
(4) Syngenecious anthers
(5) Pappus calyx

Q.75 Match the columns : **[EAMCET 2005]**

Column I	**Column II**
(1) Solanaceae	(i) Launaea
(2) Malvaceae	(ii) Pongamia
(3) Fabaceae	(iii) Petunia
(4) Asteraceae	(iv) Withania
	(v) Thespepsia

(1) (1)–(iii),(2)–(iv),(3)–(i),(4)–(ii)
(2) (1)–(ii),(2)–(v),(3)–(i),(4)–(iv)
(3) (1)–(iv),(2)–(v),(3)–(ii),(4)–(i)
(4) (1)–(v),(2)–(ii),(3)–(iii),(4)–(iv)

Q.76 In solanaceae the fruit is **[CPMT 2005]**
(1) Drupe (2) Berry or Capsule
(3) Siliqua (4) Pod or achene

Q.77 Perianth occurs in family **[RPMT 2005]**
(1) Solanaceae (2) Fabaceae
(3) Brassicaceae (4) Liliaceae

Q.78 Plant used both as packing material as well excellent fodder is **[AMU 2005]**
(1) Medicago (2) Crotalaria
(3) Pongamia (4) All the above

Q.79 What type of placentation is seen in Sweeet Pea? **[CBSE 2006]**
(1) Marginal (2) Basal
(3) Axile (4) Free central

Q.80 Pentamerous actinomorphic flowers, bicarpellary ovary with oblique septum and a fruit of capsule or berry, belong to family [**CBSE 2006]**
(1) Liliaceae (2) Asteraceae
(3) Brassicaceae (4) Solanaceae

Q.81 Aloe used in medicine belongs to family **[Bih. PMT 2006]**
(1) Solanaceae (2) Liliaceae
(3) Asteraceae (4) Malvaceae

Q.82 Soyabeen belongs to **[Orissa 2006]**
(1) Fabaceae (2) Poaceae
(3) Solanaceae (4) Asteraceae

Q.83 Name the most advanced family of monocots **[Orissa 2006]**
(1) Arecaceae (2) Orchidaceae
(3) Poaceae (4) None of the above

Q.84 Leguminous plant used for prevention of Parkinson's syndrome is **[Orissa 2006]**
(1) Acacia catechu (2) Acacia arabica
(3) Abrus precatorius (4) Arabidopsis

Q.85 Which is not a feature of fabaceae **[Kerala 2007]**
(1) Corolla 5, polypetalous, anteriorlarge and outermost
(2) Descending imbricate, 10 stamens, diadelphous, ovary superior
(3) Sepals 5, gamosopalous, imbricate aestivation, placentation marginal
(4) Monocarpelley, ovary sperior, style long, slightly bent at the apex
(5) Zygomorphic flowers, diadelphous stamens, many ovules

Q.86 Select the wrong statement **[Kerala 2007]**
(1) Persistent calyx in Solanaceae
(2) Flowers are hypogynous in Asteraceae
(3) Santonin are obtained from Artemesia
(4) In Poaceae, perianth is represented by lodicules
(5) Parietal placentation occurs in Brassicaceae

Q.87 Most of economically important fibre yielding plants belong to family **[CPMT 2007]**
(1) Cruciferae (2) Poacece
(3) Solanaceae (4) Malvaceae

Q.88 The floral characters of liliaceae are **[Kerala 2008]**
(1) Six tepals, zygomorphic, six stamens, bilocular ovary, axile placentation
(2) Tetramerous, actinomorphic, polyphyllous, unilocular ovary, axile placentation
(3) Trimerous, actinomorphic, polyandrous, superior ovary, axile placentation
(4) Bisexual, zygomorphic, gamophyllous, inferior ovary, marginal placentation
(5) Unisexual, actinomorphic, trilocular, inferior ovary, axile placentation

Q.89 Which one is not characteristic feature of Asteraceae **[Kerala 2008]**
(a) Cypsela fruit
(b) Syngenesious stamens
(c) Ovary bicarpellary superior
(d) Plancentation marginal
(e) Head type inflorescence
(1) a, b only (2) c and e only
(3) e only (4) c and d only
(5) b, c and d only

Q.90 Match the columns **[Kerala 2008]**

Column I	**Column II**
(a) Artemesia species	(1) Insecticide
(b) Solidago species	(2) Santonin
(c) Eclipta alba	(3) Dropsy
(d) Chrysanthermum roseus	(4) Tonic in spleen enlargement

(1) a – 2, b – 3, c – 4, d – 1
(2) a – 1, b – 2, c – 3, d – 4
(3) a – 3, b – 4, c – 2, d – 1
(4) a – 4, b – 3, c – 2, d – 1
(5) a – 3, b – 1, c – 4, d – 2

Q.91 In floral formula, (K) denotes **[WB 2008]**
(1) Polysepalous (2) Gamosepalous
(3) Polypetalous (4) Gamopetalous

Q.92 Sorghum and Cotton are respectively useful for **[EAMCET 2008]**
(a) Blood purification and organic fertillzer
(b) Animal food and paper industry
(c) B vitamin and cosmetics
(d) Explosives and organic fertilizer
(1) a, b (2) c, d
(3) b, c (4) b, d

Q.93 Match the column **[EAMCET 2008]**

Colunm I	**Colunm II**
(a) Arachis	(1) Swollen placenta
(b) Cihorium	(2) Epicalyx
(c) Lilium tuberous root	(3) Fasciculate
(d) Physatis	(4) Geocarpy
	(5) Bulbils

(1) a – 4, b – 3, c – 2, d – 5
(2) a – 4, b – 1, c – 2, d – 3
(3) a – 5, b – 4, c – 3, d – 1
(4) a – 4, b – 3, c – 5, d – 1

Q.94 Major crop of Asia is **[BHU 2008]**
(1) Jower (2) Millet
(3) Rice (4) Sugarcane

Q.95 Bicarpelley syncarpous ovary with axile placentation is found in **[JKCMEE 2008]**
(1) Solanaceae (2) Asteraceae
(3) Malvaceae (4) Caesalpiniaceae

Q.96 Sunflower belongs to family **[DPMT 2009]**
(1) Liliaceae (2) Cruciferae
(3) Fabaceae (4) Asteraceae

Q.97 Brinjal, Potato, Tomato, Onion, Ginger belong to **[Orissa 2009]**
(1) A single family (2) Four genera
(3) Five genera (4) Same genus

Q.98 A member of lilaceae is **[AMU 2009]**
(1) Lupin (2) Petunia
(3) Tulip (4) Soyabean

Q.99 The characteristics of Poaceae are **[Kerala 2009]**

(1) Pedicellate, bracteate, bisexual, tetramerous, actinomorphic, complete and superior ovary

(2) Pedicellate, bracteate, bisexual, pentamerous, zygomorphic, complete and superior ovary

(3) Sessile, bracteate, bracteolate, incomplete uni- or bisexual, perianth modified into lodicules, stamens three, syncarpous, superior ovary and feathery stigma

(4) Bracteate, bracteolate, bisexual, pentamerous, actinomorphic, complete and superior ovary

(5) Bracteate, unisexual, actinomorphic, stamens five, inferior ovary.

Q.100 Which ones are not applicable to family solanaceae **[Kerala 2009]**

(a) Epipetalous and syngenesious

(b) Bicarpellary and syncarpous ovary

(c) Oblique ovary with axile placentation

(d) Stamens six, arranged in two whorls

(e) Bicarpelley, syncarpous and inferior ovary

(1) b and c only (2) a, d, e only

(3) a and c only (4) b, d, e only

(5) c, d, e only

Q.101 Scientific name of Sunn Hemp is **[Kerala 2009]**

(1) Crotalaria juncea (2) Erythrina indica

(3) Arachis hypogea (4) Glycine max

(5) Dalbergia sisso

Q.102 Match the column **[Kerala 2009]**

Column I	**Column II**
1. Artemesia	(a) Fibre
2. Astragalus	(b) Insecticide
3. Phormium	(c) Rat poison
4. Chrysanthemum	(d) Medicine
5. Withania	(e) Vermifuge
	(f) Gum

(1) 1 – d, 2 – c, 3 – f, 4 – b, 5 – e

(2) 1 – b, 2 – e, 3 – d, 4 – c, 5 – a

(3) 1 – c, 2 – e, 3 – a, 4 – f, 5 – d

(4) 1 – e, 2 – f, 3 – a, 4 – b, 5 – d

(5) 1 – f, 2 – e, 3 – a, 4 – b, 5 – d

Q.103 Floral formula $\oplus$ $K_{(5)}$ $\underline{G}_{(2)}$ is that of **[CBSE 2009]**

(1) Soyabean (2) Tobacco

(3) Tulip (4) Sunn Hemp

Q.104 A plant with actinomorphic and hypogynous flowers, heterochlamydeous perianth dorsified and extrose anthers dehiscing transversely belongs to **[EAMCET 2009]**

(1) Coronariae (2) Thalamiflorae

(3) Bicarpellatae (4) Calyciflorae.

Q.105 Zygomorphic condition is represented as **[CPMT 2009]**

(1) $\oplus$ (2) %

(3) P (4) G

Q.106 Lady's Finger / Okra belongs to family **[CPMT 2009]**

(1) Malvaceae (2) Liliaceae

(3) Brassicaceae (4) Cucurbitaceae

Q.107 Cotton fibre is obtained from **[CPMT 2010]**

(1) Seed coat (2) Stem

(3) Leaves (4) Root

Q.108 Colchicine is obtained from Colchicum autumanle. It belongs to family **[CPMT 2010]**

(1) Liliaceae (2) Solanaceae

(3) Leguminoceae (4) Poaceae

Q.109 Petunia, Datura and Nicotiana belong to family **[CPMT 2010]**

(1) Leguminoceae (2) Poaceae

(3) Solanaceae (4) Liliaceae

Q.110 Which of the following is not correctly paired **[AMU 2010)]**

(1) Fabaceae – Legume family

(2) Liliaceae – Sunflower family

(3) Solanaceae – Potato family

(4) Brassicaeae – Mustard family

Q.111 Select the correct match from the following **[Orissa 2010]**

(1) Malvaceae – Legume family

(2) Liliaceae – Sunflower family

(3) Caesalpiniaceae – Catechu

(4) Solanaceae – Potato family

Q.112 Which family is characteristic representative of monocotyledonous plants? **[HPPMT 2010]**

(1) Liliaceae (2) Solanaceae

(3) Fabaceae (4) Brassicaceae

Q.113 Consider the following four statements a, b, c and d and select the right option for two correct statements. **[CBSE Main 2010]**

(a) In vexillary aestivation, the large posterior petal is called standard, two lateral wings and two samll anterior keel.

(b) Floral formula of liliaceae is $\oplus\ P_{3+3}\ A_{3}\ +3\ \underline{G_{(3)}}$

(c) In Pea flower the stanens are monadelphous

(d) Floral formula of solanaceae is $\oplus\ K_{(5)}\ C_{(3)}\ A_{(4)}\ \underline{G_{(2)}}$

Correct statements are.

(1) a and c (2) a and b

(3) b and c (4) c and d

ANSWER KEY

EXERCISE – 3

Q.1	**1**	**Q.2**	**2**	**Q.3**	**2**	**Q.4**	**4**	**Q.5**	**4**	**Q.6**	**2**	**Q.7**	**3**
Q.8	**2**	**Q.9**	**2**	**Q.10**	**2**	**Q.11**	**3**	**Q.12**	**4**	**Q.13**	**4**	**Q.14**	**1**
Q.15	**2**	**Q.16**	**2**	**Q.17**	**1**	**Q.18**	**4**	**Q.19**	**2**	**Q.20**	**3**	**Q.21**	**4**
Q.22	**4**	**Q.23**	**4**	**Q.24**	**3**	**Q.25**	**1**	**Q.26**	**4**	**Q.27**	**3**	**Q.28**	**2**
Q.29	**1**	**Q.30**	**3**	**Q.31**	**1**	**Q.32**	**1**	**Q.33**	**1**	**Q.34**	**1**	**Q.35**	**4**
Q.36	**2**	**Q.37**	**2**	**Q.38**	**3**	**Q.39**	**3**	**Q.40**	**1**	**Q.41**	**4**	**Q.42**	**1**
Q.43	**3**	**Q.44**	**1**	**Q.45**	**2**	**Q.46**	**3**	**Q.47**	**4**	**Q.48**	**1**	**Q.49**	**4**
Q.50	**2**	**Q.51**	**4**	**Q.52**	**2**	**Q.53**	**1**	**Q.54**	**2**	**Q.55**	**2**	**Q.56**	**4**
Q.57	**1**	**Q.58**	**2**	**Q.59**	**1**	**Q.60**	**3**	**Q.61**	**2**	**Q.62**	**3**	**Q.63**	**3**
Q.64	**1**	**Q.65**	**3**	**Q.66**	**1**	**Q.67**	**2**	**Q.68**	**1**	**Q.69**	**4**	**Q.70**	**3**
Q.71	**1**	**Q.72**	**2**	**Q.73**	**4**	**Q.74**	**3**	**Q.75**	**3**	**Q.76**	**2**	**Q.77**	**4**
Q.78	**1**	**Q.79**	**1**	**Q.80**	**4**	**Q.81**	**2**	**Q.82**	**1**	**Q.83**	**3**	**Q.84**	**3**
Q.85	**1**	**Q.86**	**2**	**Q.87**	**4**	**Q.88**	**3**	**Q.89**	**4**	**Q.90**	**1**	**Q.91**	**2**
Q.92	**3**	**Q.93**	**4**	**Q.94**	**3**	**Q.95**	**1**	**Q.96**	**4**	**Q.97**	**2**	**Q.98**	**3**
Q.99	**3**	**Q.100**	**2**	**Q.101**	**1**	**Q.102**	**4**	**Q.103**	**2**	**Q.104**	**2**	**Q.105**	**2**
Q.106	**1**	**Q.107**	**1**	**Q.108**	**1**	**Q.109**	**3**	**Q.110**	**2**	**Q.111**	**4**	**Q.112**	**1**
Q.113	**2**												

Q.1 'Genera Plantarum' was written by
(1) Hutchinson (2) Bessey
(3) Bentham and Hooker
(4) Eichler

Q.2 In phylogenetic classification, the groups are arranged
(1) Following the evolutionary trends
(2) According to floral similarities
(3) According to their morphological characters
(4) According to their complexities

Q.3 "Ordines Anomali" of Bentham and Hooker includes
(1) Seed plants showing abnormal forms of growth and development
(2) Plants described only in fossil state
(3) Plants described in the literature but which Bentham and Hooker did not see in original
(4) A few orders which could not be placed satisfactorily in the classification

Q.4 Megasporophyll of Cyeas has the same nature as
(1) Stamen (2) Petal
(3) Sepal (4) Carpel

Q.5 Parkinsonia is a good example of
(1) Winged fruit (2) Phyllode
(3) Parachute mechanism
(4) Phylloclade

Q.6 Inflorescence, which begins as a dichasial cyme and ends in a monochasial cyme, is called
(1) Cyathium (2) Biparous
(3) Verticillaster (4) Thyrsus

Q.7 Velamen is found in
(1) Viseum (2) Vanda
(3) Santalum (4) Rosa

Q.8 The 3 sub-families of leguminosae are distinguished mainly on the basis of
(1) Nature and habit of the plants
(2) Nature of gynoecium
(3) Nature of fruit and its germination
(4) Inflorescence and flower characters

Q.9 In Gloriosa, the tendrillar part is formed by
(1) Leaf petiole (2) Stipule
(3) Axillary bud (4) Leaf apex

Q.10 When ovules are developed from the inner wall of the unilocular ovary, the placentation is called
(1) Marginal (2) Parietal
(3) Superficial (4) Basal

Q.11 Which of the following is the largest and edible bud?
(1) Cabbage (2) Onion
(3) Cauliflower (4) Agave

Q.12 An insectivorous plant having glandular structures on its leaf, secreting stickly fluid is
(1) Sundew plant (2) Aldrovanda
(3) Venus fly trap (4) All of these

Q.13 The plants in desert, in order to tolerate water stress, have
(1) Stipular spines
(2) No stomata
(3) Stems which are converted into leaf type
(4) Long root system reach the water level

Q.14 Potato is included in Solanaceae family because
(1) It is epipetalous
(2) It is pentamerous
(3) Ovary is slightly diverted from its position
(4) All of these

Q.15 The part of cauliflower that we eat is
(1) Stem (2) Leaf
(3) Flower (4) Inflorescence

Q.16 A plant has a butterfly shaped flower with one standard, two wing like and two keel petals. The plant belongs to the family
(1) Papilionaceae (2) Compositae
(3) Malvaceae (4) Rubiaceae

Q.17 Velamen is a specialtzed tissue found in
(1) Aerial roots of Orchids
(2) Succulent leaves
(3) Pneumatophores (4) Stilt roots

Q.18 Which floral family has (9) + 1 arrangement of anthers in the androecium?
(1) Malvaceae (2) Rutaceae
(3) Fabaceae (4) Caesalpiniaceae

Q.19 Clove is a part of
(1) Flower (2) Thalamus of a flower
(3) Axillary bud (4) Seed

Q.20 Coconut's Husk fibre i.e. coir of commerce is extracted from
(1) Epicarp (2) Mesocarp
(3) Endocarp (4) Seed coat

Q.21 When the filament runs along the back of anther, it is called
(1) Adnate (2) Longitudinal
(3) Versatile (4) Syngenesious

Q.22 The family containing mustard is and its main characters are
(1) Brassicaceae - Tetramerous flowers, six stamens, bicarpellary gynoecium, siliqua type fruit
(2) Brassicaceae - Pentamerous flowers, many stamens, pentacarpellary gynoecium, capsule type fruit
(3) Solanaceae - Pentamerous flowers, five stamens, bicarpellary gynoecium, berry type fruit
(4) Poaceae - Trimerous flowers, three stamens, monocarpellary gynoecium, caryopsis type of fruit

Instructions : In the following questions (23 to 25), a statement of assertion (A) is followed by a statement of reason (R).

(1) If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark (1).

(2) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark (2).

(3) If Assertion is true statement bblt Reason is false, then mark (3).

(4) If both Assertion and Reason are false statements, then mark (4).

Q.23 **A :** Systematics is the branch of biology that deals with classificatio,n of living organism.
R : The aim of classification is to group the organisms in an orderly manner.

Q.24 **A :** The two cotyledons in the seed are the embryonic leaves.
R : The embryo contains radicle and plumule.

Q.25 **A :** Ginger has a prostrate rhizome.
R : Shoot growth is not effected by gravity.

Q.26 **A :** Compositae is the largest family of angiosperm.
R : The fruit of this family is cypsella.

Q.27 **A :** The fruit of cucurbitaceae are bitter in teste.
R : It is due to presence of tetracyclic triterpens Cucerbitacine.

Q.28 **A :** Colchicine is known as mitotic poision.
R : Colchicine is obtained from liliaceae.

Q.29 **A :** Glumes are found in the infloroscence of graminae.
R : Glumes are the modification of bracts.

Q.30 **A :** Ringing experiment can not be performed in members of cucurbitaceae.
R : The vascular bundles are bicolateral.

Q.31 **A :** Synandrous stamens are found in cucurbitanceae.
R : Stamens are fused through out their length.

Q.32 **A :** Tetradynamous stamens are found in cruciferae.
R : The outer four stamens are longers and inner two are smaller.

Q.33 **A :** Ratti is known as jweller's weight.
R : It is related with leguminoceae.

Q.34 **A :** Epicalyx are related to cruciferae.
R : These are the modification of stamens.

Q.35 **A :** Sterile stamens are found in mimosoidae.
R : Amaltas is the member of mimosoidae.

Q.36 **A :** Cruciferae is named on the basis of there corolla.
R : 4 petals are arranged in cruciferae manner.

Q.37 **A :** Versatile stamens are the characterstic feature of graminae.
R : In grases, versatile anther is the characterstic of anemophilous flowers.

Q.38 **A :** Axile placentation is found in liliaceae.
R : Incomplete flowers are found in liliaceae.

Q.39 **A :** Leguminoceae is classified into three sub familes on th basis of corolla and androdcium.
R : Monoadelphous stamens are found in paplionatae.

Q.40 **A :** Butea monosperma is known as 'flame of the forest'.
R : Dark red colour fruits are found in Butea monosperma.

Q.41 **A :** Allium sativum (Garlic) is beneficial edible material for heart patient.
R : The essential oil of Garlic reduces the amount of cholestrol in blood.

Q.42 **A :** Caryopsis is the characterstic fruit of graminae.
R : Legumes are the chief source of food in the world.

Q.43 **A :** Oblique ovary is found in solanaceae.
R : Oblique ovary in solanaceae is due to rotation of posterior towards right side and antirial carpal towares left side.

Q.44 **A :** Pulses are the goods source of protein.
R : It is due to presence of root nodules in pulses.

Q.45 **A :** Graminae is the largest family of Indian flora.
R : Most of the food is obtained from the members of graminae.

Q.46 **A :** Coriender is the member of Umbelliferae.
R : Umbel infloroscence is found in.

Q.47 **A :** The flower of candytuft is zygomorphic.
R : The anterior petal of candytuft are unequal.

Q.48 **A :** The flower of paplionatae are zygomorphic.
R : The petals are butterfly shaped and unequal.

Q.49 **A :** Syngenecious stamens are found in compositae.
R : Filament are free but anthers are united.

Q.50 **A :** Trimerous flowers are found in solaneceae.
R : All the floral parts are arranged in three whorals.

Q.51 **A :** Persistant style is the characterstic feature of anemophilous flower.
R : Persistant style is found in family graminae.

Q.52 **A :** The bracts of graminae are represented by awm shaped lemma.
R : Bractoles of graminae are represented by palea.

Q.53 **A :** The ovary of cruciferae is bilocular.
R : A true septum divides the ovary into two locules.

Q.54 **A :** Reduced parienth are known as lodecules.
R : Lodecules are found in member of graminae.

Q.55 **A :** The ovary of cucurbitaceae is unilocular but appear as trilocular.
R : Placenta are embedded into ovary appearing it as trilocular.

Q.56 **A :** The classification of Bentham and hooker is not phyolgenetic.
R : Bentham and Hooker could not explain the evolution theory of darvin.

Q.57 **A :** The generic and specific epithet are similar in tautonyms.
R : Tautonyms are not accepted in botanical nomenclature.

Q.58 **A :** Angiosperms are classified on the basic of floral characters.
R : Floral characters are more conservative than vegetative character.

Q.59 **A :** The venation of leaves the basis of the classification of angiosperms.
R : Reticulate venation is the characterstic feature of dicots.

Q.60 **A :** According to Bentham & Hooker, superior ovary is more advanced in polypetalae.
R : Inferior ovary is found in gamopetalae.

Q.61 **A :** Touch me not is the menber of mimosoidae.
R : Four stames are found in Touch me.

Q.62 **A :** Most of the plants of cucurbitaceae are monoecious.
R : Cucurbitaceae is the family of dicot.

Q.63 **A :** In didynamous the outer two stamens are large and inner to are small.
R : Six stamens are found in didynamous condition.

Q.64 **A :** The members of malvaceae and compositae are fiber and oil yielding.
R : The members of malvaceae and compositae are herbs.

Q.65 **A :** Head infloroscence is found in compositae.
R : Compositae is the family of dicot.

Q.66 **A :** Head is the most advanced infloroscence.
R : All the flowrs are so compact to each other that can be easily pollinated.

Q.67 **A :** Bentham and Hooker kept the gymnosperm in between monocot and dicot.
R : Gymnosperm is the most advaced family of dicot.

Q.68 **A :** Linnaeus classification is also known as sexual classification.
R : Linnaeus classification is based on the character of stamen.

Q.69 **A :** Royal Botanical Garden is the largest herbarium of the world.
R : It is classified on the basis of Bentham-Hooker system.

Q.70 **A :** Systematics involves classification of living organism.
R : The aim of classification is the systematics arrangement of organism.

ANSWER KEY

EXERCISE – 4

Q.1	3	Q.2	1	Q.3	4	Q.4	4	Q.5	2	Q.6	3	Q.7	2
Q.8	4	Q.9	4	Q.10	2	Q.11	1	Q.12	1	Q.13	4	Q.14	4
Q.15	4	Q.16	1	Q.17	1	Q.18	3	Q.19	1	Q.20	2	Q.21	1
Q.22	1	Q.23	2	Q.24	2	Q.25	3	Q.26	1	Q.27	2	Q.28	2
Q.29	1	Q.30	2	Q.31	1	Q.32	3	Q.33	2	Q.34	4	Q.35	4
Q.36	1	Q.37	1	Q.38	2	Q.39	3	Q.40	3	Q.41	1	Q.42	3
Q.43	1	Q.44	1	Q.45	2	Q.46	1	Q.47	1	Q.48	1	Q.49	1
Q.50	4	Q.51	2	Q.52	2	Q.53	3	Q.54	2	Q.55	1	Q.56	3
Q.57	1	Q.58	1	Q.59	2	Q.60	4						

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

ANATOMY OF FLOWERING PLANTS

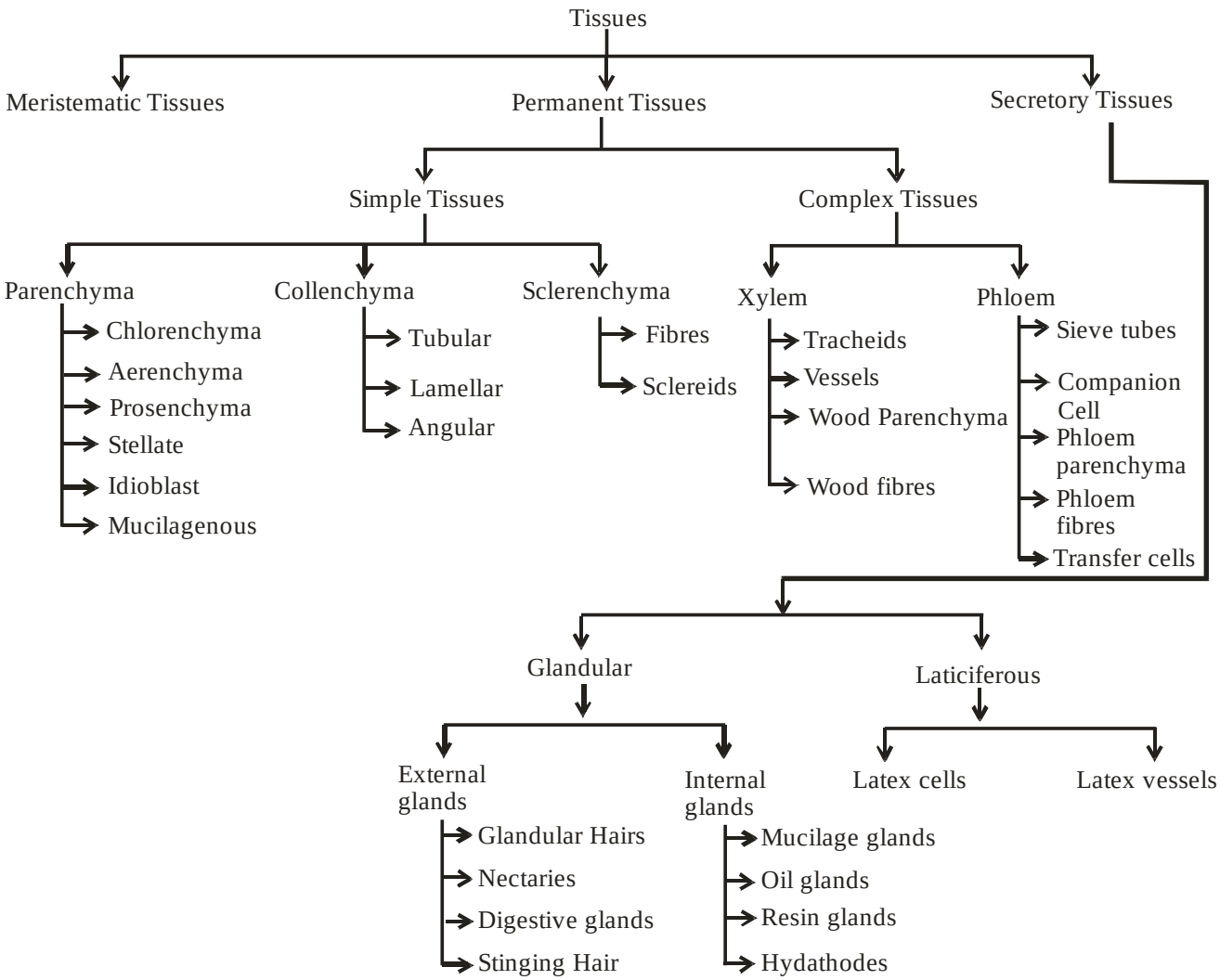
PRIMARY STRUCTURE OF PLANTS

PLANT ANATOMY

- It is the branch of Botany which deals with study of internal structures and organization of plants by the section cutting is called **Plant anatomy.**
- Anatomy is a Greek Word. Ana → asunder & temnein → to cut. Plant anatomy is also called as **Internal Morphology**.
- **N.Grew** is known as father of plant anatomy.
- **K.A. Chaudhary** is known as father of Indian plant Anatomy.
-

PLANT TISSUE

- An organized group of cells which is having similar or dissimilar in shape, having a common origin and usually performing a common function is called **tissue.**
- The term tissue was coined by **Nehemiah Grew.**



1. MERISTEMATIC TISSUE –

- Term given by Nageli.
- **Meristem :** Growth in plants is largely restricted to specialised regions of active cell division called meristerm./A meristem is a localized region in which actual cell division occurs.

A. Characteristics of meristematic tissues –

- It is an **undifferentiated tissue.**
- Cell cycle of meristem is in **continuous** state of division. It means they have the capacity to divide. So meristematic tissue is composed of **immature cells.**
- Meristematic cells have only primary cell wall which is thin and flexible (elastic) and made up of cellulose. Secondary cell wall is absent.
- Cells of meristem are small and isodiametric.
- They have **dense cytoplasm.**
- **Normally vacuoles are absent in meristematic cells but if present then small.**
- They have **prominent** and large nucleus.
- Meristematic cells are **metabolically** highly active so lack of reserve food occur in these cells.
- **Plastids** are **absent** in meristems. If they are present, then only in the **proplastid stage** ER is poorly developed.
- They do not have **intercellular** spaces. Cells are closely fitted (Packed) together. So it is a **compact tissue**.

B. Classification of meristematic tissue –

- **Meristematic tissue based on origin and development –**

  On the basis of origin and development meristems can be divided into following three types :

(i) Promeristem/Embryonic Meristem/Primordial Meristem :

- This meristem develops in begining during embryonic stage.
- They divide and give rise to primary meristem.

(ii) Primary meristem :

- Meristematic cell developed from promeristem are known as **primary meristem.**
- These cells are always in division phase and form primary permanent tissue.
- They are present below the promeristem at shoot and root apices, at the apex of leaves and in intercalary parts.

(iii) Secondary meristem :

- These are the meristems developed from primary permanent tissues. They are not present in the embryonic stage of the plant. These are present in mature region of root and stem of many plants particularly those that produce woody axis.
- Some of the cells of primary permanent tissues become meristematic and constitute secondary meristem.
- By the activity of secondary meristems, **secondary growth** takes place.
- Cork cambium, Interfascicular cambium & root cambium are excellent examples of secondary meristems.

  Note : Formation of meristem from any permanent tissue is called **dedifferentiation.**

  or

  Formation of undifferentiated tissue from differentiated tissues is called **dedifferentiation.**

- Promeristem $\longrightarrow$ Primary meristem $\longrightarrow$ Permanent tissue

  $\downarrow$

  Secondary meristem

- **Meristematic tissues based on location (position) in plant body –**
  On the basis of position, meristematic tissues are divided into three types :

(i) Apical Meristem :

- The meristems which occur at the tips of roots and shoots and produce primary tissues are called apical meristems. They are responsible for increase in the length of plant organs. Example : **Root apex, Shoot apex.** They are responsible for primary growth.

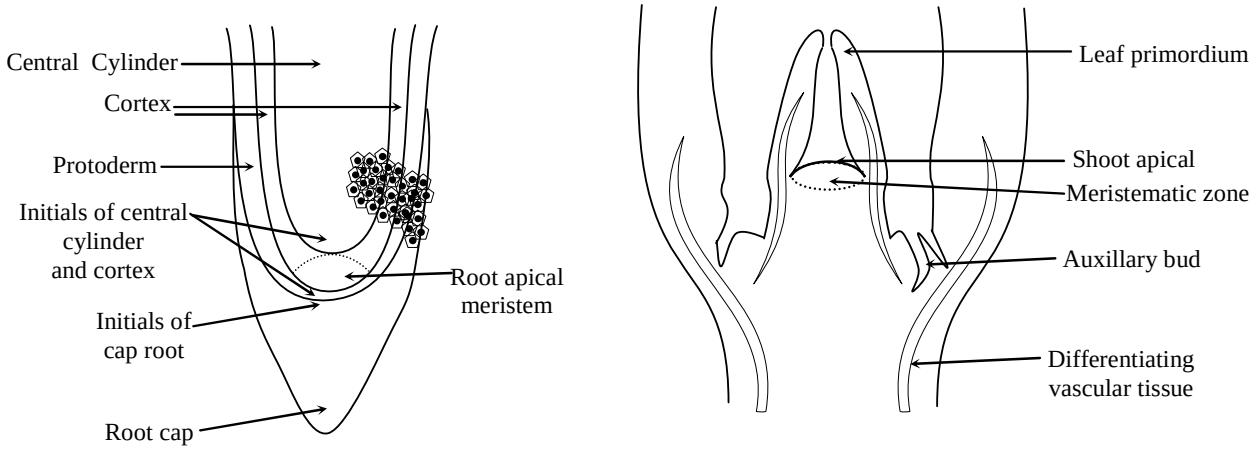


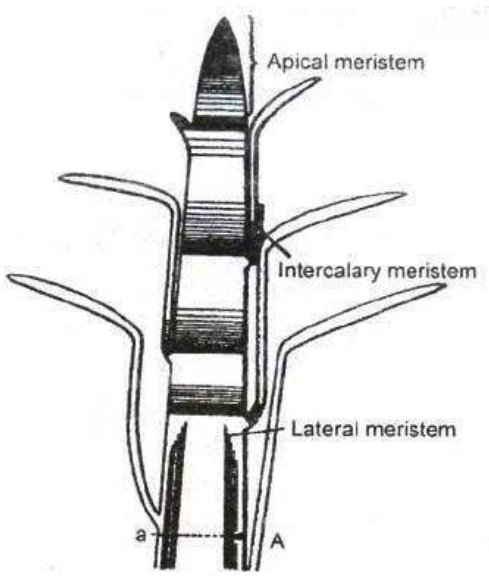
Fig.: Apical Meristem : (A) Root (B) Shoot

- Apical meristem has two regions at embryonic stage :
- **First – Promeristem** or **Primordial Meristem –** Which develops in embryonic stage.
  Second – Eumeristem – It is formed from the division of primordial meristem.

- During elongation of leaves and elongation of stem, some cells left behind, they form auxillary bud and from new branches.

(ii) Intercalary Meristem :

- The meristem which occurs between mature tissues.
- This is the separated region of apical meristem. This meristem is found between plant organs.
- By the activity of this meristem length of the plant organs increases.
- They are present in some plants stem.
- They may be present either at the base of internode e.g., grasses, bamboo and Equisetum etc. or at the base of node e.g., **Mint.** They are also present at the base of leaves e.g., **Pinus.** By the activity of this meristem, **length** of leaves increases. They are responsible for regeneration of parts removed by grazing herbivores in grasses.



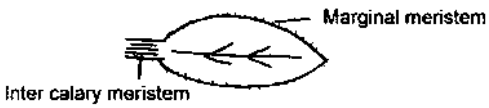
Note : They are short lived and convert into permanent tissue.

Both apical meristem & intercalary meristems are primary meristem because they appear early in the life of a plant and contribute to the formation of primary plant body.

(iii) Lateral Meristem :

- Lateral meristem occurs in **lateral side** of plant organs or parallel to the **longitudinal axis** (Tangential plane) of plant organs.
- Activity of lateral meristem increases the **girth of plant** organ, so it is **responsible** for **secondary growth.**
- Lateral meristems are both primary and secondary in origin **(mostly secondary in origin).** There are two examples of **primary lateral meristem.**

1. **Marginal meristem :-** It occurs at the margin of leaf. Its activity increases the **width** of leaf so total growth of leaf is called **intercalary marginal growth.**



2. **Intra fascicular cambium or fascicular cambium :-** This cambium occurs inside the vascular bundle of the stem. Except intra fascicular cambium all cambia are secondary in origin.

C. Classification based on plane of division –

(i) Rib-Meristem/File Meristem :

- Meristem in which anticlinal division occurs in **one plane**. For example, **tunica** is a type of rib-meristem. Formation of some cells of **cortex** and **pith** takes place by this meristem.

(ii) Plate-Meristem :

- Meristem which divides anticlinally into **two plane** at right angle to each other. By this division a plate like structure is formed. Formation of leaf blade takes place by the activity of this meristem.

(iii) Mass-Meristem :

- Meristem which divides in **all possible planes** resulting in the increase in the volume of plant body (organ). **Example :** The formation of embryo and endosperm takes place by this kind of meristem.

On the basis of function –

(i) On the basis of function, **Haberlandt** divided meristem into three group.

(a) Protoderm :- It is the outer most layer of eumeristem. By the activity of protoderm **epidermal tissue system** is formed. It includes Epidermis, Root hair, Stem hair etc.

(b) Procambium : These cells are long and it gives rise to the **vascular tissue system.** It includes Xylem and phloem.

(c) Ground Meristem : The cells of this region are large, thin walled and **isodiametric. Ground tissue system** is formed by the acitivity of these cells. It includes hypodermis, cortex, endodermis, pericycle, pith-rays and pith.

(ii) Apical shoot meristem is terminal in position while root apical meristem is sub terminal in position.

D. Composition of apical meristem in different plants –

- **Apical meristem** is **absent** in lower **Algae** and **Fungi.** All the cells of these plants are divisible, So they do not show apical growth. Thus such type of growth in these plants is called diffused growth.
- Apical meristem in higher algae (eg., *Fucus, Dictyota & Sargassum*), Bryophytes and Some Pteridophytes (eg., *Selaginella*) is consist of **single cell.** This cell is known as **apical cell.**
- Apical meristem in **Ferns, Gymnosperms** and **Angiosperms** consist of **many cells.**

2. THEORIES RELATED TO SHOOT AND ROOT APEX ORGANISATION –

A. Apical cell theory –

- This theory proposed by **Karl Nageli** and **Hofmeister** and supported by **wolff.**
- According to Nageli and Hofmeister, the apical meristem is composed of single apical cell. This view is only applicable on Bryophytes and some Pteridophytes and some higher algae (*Fucus, Dictyota* & *Sargassum*).

Fig.: Apical Cell

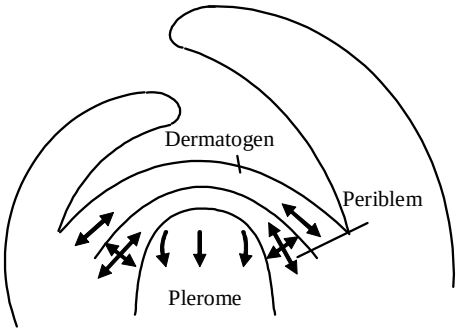
B. Histogen theory –

- It was proposed by **Hanstein (1870).** According to him, the root and shoot apices are distinguished into three meristematic regions or three layers of histogen cells. These are as follows-

(a) Dermatogen : This is the outermost single layer of cells. These cells form **uniseriate epidermis** by anticlinal division.

(b) Periblem : This region is situated just below the dermatogen. It forms cortex **(Hypodermis, General cortex** and **endodermis).**

(c) Plerome : This is the innermost region. Stele formation takes place by division of these cells. It means formation of **pericycle, vascular bundles, pith rays or medullary rays** and **pith.**



Organization of shoot apex proposed by Hanstein

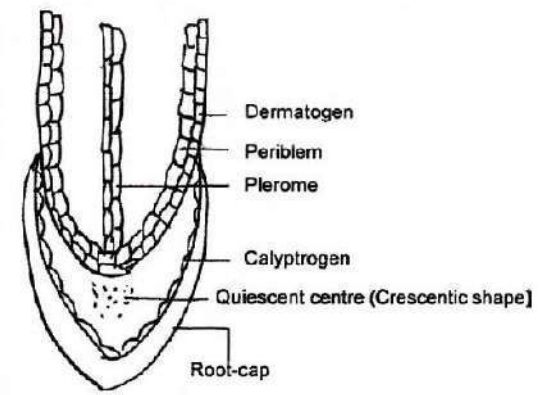
- This theory is only true for root apex. It is not applicable for shoot apex of higher plants because in most of the gymnosperms and angiosperms, shoot apex does not have distinct differentiation of three layers.
- Except above described three histogens, a fourth type of histogen is also present in **monocotyledon root apex.** This is known as **Calyptrogen.** Root cap is produced by Calyptrogen in monocots. Root cap is produced by dermatogen in dicotyledons.
  Exception : There is only **one histogen** present in **Ranunculus. Two** histogens occurs in **Casuarina.**
- Due to presence of root cap position of **root apex is sub terminal.** So maximum growth in root takes place **behind the apex.**

Note :

1. In hydrophytes root cap is absent.
2. Generally root cap is single layered but in ***Pandanus*** (Screw pine) root cap is multilayered.
3. Root cap contains large number of Golgibody which secrete mucilage which make the root slimy.

QUIESCENT CENTRE

- A group of inactive or less active cells present **between the dermatogen** and **calyptrogen** is called **quiescent centre.** These cells contain **less amount of DNA, light cytoplasm, small nuclei** and **synthesis of protein is also less.** Quiescent centre name coined by **"Clowes ".** Quiescent centre was discovered in **Maize root** with the help of **autoradiography.**
- If calyptrogen get damaged, this zone becomes active to form new cells of calyptrogen.
  Note : The quiescent centre in the root meristem serves as a reserve for replenishment of damaged cells of the meristem.



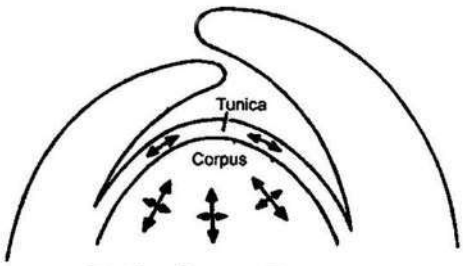
Histogen theory - Organization of root apex

C. Tunica corpus theory –

This theory was proposed by **Schmidt (1924).** This theory is **applicable on shoot apex.** According to this theory **two** types of layeres are found in the shoot apex.

(a) Tunica :

- This is peripheral layer, **epidermis** is formed by this layer. In tunica cells, **anticlinal division** takes place only in one plane.
- Anticlinal division occurs at right angle to longitudinal axis (tangential plane) of cell.
- When division occurs in single anticlinal plane they do not increase the number of layers.
- Generally, tunica is **single** layered, but some times it is multilayered, then the outer most layer forms the epidermis and remaining layers form rest types of the tissue system with the association of corpus.



Tunica Corpus Theory
Organisation of shoot apex

(b) Corpus : The mass of cells present below the tunica is called **Corpus.** The cells of this zone divide in all direction (many planes) due to which, **volume** increases. The cell of corpus usually larger than the cells of tunica. It forms rest of the tissue system.

D. Korper-kappe theory –

- It was proposed by **Schuepp (1917).** According to this theory, the cells of central and peripheral part of the root apex exhibit differences in planes of cell divisions.
- In peripheral region each cell first divides transversely and there after the lower daughter cell divides longitudinally thus forming the shape of 'T'. Such divisions are called the Kappe divisions. In the central region T is inverted (⊥) as the second division takes place in the upper daughter cell. Such divisions are called the Korper divisions. As a result of these 'T' or '⊥' divisions, the cells in root apex remain arranged in rows.
- Korper form the body of organism while Kappe form the covering or cap.
- By Kappe divisions, the number of row increases downwardly and by Korper divisions upwardly.

3. PERMANENT TISSUES

- Permanent tissues are composed of cells which have lost the power of division temporarily or permanently. They are formed by division and differentiation of meristematic tissues.
- They are present either in permanent G_0 stage or in arrested G_1 stage.
- Their cells may be **living** or **dead.**

4. SIMPLE TISSUES

- These tissues are **made up of similar type of cells** that perform a common function and have common origin. Simple tissues are of three types :-

  (A) Parenchyma (B) Collenchyma (C) Sclerenchyma

(A) Parenchyma :

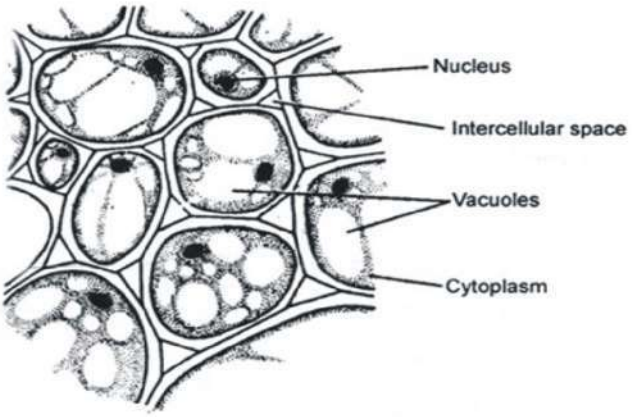
It is very primitive type of tissue. It is first evolved tissue. Remaining all different type of tissues are derived from this tissue. So it is also called as fundamental tissue.

Parenchyma name coined by **Grew.**

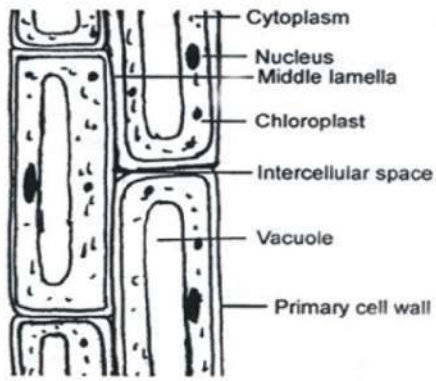
- **Characteristic Features :**

– It is a living tissue.

- Tissue first to be differentiated from meristem is parenchyma.
- It is a universal tissue and a major component of internal plant organs.
- Body of Bryophyte is mainly composed of parenchyma.
- All the cells of parenchyma are thin walled. Cell wall is made up of pectocellulose. **(Mainly cellulose).** So parenchyma is a soft tissue.
- Each cell containing large central vacuole.
- Inter cellular spaces are present between cells of this tissue, it is a loose tissue. Intercellular spaces are **schizogenous** in origin.
- The cells are **isodiametric.** Flesh of a fruit is mainly composed of parenchyma.



T.S. of Parenchyma



L.S. of Parenchyma

- **Shape :**

  The cells of parenchyma are spherical, oval or polygonal in shape. Each parenchymatous cell contains 14 planes of lateral line, which are maximum possible plane in a cell. These are known as **tetrakaidecahedron.**

- **Modification of Parenchyma :**

  (a) Prosenchyma : The cells of this parenchyma are long with pointed ends. This parenchyma forms the **Pericycle of roots.**

  (b) Aerenchyma : This parenchyma is made up of **rounded** cells. These cells surround the large **air chambers.** Air chambers are lysigenous in origin. It is found in cortex region. It provides **buoyancy** to **hydrophyte** plants.

  (c) Stellate parenchyma : The cells of this tissue are stellate and branched. Air spaces are also present but they are less developed. Main function of this parenchyma is to provide **mechanical support.**
  It is found in the leaf bases of **banana** and **canna.** It provides strength to leaf bases.

  (d) Chlorenchyma : Such type of parenchyma in which abundant quantity of chloroplasts are found. Two types of chlorenchyma are present in dorsiventral leaves :-

  (i) Palisade tissues :- Inter cellular spaces are absent. Their cells are tightly fitted together. They are present towards adaxial/ventral/upper side of leaf. Numbers of chloroplasts are more in palisade tissue as compare to spongy tissue. So upper surface of a leaf appears more green as compared to lower surface.

  (ii) Spongy tissues :- Large intercellular spaces are present. So they facilitate transpiration and gaseous exchange. They are present towards abaxial/dorsal/lower side of leaf.

  (e) Mucilage Parenchyma : In the mucilage parenchyma **large vacuoles** and Mucilage will be found. eg., Succulent xerophytic plants. e.g., ***Aloe.*** Function –storage of water.

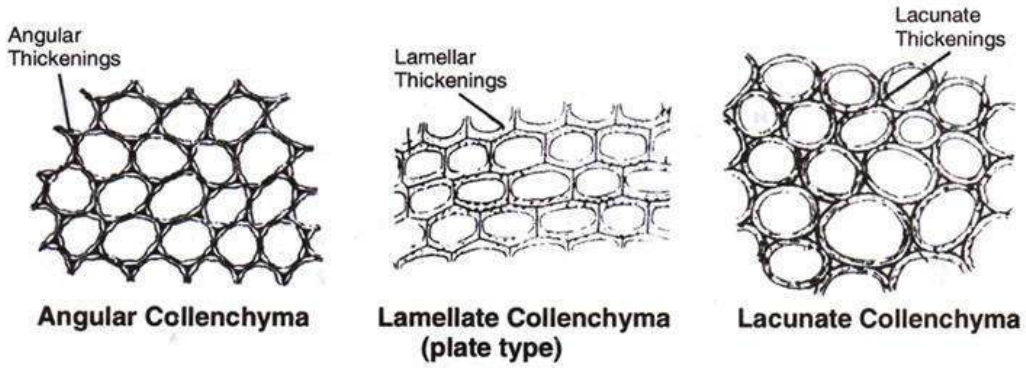
  (f) Idioblast : In this type of parenchyma non-living ergastic substances like tannins, oils, crystals etc. are present.

- **Functions of parenchyma :**
  The main function of this tissue is **storage of food.**

(B) Collenchyma : Term coined by **Schleiden.**

Main characteristics :

- Collenchyma is a **living mechanical tissue. Lignin is absent,** but simple pit **may be present**.
- It is made up of **elongated (oval, spherical or polygonal** shape in section) cells.
- **Localized** deposition of pectocellulose (mainly **pectin**) & hemi cellulose is the characteristics feature of collenchyma.
- **Vacuolated** cytoplasm is found in the cells of collenchyma. Intercellular spaces are not present.



- **Origin of collenchyma :-** Collenchyma originates from **ground meristem.**

Occurance :

- Collenchyma is **not a universal tissue.** It is found in the stems of **herbaceous dicotyledons.**
- Collenchyma is absent in parts of woody plant parts, root and monocotyledons.
- Collenchyma forms the **hypodermis** of **dicotyledon** stems.
- Collenchyma is absent in plants after the secondary growth because plant becomes woody.
- Chloroplast may be found in the cells of collenchyma.
- **Lamina margins** of leaves also bear collenchyma. This protects the cracking of lamina margin due to the action of wind.

- **Type of Collenchyma :**
  - On the basis of **place of deposition,** it is classify into three types by Majumdar :

  (1) Lamellar / plate collenchyma : The cells of collenchyma arranged in lamellar forms. The cell have thickening on the **tangential walls.** Due to such type of deposition, cell looks like a lamellar or plates. Ex. **Sunflower stem.**

  (2) Angular collenchyma : This type of collenchyma abundantly found in plants. The cells of this tissue are angular. The deposition of pectocellulose at the angle of cell. **eg.,** Stem of *Datura, Solanum* and Tomato.

  (3) Lacunar collenchyma/tubular collenchyma : Large intercellular spaces are present in the cells of this tissue. Deposition of pectocellulose on the wall of intercellular spaces. Intercellular spaces of collenchyma are thickened. e.g., *Cucurbita* stem and aerial roots of *Monstera*.

  Functions :

  - **Mechanical** as well as **Physiological.** They provide mechanical support to growing parts of plant such as young stem and petiole of leaf.
  - Due to the presence of chloroplast, it is also participates in the process of **photosynthesis.**

(C) Sclerenchyma : Name coined by **Mattenius.**

Main features :

- Sclerenchyma is the **main mechanical tissue.**
- These cells are long, narrow, thick walled and dead.

- Cell wall is **thick** and **lignified.**

Function : It provide mechanical support/mechanical strength to plants.

- Various types of pits are formed due to the deposition of **lignin on hard wall.**

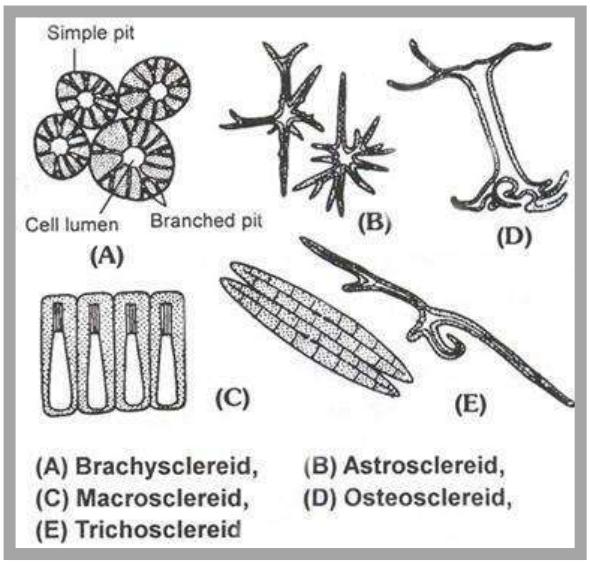
- **Type of sclerenchyma :**
  - On the basis of cells and quantity of deposition of wall materials, sclerenchyma cells are of **two types.**
    (i) Sclereids **(ii) Sclerenchymatous fibres**

(i) Sclereids : These cells are small, extremely thick walled and their ends are not pointed. Sclereids are isodiametric or **irregular** in shape. Sclereids cells have **more pits** and **lumen** is almost **very small.** There pit cavity is **branched.**

- Sclereids are classsify by **Tschierch,** on the basis of their shapes :

(a) Stone cells or Brachysclereids or Grit cells : These cells are spherical or oval in shape. They are found in endocarp of drupe fruits, so endocarp becomes hard.

- They are present in endocarp of **Coconut, Mango, Almond, and Walnut** etc.
- Brachysclereids are also present in **fleshy (edible) part of pear (*Pyrus*).**
- Brachysclereids are also found in pulp of guava and sapota.



(b) Trichosclereids : These are also known as **internal hairs.** They are spines like, bifurcated cells. These are found in **floating leaves.** Also present in aerial roots of monstera.

(c) Astro Sclereids or **Stellate sclerenchyma :** These cells are stellate (star) shaped. They are found in floating leaves.

Example : Both Astro and Tricho sclereids are present in floating leaves.

Victoria, *Nelumbo* (Lotus) and *Nymphaea* petiole.

Note : Astrosclereids are also found in tea leaves.

(d) Macro-sclereids or Rod cells or Malpighi cells :

- They are small and rod like cells. They are present in **seed coats.**

Example :

- They form part of seed coat in legume plants. Due to their presence seed coat becomes hard and dormancy is present in legume seeds.
- In **leguminous plants** hardest seed coat is found in **French bean.**
- In plant kingdom, hardest **Seed coat** is found in lotus.

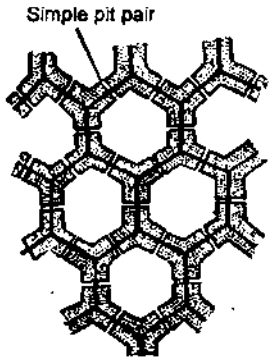
(e) Osteo-Sclereids or Bone cell :

- These are known as prop-cells. These are pillar like cells. Both end of pillar like cells spreads to form bone like structure.

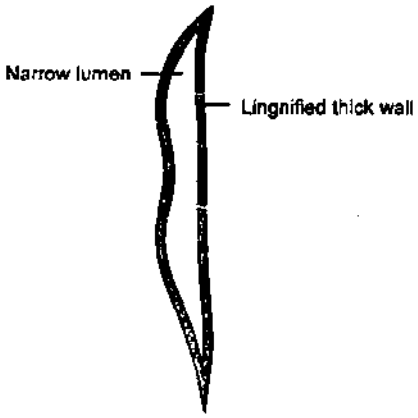
  Example : These cells are found in leaves of *Hakea* and *Osmanthus*.

(ii) Sclerenchymatous Fibres :

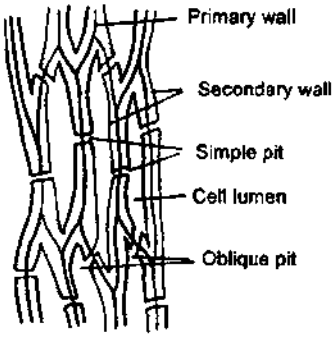
- These cells are fibrous. They are longest cells in plant body.Their both ends are pointed (tapering). Due to thick wall, lumen is reduced.
- Their cell wall contains simple and bordered pits.



T.S. of Sclerenchyma fibre



L.S. of Single Sc. fibre



L.S. of Sclerenchyma fibre

- On the basis of structure fibres are classified into two groups :

(a) Libriform fibres : They are highly thickened long fibres. They posses **simple pits** and narrow lumen. Libriform fibres are found in phloem, xylem, pericycle and hypodermis **(Maximum in phloem).**

(b) Fibre Tracheids : They are also highly thickened. **Bordered pits** are present in these fibres and lumen is broad. They are only found in **xylem.**

- On the basis of position, fibres are divided into three types :

A. Surface fibres : They are present on the surface of plant. These fibres also called as filling fibres.

(i) Seed surface fibres –

Example 1 : Cotton fibres : Cotton fibres are formed by the **out growth of seed coat.** They are not any type of tissue or cell.

Cotton fibres are composed of **cellulose** these fibres are **non-lignified.** So cotton fibres are **not true fibres.** Two types of fibres are found in cotton. Long fibres are called **'lint'** and small fibres are known as **'fuzz'.** Lint fibres are used in cloth industry. Fuzz are filling fibre. Cotton fibres are most pure form of cellulose in nature.

Cotton fibres are not an example of any type of cell because these fibres are formed by out growth of testa.

Example 2 : Red silk cotton (Semal fibre)- Obtained from ***Salmalia malabaricum.***

Example 3 : White silk cotton (Kapok) – Obtained from ***Ceiba pentendra.***

(Both red and white silk cotton fibres are not true fibres and they are also an example of seed surface fibre.)

(ii) Coir of coconut is also a type of surface fibre. They are derived from the **mesocarp.** These are **true fibres.**

B. Xylary or wood fibres : These are hard fibres. These fibres are not flexible. They can not be knitted (weaved) easily so they are not useful. These are found in xylem. Ex. Munj fibre (*Saccharum munja*)

C. Bast fibres / Extra xylary fibres / Phloem fibre : These are known as **commercial fibres.** These fibres are flexible and can be **knitted (weaved)** easily. They have great economic value.

- These fibres are obtained from the phloem and pericycle of plants.
- The bast fibres of *Corchorus capsularis* (Jute), *Crotalaria juncea* (Sunn hemp) and *Hibiscus sabdariffa* (patua) are obtained from the secondary phloem of stem.
- The bast fibres of hemp (*Cannabis sativa*) and *Linum usitatissimum* (flax) are obtained from the pericycle. Fibres which are obtained from pericycle are called perivascular fibres.

Leaf fibres ➡ Manila hemp (*Musa textilis*) and agave hemp (*Agave sislana*) : These are obtained from sclerenchymatous bundle sheath.

Special Points :

- Fibres are longest plant cell. Longest fibres occur in *Boehmeria nivea* (Ramie fibre) length -55 cm.
- In plant kingdom hardest seed coat is found in *Nelumbo* (Lotus).

- In plant kingdom largest leaves are found in *Victoria regia.*
- Longest leaves are found in *Raphia vinifera*. Length 10-15 m.
- Longest commercial fibres – Jute fibres.
- Living sclerenchymatous fibres are present in *Tamarix.*

5. COMPLEX PERMANENT TISSUES

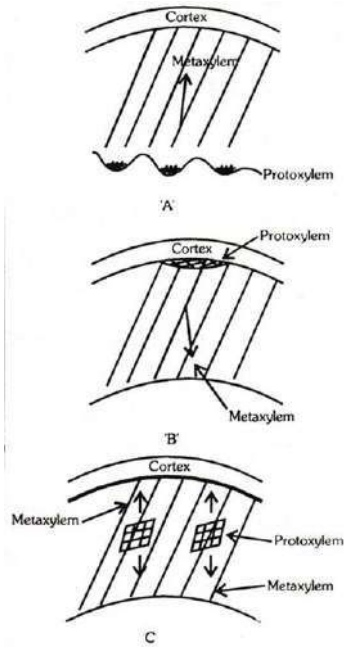
- The complex tissues are made up of more than one type of cells and these work as a unit. Complex tissue are heterogenous.
- Complex tissues are absent in gametophytes.
- During vascularisation in plants differentiation of procambium followed by the formation of primary phloem and primary xylem simultaneously.

- Complex tissues are of two types :

(A) Xylem **(B) Phloem**

A. Xylem :

- The term 'Xylem' is coined by **Nageli.** (Greek xyles–wood.)
- The function of xylem is to conduct water and mineral salts upwards form the root to stem and leaves and to give mechanical strength to the plant body.
- For conduction of water, death of protoplasm is must. Dead tissues are more develop in water scares condition.
- On the basis of **origin,** xylem is divided into **primary xylem** and **secondary xylem.**



I. Primary xylem : Originates form **procambium.**

- On the basis of development primary xylem divided into two parts :
  (a) Protoxylem **(b) Metaxylem**
- Cells of protoxylem are small as compare to metaxylem. Metaxylem is more mature than protoxylem.
- **Development of water conducting elements of Xylem :**
  It is of three types –

(i) Centrifugal : In this type of development, the protoxylem formed near the central axis and metaxylem is formed away from the centre it means towards the periphery. This condition is known as **endarch. Ex.-** Stem of Angiosperm and Gymnosperm.

(ii) Centripetal : In which protoxylem is formed away from the centre it means near the pericycle and metaxylem is formed toward the centre. This condition is called **exarch.** Ex. Roots.

(iii) Centrifugal and Centripetal : In which elements of metaxylem is formed from both side of the elements of protoxylem. In this type of development protoxylem is surrounded by metaxylem. This condition is known as **Mesarch.** Ex.-Fern rhizome.

II. Secondary xylem : Originates from vascular cambium.

- The elements of xylem are :

(a) Tracheids, (b) Vessels or tracheae, (c) Xylem fibres — Dead elements

&

(d) Xylem parenchyma — Living elements

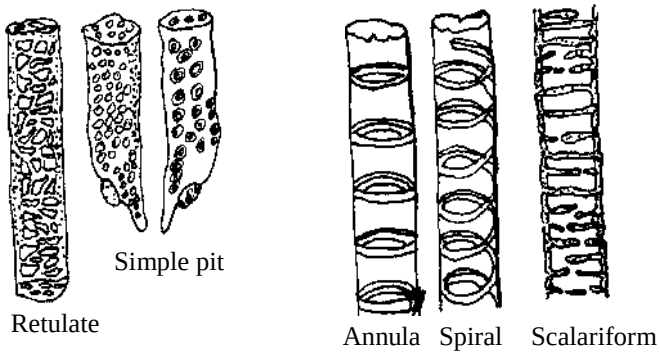
(a) Tracheids : Term was coined by **Sanio**.

- **Tracheids** are primitive **conducting elements** of xylem. They are present in all tracheophytes.
- **Tracheids** having a **narrow lumen**.

- Tracheids join together from **their ends** to form a **long row.** These rows extending form the root to leaves via stem.
- A **transverse septum** lies between each two tracheids. It bears **pits.** Water moves from one tracheid to another Tracheids through pits.
- Due to presence of transeverse septum lumen is discontinuous in tracheids.
- Tracheids are **dead** and **lignified** cells. The deposition of lignin on cell wall is responsible to form different type of thickenings. (Pits are nonlignified areas on lignified wall)

Note :

1. Usually broadered pits are present at end wall of tracheids.
2. The maximum bordered pits are found in the tracheids of Gymnosperm plants.
3. Maximum deposition of lignin is found in pitted type of thickening.
4. Annular and Spiral type of thickening of lignin is found in protoxylem.
5. Reticulate and Pitted (mainly) type of thickening of lignin is found in metaxylem.
6. In metaxylem tracheids of pteridophytes scalariform type of thickening is found.



Different lignified thickening in xylem (tracheids and vessels)

(b) Vessels :

- It is advance water conducting element of xylem. The basic structure of vessels is same as tracheids.
- The **lumen of vessels** is **wider** than tracheids and end wall is perforated **(Transverse septum** is absent between two vessel elements. If present then **porous.)** Thus vessles are more capable for conduction of water than tracheids. Due to presence of perforated end wall, vessels **work as a pipe line** during conduction of water.
- Vessels contain usually simple pits at their lateral wall. Thickening type of wall is the same as tracheids.

Note :

1. Vessels are only found in xylem of angiosperm but exceptionally it is also present in some Gymnosperms like *Ephedra, Gnetum* and *Welwitschia*.
2. Vessels are absent in some Angiospermic plants such as *Dracaena, Yucca, Dazinaria, Drimys.* There are some angiosperms families in which vesselless angiosperms are include. eg., Winteraceae, Tetracentronaceae and Trochodendronaceae.
3. Vessels are example of dead syncyte.
4. Tracheids are unicellular whereas vessels are multicellular.

➡ **Syncyte :** Cell which is formed by fusion of cells, called as syncyte.

(c) Xylem fibres :

- Xylem fibres **provides strength** to the tracheids and vessels. Mainly these fibres provide strength to the vessels.
- They are present **more abundant** in **secondary xylem.**

(d) Xylem Parenchyma :

- It's cell wall is made up of cellulose. It store starch, fats and tannin etc.

- The **radial conduction of water** is the function of xylem parenchyma. (It conducts water to peripheral part of plant organs).
- Their wall possesses pits.

Hadrom :

Tracheids and **Vessels** are **collectively** known as **water conducting elements** or **"Hadrom".** Hadrom term was proposed by **Haberlandt.**

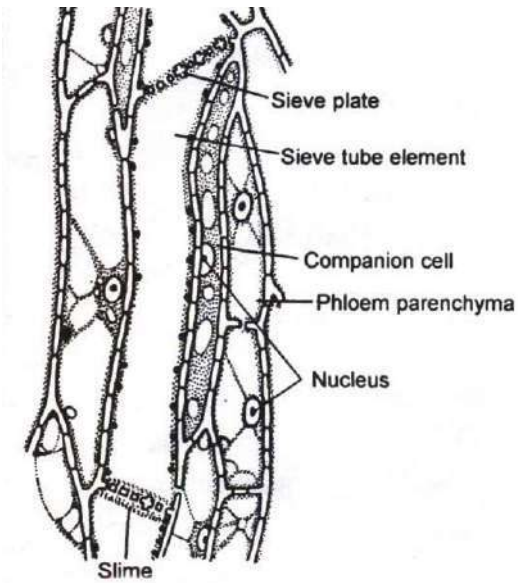
B. <u>Phloem</u> :

- The term **'Phloem'** is coined by **Nageli.**
- The main function of the phloem is to conduct food materials, usually from the leaf to other plant parts (eg., storage organ and growing regions.)
- On the basis of origin, phloem is classified into two categories primary and secondary phloem.
- Primary phloem originates from procambium and secondary phloem originates from vascular cambium.
- On the basis of development primary phloem categorised into protophloem and metaphloem.
- The protophloem has narrow sieve tubes whereas metaphloem has bigger sieve tubes.
- Phloem remains active for less duration as compared to xylem.
- Phloem consist of **4 types** of cells.

(a) Sieve cell (In Gymnosperms**)**

Or Sieve tube (In Angiosperms and pteridophytes**)**

- Sieve elements was discovered by **Hartig.**
- Sieve cell/sieve tube element are living and thin **walled.**
- Mature sieve tube elements are **enucleated** living cells.
- **Central vacuole** is present in each sieve cells/sieve tube element. Cytoplasm of sieve cells/sieve tube element show **cyclosis** in the form of thin layer around the vacuole.
- **In Angiosperm plants** sieve tube elements are arranged with their ends and form **sieve tube.**
- Sieve plate (oblique transverse perforated septa) is present between the two sieve tube elements. Materials are transported through these pores.
- **Callose** deposited on the radius of pores during **dropping season** (autumn) of leaves, to form a thick layer. This is called **Callus pad.**
- Sieve plate is protected by callus pad. It is also prevented from **bacterial infection** and drought.
- Callose dissolves during spring season by callase enzyme. Callose is a β-1-3 glucan.
- In Gymnosperms and pteridophytes sieve cells are arranged irregularly. Sieve cell have sieve plates on their lateral walls. Thus conduction of food takes place in zig-zag manner.
- In Angiosperms food conduction is erect and efficient.
- Sieve elements contain special type of protein **P-protein** (p-phloem)



L.S. of Phloem Tissue

Note :

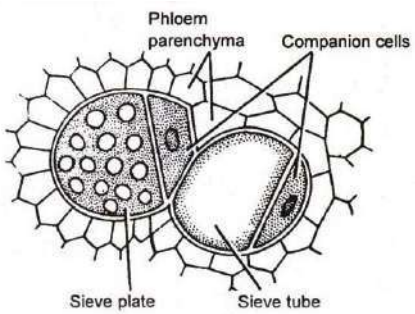
1. Food conduction is **bidirectional** in sieve tube.
2. Sieve tube is an example of living enucleated syncyte.
3. Most likely function of p-protein is sealing mechanism on wounding and it is also related with conduction of food.

(b) Companion cell :

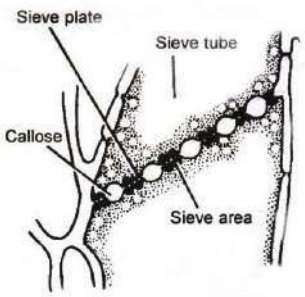
- These are **thin walled living cells.** The sieve tube elements and companion cells are connected by pits present in their longitudinal wall, which is common wall for both and with the death of one, other cell also dies.
- A companion cell is laterally associated with each sieve tube element in Angiospermic plant. (In carrot more than one)
- Sieve tube element and companion cell originates together. Both of them originates from **a single mother cell**. So called as **sister cells.**
- The companion cell and sieve tube elements maintain close **cytoplasmic connections** with each other. Companion cell maintain pressure gradient in sieve tube.
- Companion cells are only found in Angiosperms. (Exception – *Austrobaileya* is angiosperm plant but companion cell are absent).
- Special type of cells attached with the sieve cells in gymnosperm and pteridophytes in place of companion cells. These cells are called as albuminous cells/strassburger cell.

Note :

1. Albuminous cells in conifers are analogus to companion cells of angiosperms. They are modified phloem parenchyma cells.
2. The companion cells play an important role in the maintenance of a pressure gradient in the sieve tube.
3. In phloem of pteridophytes and gymnosperms, Sieve cells are present which are comparable to the tracheids.



T.S. of Phloem Tissue



L.S. of Sieve plate

(c) Phloem fibres :

- Fibres which are present in **phloem** are called bast fibres. These fibres are generally not found in primary phloem.
- These fibres provide mechanical support to the **conducting elements** (sieve cells and sieve tube.)

(d) Phloem Parenchyma :

- It is also known as bast parenchyma.
- It's cells are living and thin walled. It store various **material. eg.,** Resin, Latex, Mucilage etc.
- The main function of phloem parenchyma is **conduction of food in radial direction** and **storage of food.** The food conducting element of phloem is called **Leptom.**

Leptom includes < Sieve cell, Sieve tubes

- **Leptom** term was proposed by **Haberlandt.**

Note :

1. Phloem parenchyma is absent in the stems of monocotyledon plants.
2. Phloem parenchyma is absent in the stems of Ranunculaceae plants. (dicot family).
   e.g., *Thalictrum*.

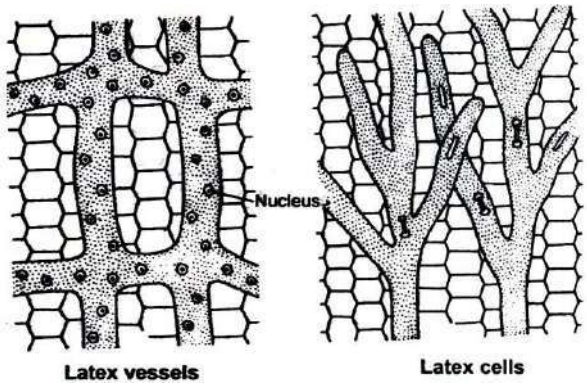
6. SPECIAL TISSUES OR SECRETORY TISSUE

- The cells of this tissue have secretory function. The substances get isolated from cytoplasm and get deposited or aggregated in vacuole of living cells, in dead cells or cavities and canals.
- These tissues are of two main types -

(A) Laticiferous tissues **(B) Glandular tissues**

A. Laticiferous tissue :

- These are made up of long, highly branched and thin walled cells. These cells are filled with milky juice, called as **Latex.**
- Latex is the mixture of saccharides, starch granules, alkaloids, minerals and waste materials.
- Starch granules present in latex are **dumble shaped.**



Function :

- Latex provide **protection** to the plant.
- It prevents the plants from infection of bacteria and fungus. In laticiferous tissue there are two types of cells-

(I) Latex vessels **(II) Latex cells**

(I) Latex vessels : These are **articulated** vassels. Latex vessels are formed due to dissolve of cell walls of meristematic cells. Thus these are syncyte, coenocytic cell (multinucleated).

Example : Latex vessels are present in *Hevea, Ficus, Papaver, Papaya, Argemone* and *Sonchus.*

⇒ Highly developed latex vessels are found in the fruit wall of unripe fruit (capsule) of Poppy.

- Opium is obtained from the latex of ***Papaver somniferum*.** It contains an alkaloid named as morphine.
- An enzyme **papain** is obtained from the latex of papaya **(*Carica papaya*).**
- Indian rubber is obtained from ***Ficus elastica*** and para rubber is obtain from ***Hevea brasiliensis.***
- Chewing gum is obtained from Latex of *Achras sapota.*

Mostly latex is white in colour but in some plants latex is coloured.

Ex. Papaver – Dark brown.

Argemone, Sonchus] Yellow colour

In some plants latex is colourless. **Ex. Banana.**

(II) Latex cells : These are **non articulated** latex ducts/tubes. These are long, branched and multinucleated cells **(coenocytic cells).**

Example – Latex cells are found in ***Calotropis, Euphorbia*** and ***Nerium*. M.Calvin** coined petroplant term for Latex producing plants.

Note : Latex vessels and latex cells are found in cortex.

B. Glandular tissue :

- As the name indicates that this tissue is made up of **glands.** These glands contain secretory or excretory materials.
- Glandular tissues have **two types** of glands :

(a) Unicellular. *Urtica-dioica.* These cell are present on the **surface of the leaves.** These are spiny glands in which **formic acid** is filled. It protects the plants from **grazing animals.** It is commonly known as **Bichchuvati.**

(b) Multicellular : Multicellular glands are of two types.

(i) External Glands : These are located **on the surface of the plants** and arising as an outgrowth from the epidermis. These glands are of various types :-

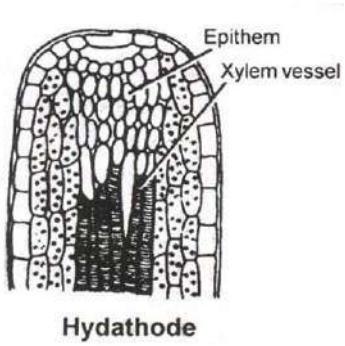
- **Glandular hairs :** They secrete gum-like sticky substance in **tobacco** and **Plumbago,** digestive juicy substance in **Drosera.**
- **Nectar Glands :** These glands secrete **sugar solution.** These are found in floral parts mainly in **thalamus.** Exeption → In **passiflora,** nectar glands are found in leaves.

(ii) Internal Glands : These glands are embedded in the tissues. Internal glands are of following types.

- **Digestive glands :** Digestive glands are found in **insectivorous plants.** These are found in ***Utricularia, Drosera, Dionea*** etc. They secrete proteolytic juice.
- **Mucous secreting glands :** These glands secretes mucous.These are found in the **leaves of betel.**
- **Oil glands :** These secretes **Volatile oil.** It acts as **antiseptic.** These glands are found in fruits and leaves of **lemon and orange.**

  Mostly , Oil glands are **lysigenous** but in sunflower these glands are **schizogenous.**

  Note : Oil glands which secrete volatile oil are called **osmophores.** Osmophores develop fragrance in flowers. Oils which are obtained from **Eucalyptus** leaves are used in medicines.



Hydathode

- Tennin, resin, gum secretory glands are also internal glands. Maximum resin glands are found in **Pinus.**

  Resin ducts are schizogenous. Gum glands are found in ***Acacia*.**
- **Water glands / Hydathode :** These glands are related with **guttation.** Hydathodes are present in **Tomato, Pistia** and **Eichhornia etc.**

TISSUE SYSTEM

In higher plants several tissues work together in form of a unit to perform a particular function. These tissues have the same origin. Such tissues form a system which is called **tissue system.** On the basis of **division of labour** tissue categorized by **Sachs** into three different system. Each system usually consist of an association of tissues which perform specific function-

1. Epidermal tissue system :

The epidermal tissue system forms the outermost covering of the plant body. It is made up of elongated compactly arranged cells which form a continuous layer. Epidermal cells are Parenchymatous cells.This system includes epidermis and its related structures. eg., Root hairs, trichomes, stomata and bulliform cells etc. It is developed from **protoderm.**

- The epidermis (Greek, Epi = upon ; Derma = skin) of most of plant organs is uniseriate, i.e. composed of single layer of epidermal cells but in some cases it may be multilayered e.g., *Ficus , Nerium, Peperomia.*
- Each cell has a large central vacuole & peripheral thin cytoplasm. They may contain chloroplasts, anthocyanin pigments, tannins, oils and crystals etc.
- Some members of gramineae and cyperaceae possess two types of epidermal cells - the long cells and the short cells. The short cell may be cork cell or silica cells.

Stomata :

Stomata are minute apertures in the epidermis. Each aperture is bounded by two kidney/bean shaped cells, called as **guard cells**. Dumbell shaped guard cell are present in grasses.

- Guard cell contains chloroplasts. Inner wall of guard cell is thickened.
- There are different numbers of cells of variable size in the epidermis around the guard cells. These are called as subsidiary cells.
- Stomata are absent in roots, underground parts and submerged hydrophytes.

- The function of stomata is exchange of gases and control of transpiration.

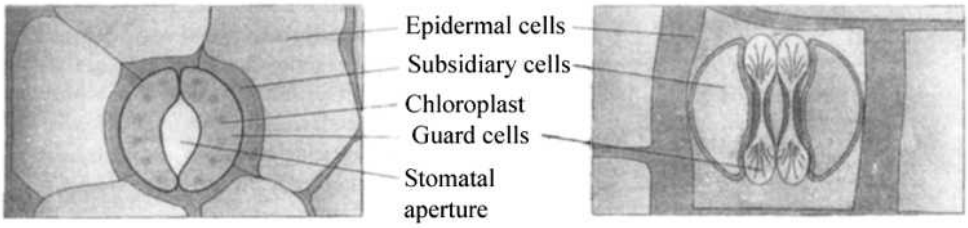


Fig.: Diagrammatic representation : (a) Stomata with bean-shaped guard cells. (b) Stomata with dumb-bell shaped guard cell.

Trichomes :

The cells of the epidermis give rise to a number of protuberances which vary markedly in their shape, structure and function. These are known as **trichomes.** These appendages can be unicellular or multicellular. The unicellular trichomes are usually simple, unbranched (sometimes also branched) and elongated structures. On the other hand, the multicellular trichomes and glands are made up of several layers of cells.

Note : In shoot system, **trichomes are usually multicellular.** Stem hair are not present on monocot stem.

Function : The trichomes help in protection, dispersal of seeds and fruits and reduction of water loss.

Root hair :

The root hairs are formed due to the elongation of the epidermal cells and are not protuberances or appendages. These have vacuolated protoplasm and the nucleus moves towards the apical part of the cell. The thin wall is made up of cellulose and pectic materials.

Root hairs are always **unicellular.** Root hairs are endogenous in origin.

Function : Root hairs play an important role in anchoring the plant body in the soil besides absorbing water and mineral solution from it.

2. Ground tissue system :

It is the largest tissue system. It includes hypodermis, general cortex, endodermis, pericycle pith and medullary rays (pith rays). It is also called as **fundamental tissue system.**

Hypodermis :

- In stem, below the epidermis hypodermis is present. It can be collenchymatous or sclerenchymatous.
- In monocots hypodermis is usually **sclerenchymatous**.

Cortex :

- The cells have prominent intercellular spaces. Starch grain, oil, tannin, and crystals of various types are present in cortical cells. It is loosely packed multi layered structure.

Endodermis :

Inner most layer of cortex is known as endodermis.

- Endodermal cells get elongated to becomes barrel shaped & have **casparian bands**.
- Casparian bands are characteristics feature of endodermis. These bands have **lignosuberin** deposition mainly suberin.
- In roots, the endodermal cells opposite to protoxylem are thin walled. They are called as **passage cells**.
- In young stem of angiosperms, endodermis is also called as **starch sheath** due to abundant starch granules present in them.
- There are several functions of endodermis, e.g., it act as a **water tight jacket** between vascular & nonvascular region, it stores starch, it may serve as protective layer and maintain root pressure.

Pericycle :

- In roots, the pericycle is made up of thin-walled parenchymatous cells which later on give rise to lateral roots.
- In dicot root the cork cambium originates in pericycle. It also give rise to a part of vascular cambium.

Medullary ray :

- In dicot stem the part outside the pith but in between the vascular bundles is called **medullary ray**.
- They serve the function of **lateral transport**.

Function of ground tissue :

- Manufacture and storage of food material.
- Mechanical support (additional work).

3. VASCULAR BUNDLES / VASCULAR TISSUE SYSTEM

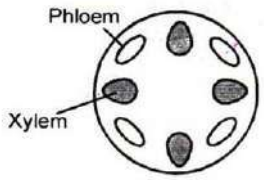
- This tissue system originates from **pro-cambium.**
- Xylem and phloem are collectively termed as **Vascular bundles** or **Vascular tissues system**.

Type of Vascular Bundles :

On the basis of arrangement of different parts, vascular bundles are divided into three categories :

I. Radial vascular bundles :

- When the xylem and phloem are present separately on different radii in alternate manner. Such vascular bundles are called **radial vascular bundle.**
- The order of development of xylem in these vascular bundles is **centripetal.** Thus, these vascular bundles are called exarch. Example : Most of the roots.
- **Exception :-** In Radish, Carrot, Turnip, Sugarbeet Conjoint-callateral, Vascular bundle are present.



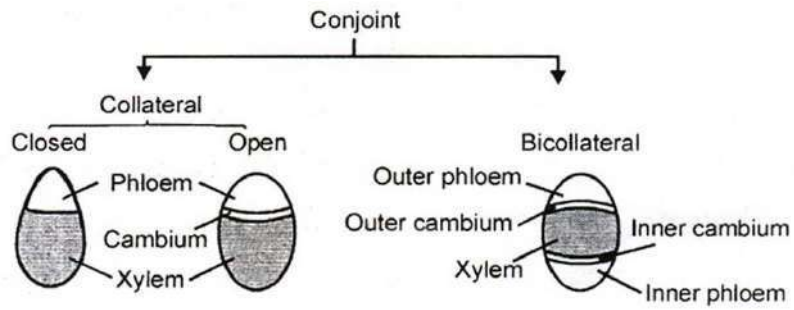
Radial vascular bundle

II. Conjoint vascular bundles :

- In this type of vascular bundle xylem and phloem are present on the same radius. These are of two types -

(1) Conjoint collateral :

In this type of vascular bundle xylem and phloem are present on the same radius and phloem present towards the periphery. These are two types:



(i) Open – If the cambium is present between the xylem and phloem, It is known as **open** vascular bundle. Ex. Open vascular bundle is found in stem of **dicotyledons** and **gymnosperm.**

(ii) Close – When cambium is absent between the xylem and phloem, in conjoint vascular bundle, it is called as **closed vascular bundle.** Ex.- Closed vascular bundles are found in **monocotyledons stem.**

- In this type of vascular bundle, order of development of xylem is **centrifugal.** So **endarch** condition is found in xylem.

(2) Conjoint bicollateral and Open Vascular bundle –

There are two patches of phloem, one on each side of xylem, are found. There are two strips of cambium (outer and inner), one on each side of xylem, are found. Such types of vascular bundles are known as conjoint, bicollateral and open vascular bundle.

- Order of development of xylem is centrifugal so endarch condition is found.

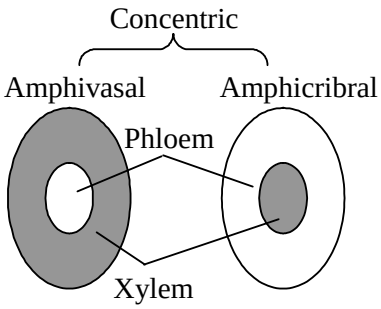
  Ex.- Stem of family Cucurbitaceae, Apocynaceae and Solanaceae.

III. Concentric vascular bundles :

- In this type of vascular bundle either xylem surrounds the phloem or phloem surrounds the xylem. Concentric vascular bundles are always closed. They are of two types -

(a) Amphicribral or Hadrocentric :

- In this type of vascular bundle xylem is completely surrounded by phloem. It means xylem is present in the centre of vascular bundle. Such type of vascular bundle is termed as **amphicribral.**
- The order of development of xylem in these vascular bundles both centripetal and centrifugal manner. In this type of vascular bundle protoxylem surrounded by metaxylem. These are known as mesarch vascular bundle.
- Such types of vascular bundles are found ferns rhizomes.



Amphivasal or Leptocentric :

- In this type of vascular bundle phloem is completely surrounded by xylem. It means phloem is present in the centre of the vascular bundle.
- In this type of vascular bundle, xylem is endarch. Eg., Stem of *Dracaena, Yucca* etc.

STELE –

- The stele is the whole central mass of vascular tissue (vascular cylinder) with or withouth pith surrounded by endodermis. **Van Tieghem** and **Douliot** put forward the hypothesis about stele. Stele surrounded by endodermis but endodermis is originally the part of cortex. It is not a part of stele. All the tissues inside endodermis is known as stele.
- According to him stele is the central part or core of the axis of the plant which includes the vascular system and its related structures.
- The tissues which lies inside the stele is called **intrastelar tissues** and the tissues which lies out side the stele is known as **extra stellar tissues.**
- Steler system started from **pteridophytes.**

INTERNAL STRUCTURE OF STEMS, ROOTS & LEAVES

1. INTERNAL STRUCTURE OF DICOT STEM

Internal structure of a typical dicot stem show following features :

I. Epidermis :

Epidermis is the outermost layer of the stem. It is single layered and lack of chloroplast. Multicellular hair (trichomes) and stomata are found on epidermis. Outer side of epidermis, a layer is present which is made up of cutin is called cuticle.

- Epidermis plays a significant role in protection.

II. Cortex :

In dicotyledon stem cortex divided into three parts :

(a) Hypodermis (b) General cortex (c) Endodermis

(a) Hypodermis : It is present just below the epidermis. It provides additional support to epidermis. It is thick multicellular layer. This layer is composed of **collenchyma** and their cells contain **chloroplast.**
So, hypodermis is **green** and **photosynthetic.**

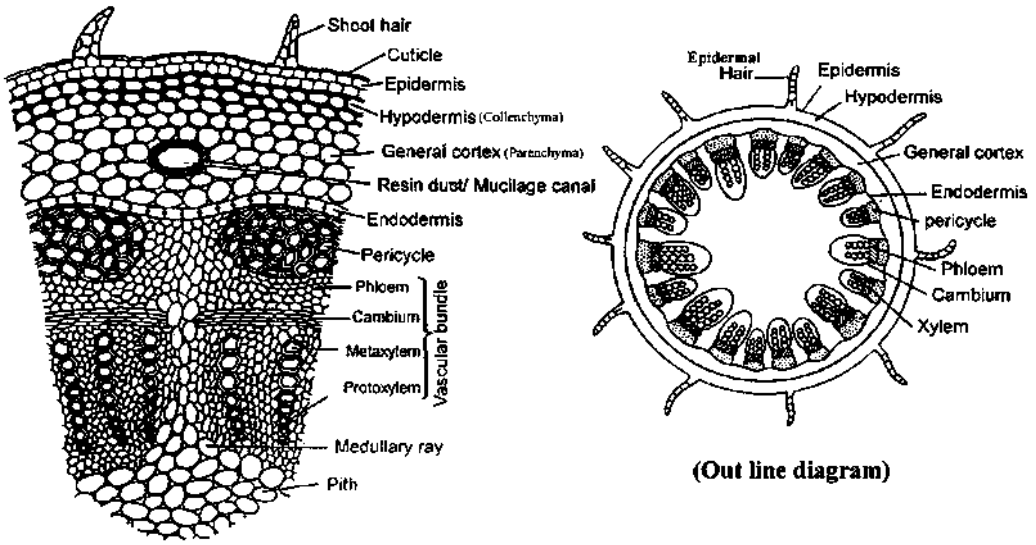
(b) General cortex : This part is composed of **parenchyma.** Storage of food is the main function of the cortex. Resin canal/mucilage canal are present in it. These are **schizogenous** in origin.

(c) Endodermis : It is single celled thick layer. The cells of **endodermis are barrel shaped.** These cells accumulate **starch** in stem of dicot. Thus, it is known as **"starch sheath".**

III. Pericycle :

This layer situated in between the endodermis and vascular bundle. The pericycle of stem is multilayered and made up of **sclerenchyma.** Sclerenchymatous pericycle is also known as **Hard bast.**

Note : In **sunflower** stem, pericycle is made of alternate bands of **parenchymatous** and **sclerenchymatous** cells. In which pericycle which is present in front of the vascular bundle is made up of sclerenchyma and remaining is composed of **parenchyma.** Part of pericycle which is situated in front of vascular bundle is known as **Bundle cap.** Pericycle is **heterogenous** in sunflower stem.



(Out line diagram)

T.S. OF SUNFLOWER STEM - [A part of Cellular]

IV. Vascular Bundle :

The vascular bundles **(wedge shaped)** are arranged in a ring. Each vascular bundle is **conjoint, collateral** and **open.** Each vascular bundle is made of phloem, cambium and xylem. **Eustele** is present in dicotyledon stems.

V. Pith :

This is well developed region, spreading from ring of vascular bundle to the centre. The cells of this region mainly made up of **parenchyma.**

Function of pith – Storage of water and food.

Note : The part of pith which is radially arranged between the vascular bundles, called **pith rays or medullary rays.** The main function of pith rays is radial conduction of food and water.

2. INTERNAL STRUCTURE OF MONOCOTYLEDON STEM

I. Epidermis :

Epidermis is the outer most single celled thick layer. It is covered with thick cuticle. Multicellular hair are absent and stomata are also less.

II. Hypodermis :

Hypodermis of monocotyledon is made up of **sclerenchyma.** It is 2-3 layered. It provides **mechanical** support to plant.

III. Ground tissue :

The entire mass of parenchyma cells next to hypodermis and extending to the centre is called ground tissue. There is **no differentiation** of ground tissue in monocotyledon stem. It means ground tissue is not differentiated into endodermis, cortex, pericycle etc.

Note : Sometimes in some grasses, wheat etc. the central position of ground tissue becomes hollow and is called pith cavity.

IV. Vascular Bundle :

Many vascular bundle are scattered in the ground tissue and V.B. are generally oval shape.

- Vascular bundles lies towards the centre are large in size and less in number.
- Vascular bundles situated towards the periphery are smell in size but more in number.
- Each vascular bundle is conjoint collateral and closed. Vascular bundle surrounded by the layer of sclerenchymatous fibre is known as **bundle sheath**.

(a) Xylem : In xylem number of **vessels** is less. In metaxylem there are **two** large vessels while in protoxylem there are **one** or **two** small vessels. Vessels are arranged in **V** or **Y** shape. Just beneath protoxylem vessels, there are a **water cavity** which is schizolysigenous in origin but major part of water cavity is **lysigenous.** This cavity is formed by disintegration of the element present below the protoxylem and neighbouring parenchyma.

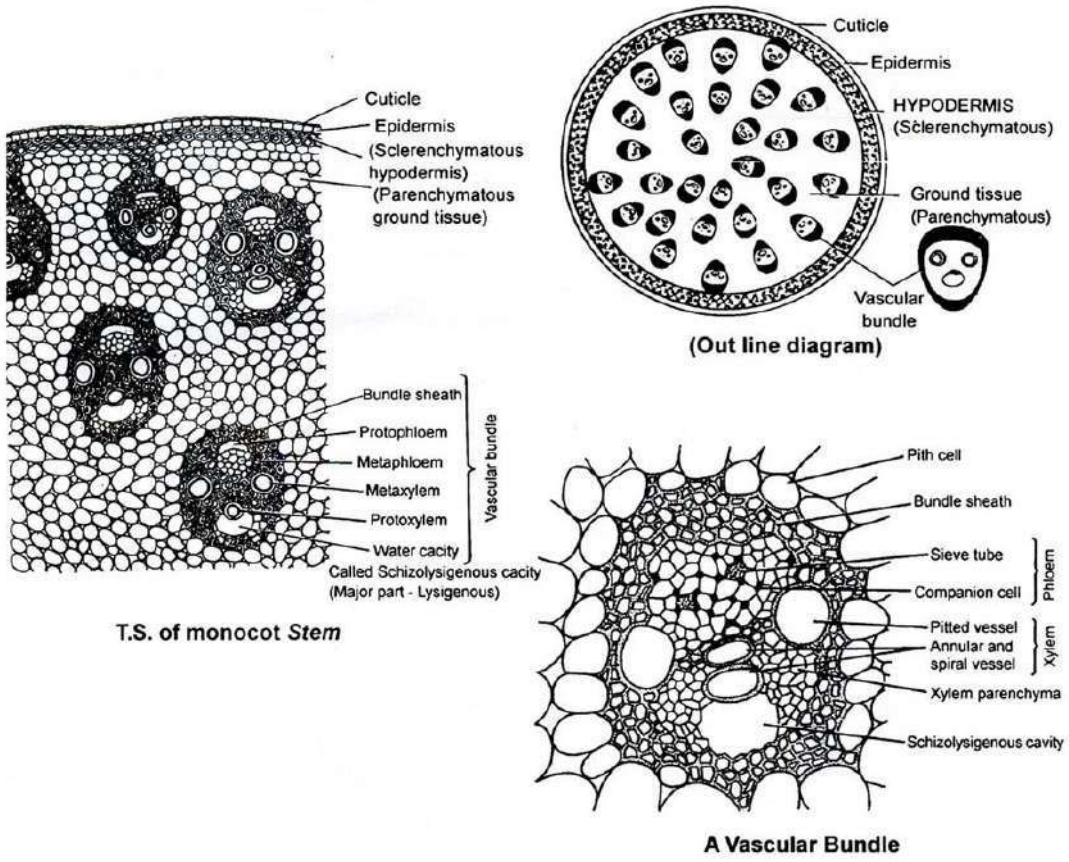
Exception : In *Asparagus* water cavity and bundle sheath are absent.

(b) Phloem : It consist of sieve tube elements and companion cells. **Phloem parenchyma** is absent.

V. Pith :

Pith is undifferentiated in monocotyledon stems.

Stele : Atactostele is found in monocotyledon. This is the most **developed stele.**



S. No.	Monocot stem	Dicot stem
1.	Epidermis with generally comparatively **smaller** cells.	Epidermis is made of comparatively **larger** cells.
2.	Hairs are generally **absent**.	Multicellular hairs are **present**.
3.	Hypodermis is **sclerenchymatous**.	Hypodermis is **collenchymatous**.
4.	Cortex is generally absent, but from hypodermis to centre of stem there is **ground tissue** present.	Cortex is made of many layered parenchymatous cells.
5.	Endodermis is absent.	Endodermis is **present** but usually poorly developed.
6.	Pericycle is **absent**.	Pericycle is made of one or many layers of cells.
7.	Medullary rays are **absent**.	Medullary rays are **present** between vascular bundles.
8.	Pith is **absent**.	Pith is **present**.
9.	Vascular bundles :	Vascular bundles :
	(a) Scattered V.B.	(a) V.B. are arranged in a ring.
	(b) V.B. are conjoint, collateral and **closed**.	(b) V.B. are conjoint, collateral and **open**
	(c) There is differences in the size of V.B. in the centre and at periphery, i.e., V.B. in centre are larger in size and towards periphery are smaller.	(c) V.B. are of same size.
	(d) Bundle sheath is **present** around vascular bundle in monocot stem	(d) Bundle sheath is **absent**.
	(e) **Oval** vascular bundles.	(e) **Wedge shaped** vascular bundles.
	(f) Phloem parenchyma is **absent**.	(f) Phloem parenchyma is **present**.
	(g) Xylem vessels are 'Y' or 'V' shaped.	(g) Xylem vessels are radial.

3. INTERNAL STRUCTURE OF TYPICAL DICOTYLEDON - ROOT

Internal structure of a typical dicotyledon root shows following features : -

I. Epiblema : -

It is **uniseriate** outermost layer. It comprising tubular living components. Cuticle and stomata are absent. Unicellular root hairs are formed due to elongation of some cells of epiblema. Epiblema also known as Rhizodermis or Piliferous layer. Root hairs are present in maturation zone of root.

II. Cortex : -

It is made up of parenchymatous cells.

Chloroplast is absent so they are non-photosynthetic but chloroplast is present in roots of **Tinospora** and **Trapa** so they are photosynthetic.

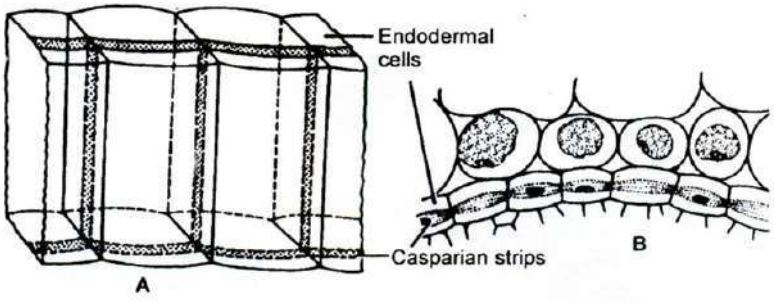
Note : The cells of outer part of cortex are suberized in old root. It is called **exodermis.**

Exodermis found in some dicotyledon roots and most of the monocotyledon roots.

III. Endodermis : -

This layer is situated between the pericycle and cortex. **Casparain strips** are present on radial and tangential wall of endodermis. These strips are made up of **ligno suberin (mainly suberin)**. Casparian strips are discovered by **Caspari**.

- The cells of endodermis which are situated in front of protoxylem cells lack of casparain strips.
  These are called **passage cells.**
  The number of **passage cells** is equivalent to the **protoxylem cells** and number of rows of root hair equivalent to protoylem cells.



Endodermal cells : Casparian strips in tangential and radial walls

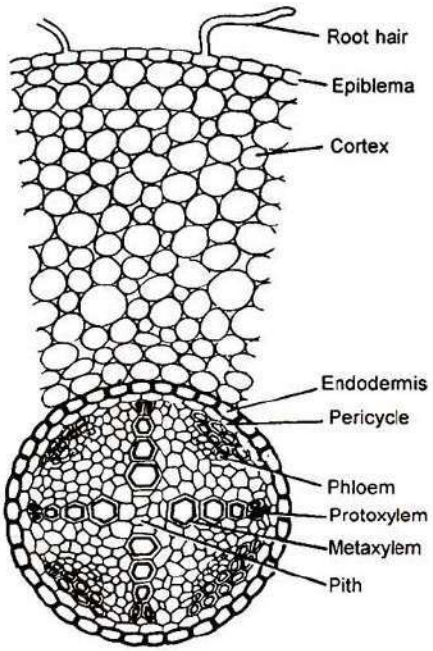
- Passage cells provide path to absorbed water from cortex to pericycle.

Note :

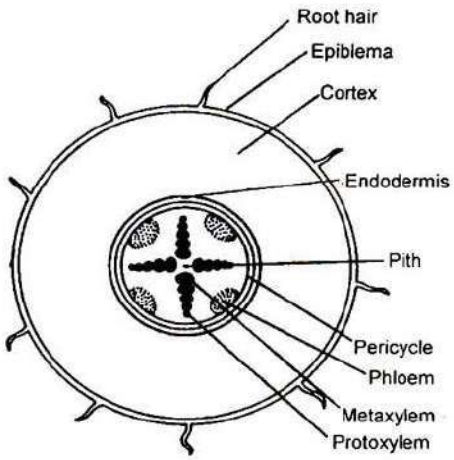
(a) Root hairs are linearly arranged on root apex.

(b) Casparian bands and passage cells are well developed in monocot root.

(c) Endodermis acts as a **water tight jacket** and prevents radial conduction of water



T. S. OF TYPICAL DICOTYLEDON ROOT



(Out line diagram)

IV. Pericycle :

It is single layered. It is composed of **prosenchyma**.

- **Lateral** roots are originated from the part of **pericycle** which is lying opposite to protoxylem. Thus lateral root are **endogenous** in origin. A few mature cells of pericycle usually opposite to protoxylem, become meristematic. these cells divide by periclinal divisions and form some layers of cells. these divisions are followed by anticlinal divisions forming a primordium which grows to form a lateral root.

Note :

(i) The branches of stems are **exogenous** in origin because these are originated from extra stelar region.

(ii) Adventitious root are also **endogenous.** Because these are originated from stellar region.

- Some part of vascular cambium in root is originated from pericycle.

V. Vascular Bundles : -

Vascular bundles are **radial** and **exarch**. Xylem and phloems are separate and equal in number. The numbers of xylem bundles are two to six (**diarch** to **hexarch**).

- But exceptionally, **Ficus** (Bayan tree) root is **polyarch.**
- Parenchyma which is found between xylem and phloem, called **Conjunctive tissue.**

VI. Pith :

In dicot root pith is **less developed** or **absent.**

4. INTERNAL STRUCTURE OF MONOCOTYLEDON - ROOT

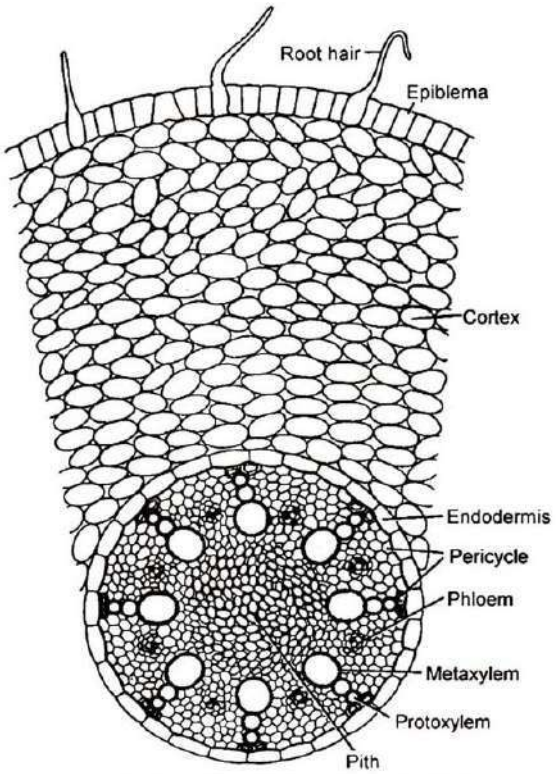
- The internal structure of a typical monocotyledon root is similar to dicotyledon root.

But

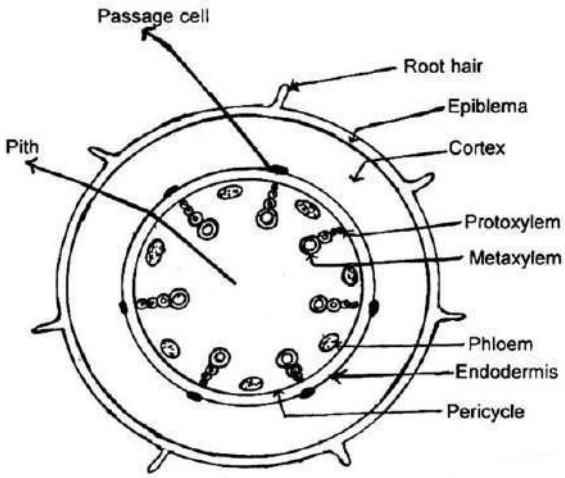
(a) Number of xylem bundles are **more than six** (Polyarch) in monocotyledon root (**exceptionally** the number of xylem bundles are two to **six** in **onion**).

(b) Pith is **well developed** in monocotyledon root

(c) Only lateral roots are originated from pericycle.



T.S. OF MONOCOTYLEDON ROOT



(Out line diagram)

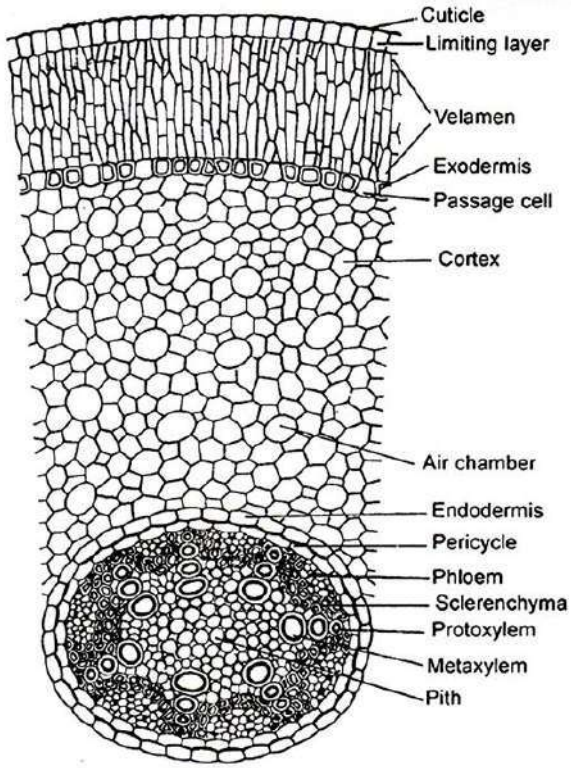
Difference between dicot root and monocot root

S.No.	Character	Dicot root	Monocot root
1.	Pericycle	Gives rise to secondary roots and lateral meristem	Gives rise to lateral roots only.
2.	Vascular bundles	Diarch to hexarch	Polyarch
3.	Cambium	Develops at the time of secondary growth	Absent
4.	Pith	Absent or poorly developed	Fully developed

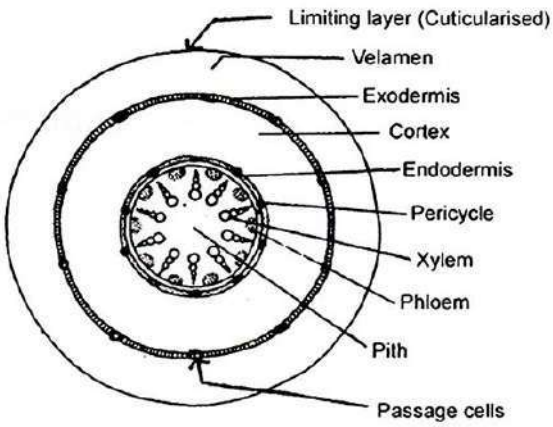
5. INTERNAL STRUCTURE OF ORCHID ROOT –

Velamen : - These are found in aerial or hanging roots of some epiphytes (eg. **orchid**)

- These are examples of multilayered epidermis.
- These are present outside the exodermis.
- These are made up of **protoderm** and are dead.
- Spiral thickening of **colloids** is found in **velamen cells**.
- Passage cells are found in both exodermis and endodermis in hanging roots of orchids.



T.S. of Orchid Root (A part of cellular)



(Out line diagram)

6. INTERNAL STRUCTURE OF LEAF

Generally leaves divided into two categories – Dorsiventral leaves and isobilateral leaves. The differences in between them as follows :

Dorsiventral or Bi-facial	Iso-bilateral or Equifacial
1. Present at right angle to stem	**1.** Arranged parallel to stem.
2. Upper surface of leaf receive more sun light as compared to lower surface, so there are difference between internal structure of upper and lower surface of leaf.	**2.** Both surface of leaf receive equal amount of sun light so there are no difference between internal structure of upper & lower surfaces.
Examples : - Dicots	Example : - Monocots
Exception – *Eucalyptus, Neruim.*	Exception – *Lilium longiflorum*

DIFFERENCE BETWEEN DICOT LEAF (DORSIVENTRAL) & MONOCOT (ISOBILATERAL)

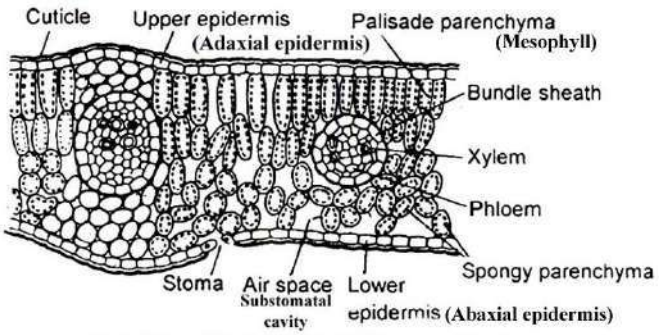
	Character	Dicot leaf	Monocot leaf
(i)	Leaf	Dorsiventral	Isobilateral
(ii)	Stomata	Usually more on lower epidermis (Hypostomatic)	Equal on lower and upper epidermis (Amphistomatic)
(iii)	Mesophyll	Made up of two types of tissues (A) Palisade parenchyma (B) Spongy Parenchyma with large intercellular spaces	Only spongy parenchyma is present which has very small spaces.
(iv)	Bundle sheath	Made up of parenchyma just above and below vascular bundle. Some parenchyma cells or collenchymatous cells are present upto epidermis	Just above and below the vascular bundles sclerenchymatous cells (up to epidermis) are found.
(v)	Bulliform Cells	Absent	Present

7. INTERNAL STRUCTURE OF DORSIVENTRAL LEAVES

- Cuticle is present on both surfaces but cuticle of upper surface is thicker.
- Dorsiventral leaves are mostly **hypostomatic** i.e. stomata present on lower surface.

Note : In amphistomatic dorsiventral leaves stomata are more on lower surface.

- Mesophyll of these leaves is divided into two regions – Palisade tissue and spongy tissue.



V.S./T.S OF DORSIVENTRAL LEAF

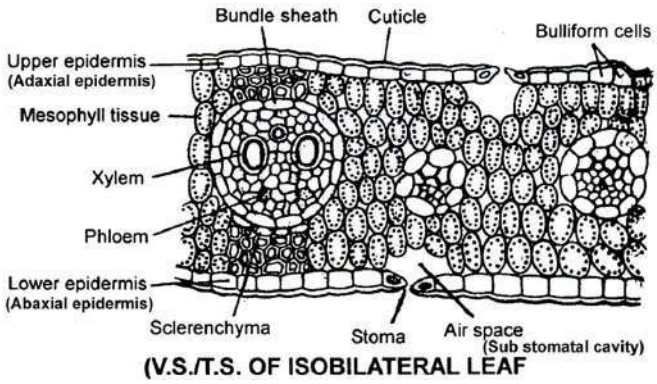
- Palisade tissue is found towards upper surface. These cells have more chloroplasts. Spongy tissues is found towards lower surface and have large intercellular space.

8. INTERNAL STRUCTURE OF ISOBILATERAL LEAVES

- The thickness of cuticle on the both surface is equal.
- Distribution of stomata on both surface's are **equal**.

Note : Isobilateral leaves are **Amphistomatic** i.e. stomata present on both sides.

- Mesophyll of isobilateral leaves is not differentiated into palisade and spongy tissues. It is completely made up of spongy tissues. **Palisade tissues are absent.**

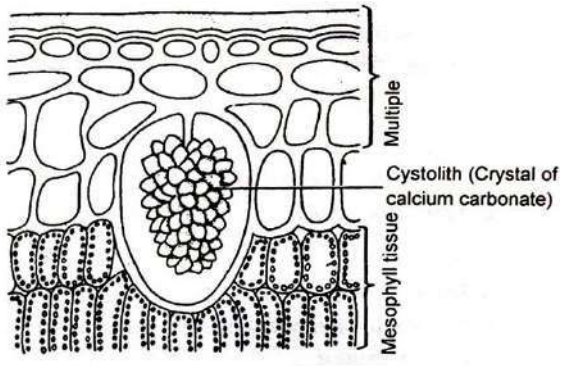


(V.S./T.S. OF ISOBILATERAL LEAF

9. VASCULAR BUNDLES OF LEAVES

- Similar types of vascular bundles are found in both dorsiventral and isobilateral leaves. Vascular bundles of leaves are **conjoint, collateral** and **closed.**

- Protoxylem is situated towards the adaxial surface and protophloem towards the abaxial surface in the vascular bundle. Leaves are devoid of endodermis and pericycle.
- Vascular bundles are surrounded by a **bundle sheath**. Bundle sheath is **chlorenchymatous** in C-4 plants.
- **Bulliform cells : -** Large cells are found in the epidermis of psammophytic (desert) grasses which are filled by liquid or empty (mostly) and colourless are called bulliform cells or motor cells. Folding of leaves during the sunny day takes place due to the presence of these specific cells. This is an adaptation to **reduce transpiration**.
  Example : - Ammophila, Poa, Empectra and **Agropyron** etc. are Psammophytic grasses.
- Epidermis of **Nerium** (both upper & lower) and **Ficus** (only upper epidermis) becomes **multilayered**. This is an adaptation to reduce transpiration.



T.S. of Ficus leaf
Druses → Crystal of calcium oxalate

SPECIAL POINTS –

1. Xerophytes with isobilateral leaves contain palisade on both sides of leaf.
   Examples : - Eucalyptus & Nerium.
2. Desert grasses contain palisade like spongy tissue
3. **Unifacial or cylindrical leaf : -** In these leaves there are no differentitation of upper surface and lower surface. Example : - Onion, Garlic
4. **Albascent leaf : -** Palisade tissue is restricted in half part of leaf so half part appears more green and other half appears less green. Example : Abutilon

ANOMALOUS PRIMARY STRUCTURE

1. ANOMALOUS STRUCTURE IN DICOTYLEDON STEM

I. Scattered Vascular Bundles : -

In some of dicotyledon stem, vascular bundles are not arranged in a ring, they are **Scattered** in the cortex.
Example : - *Thalictrum, Nymphaea, Papaver orientale* & *Peperomia.*

II. Phloem on innermost radius : -

Generally phloem is situated in the ring of vascular bundles towards peripheral (outer) radius and xylem towards the inner radius. But **anomalously** in some plants, the position of phloem is towards the inner side of xylem. Such type of phloem is called **Internal or intraxylary phloem**. Because, this phloem lies towards the pith, so it is also known as **medullary phloem**.
This anomalous condition is found in **Calotropis, Capsicum, Leptadaenia,** etc. plants.

III. Medullary vascular Bundle : -

In some plants vascular bundles are present in pith. These are found in addition to normal ring of vascular bundles. These are called **medulllary vascular bundles**.
Example : *Amaranthus, Boerhaavia, Chenopodium, Mirabilis, Achyranthes, Bougainvillea, Raphanus sativus.*

IV. Cortical Vascular Bundles : -

Some of the vascular bundles are also present in the cortex of plants except the ordinary ring of vascular bundles. They are known as **cortical vascular bundles**.
Example : *Casuarina, Nyctanthes* and *Lathyrus* etc.

V. Polystelic condition : -

Each vascular bundle is surrounded by a separate endodermis and pericycle in some plants. Hence, each vascular bundle is a **stele**. It is the normal situation in pteriodphytes but in some dicotyledons it is present abnormally.

Example : - *Primula, Dianthera*

VI. Exclusively xylem vascular Bundle : -

Abnormally, some vascular bundles are only formed by xylem except the normal vascular bundles. Phloem is not present in these vascular bundles.

Example : - Paonia

VII. Exclusively phloem vascular Bundle : -

Abnormally, some vascular bundles are only formed by phloem except normal vascular bundles in some plants. Xylem is not present in these vascular bundle.

Examples : - Cuscuta & *Ricinus communis*

2. ANOMALOUS STRUCUTE IN MONOCOT STEM

I. Vascular bundle situated in Ring : -

Normally vascular bundles are found in monocotyledon stem in scattered form but in the stem of some monocotyledon plants vascular bundles are arranged in ring. Such as *Triticum, Secale, Hordeum, Avena, Oryza* etc. Members of family Gramineae.

II. Eustele : -

Instead of atactostele, **eustele** is found abnormally in some monocotyledon stems. Presence of **eustele** is the basic feature of **dicotyledons**.

Examples : - *Tamus communis*.

SPECIAL POINT :

1. Cricket bat → from ***Salix*** (Willow)
2. Hockey → From ***Morus*** (Mulberry)
3. Monarch condition → in **Trapa root**
4. Triarch condition → in **Pisum root**
5. Tetracrch condition → in ***Helianthus annus*** *and* ***Cicer arietenum*** **root**
6. **Waiting meristem concept :** This concept was given by **Buvat.** According to this, there is an inactive centre in the shoot apex which is known as waiting meristem and it acts as reservoir of active initials and on induction it give rise to reproductive apex.
7. **Tannin** is found in latex of **banana.** When it comes in contact with air it gets oxidized and becomes reddish brown in colour.
8. **Chewing gum** is made up by latex of ***Achras sapota.***
9. Tannin glands are found in **Camellia.** These glands are **schizogenous** in origin.
10. Salt glands are found in ***Tamarix*** which secretes **sodium chloride.**
11. **Chalk glands** are found in plants of **plumbaginaceae** family which secretes **calcium carbonate.**
12. Maltilayered (14 to 15 layers) epidermis is found in **Peperomia leaves.**
13. Cystolith containing cells are found in the upper epidermis of **Ficus** leaf, called **lithocytes.**
14. The most durable wood is ***Tectona grandis.***
15. Tracheids are the chief water transporting elements in gymnosperms.
16. Phloem is embedded into the secondary xylem in some plants. Such phloem is called **included phloem** or **interxylary phloem.** This is secondary anomalous structure.
    Example. : ***Leptadaenia, Salvadora*** etc. dicot stem.
17. Pericycle is absent in roots and stem of some aquatic plants.

18. In some monocotyledonae roots, pith is **sclerenchymatous.** Ex. **Canna.**
19. A nectar secreting glands cell contains granular cytoplasm and a large conspicuous nucleus.

ANATOMY – SECONDARY GROWTH

Primary Growth :

- Cells of apical meristems divide, differentiate and develop to form primary tissues, As a result the plant grows in length. This is called **primary growth**.

Secondary Growth :

- By the activity of lateral meristems, increase in the **circumference/girth** of the plant organs due to the formation of secondary tissues in stelar & extra stelar regions called secondary growth.
- Normally secondary growth takes place in roots and stem of **dicotyledons & Gymnosperms**.
- Due to lack of cambium in monocotyledons, secondary growth is absent. But exceptionally secondary growth takes place in some monocotyledons. Such as- ***Palm, Yucca, Dracaena, Smilax, Agave, Coconut*** etc.
- Pteridophytes and monocots have only primary structure but gymnosperm and dicots soon start undergoing secondary growth.

SECONDARY GROWTH IN DICOT STEM

A. Secondary growth in stelar region or secondary growth in vascular region :

Secondary growth in stelar region begins earlier than the extra stelar region.

Formation of ring of vascular cambium : -

A cambium which is present inside the vascular bundle is called **intrafascicular – cambium**. This is a type of primary meristem.

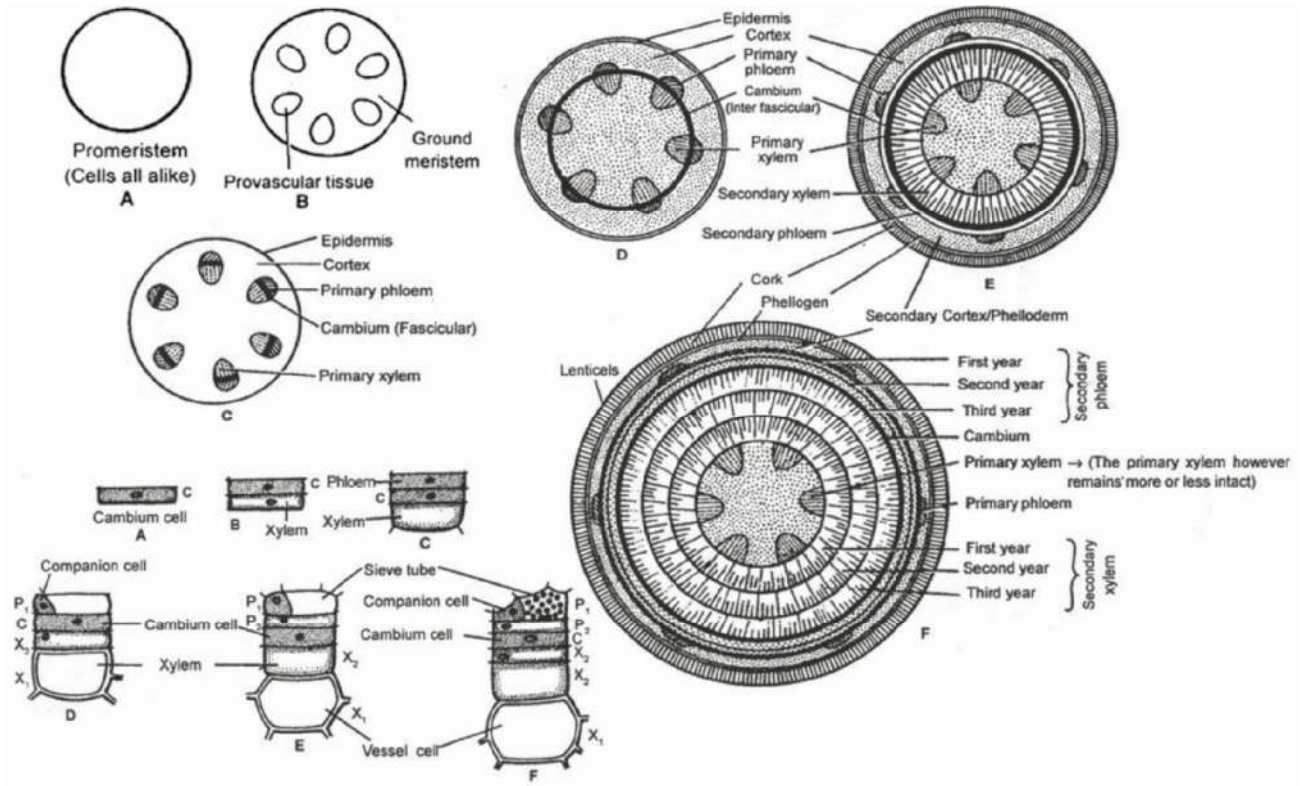
- First of all, cells of medullary rays become meristematic to form interfascicular cambium which is secondary lateral meristem.
- Intrafascicular and interfascicular cambium are collectively known as **vascular cambium**. Vascular cambium is formed in the form of a complete ring which is made up of single layer of cells.
- In dicot stem some part of vascular cambium is primary and some part is secondary.
- Two types of cells are found in the ring of this vascular cambium.
  (I) Fusiform initials (II) Ray initials.
- Fusiform initials are long with **pointed ends**, while ray initials are **spherical** (oval).
- **Amount of fusiform initials** is more in **vascular cambium**.

I. Activity of vascular fusiform initials :

Activity of fusiform initials :

- Continuous **periclinal** divisions or **tangential** division takes place in fusiform initials .
- This type of activity few cells are formed towards the periphery and these cells differentiate into secondary phloem or bast and some of the cells are formed towards the central axis and these cells are differentiated into secondary xylem or wood.
- Normally more secondary xylem is formed as compared to secondary phloem due to unequal distribution of hormones.
  (Secondary xylem is formed 8-10 times more as compared to sec. phloem).
- By the pressure of secondary phloem, primary phloem is pushed towards the outside and gets crushed.
- By the pressure of secondary xylem, all the primary tissues-such as primary xylem, pith etc and old secondary xylem degenerates in the centre of the stem. Due to this, central part of the stem becomes woody. These activities are going on continuously in plants throughout the life.

- Secondary xylem forms in plant regularly and primary tissues degenerate continuously. This new secondary xylem also degenerate the old secondary xylem. Waste materials are formed in the stem such as **lignin, suberin, tannin, resin, gums** etc. due to degeneration of the cells. All these waste materials are filled in the **lumen** (cavity) of **tracheids** and **vessels of secondary xylem**. Because of this, wood in the central region of the stem becomes dark coloured (Black brown). It is called **Heart wood or Duramen**. The peripheral or outer wood which looks light in colour is known as **Sap wood or Alburnum**. As a result of growth of secondary xylem, the **diameter** of **heart wood increases**.



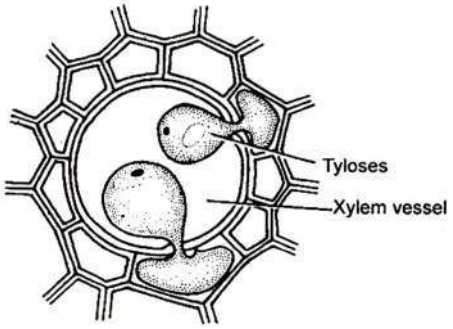
Different Stage of Secondary Growth in Dicotyledon Stem

Physiologically active wood is sapwood. The main function of sap wood is water conduction. Heart wood provides maximum mechanical strength to stem.

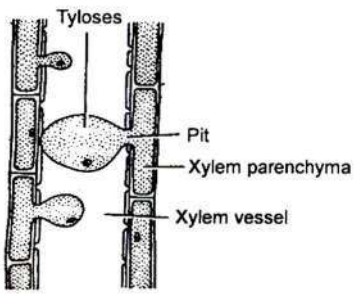
Note : Conduction of water is not carried out by heart wood because : -

1. Cavities of tracheids and vessels are progressively filled by waste materials.
2. The bladder like ingrowth of parenchyma cells, which enter the lumen of vessels (mainly) & tracheids through the pits in their wall. Such bladders like ingrowth are called as **tyloses**. Tyloses blocks the **conduction** of water.

Note: In gymnosperms **tylosoids** are formed in place of tyloses.



T.S. of Sec. xylem vessels showing tyloses



L.S. of Sec. xylem vessels showing tyloses

SPECIAL POINT :

1. If the heart wood is destroyed in any stem, then there will be no effect on plants (any vital function is not effected), but if the sap wood is destroyed, then the plant will die because conduction of water will be blocked.
2. Heart wood provides stiffness to the stem. The waste materials of heart wood are **antiseptic** in nature. Heart wood is resistant to bacteria and fungus. Heart wood has a power of **repelling** insects. So it is resistant to the **termites** and in rainy season it does not imbibe water. Thus it is the best quality of wood.
3. Study of wood is known as **Xylotomy**.
4. If a wood is exposed freely in air then **decomposition** of **sap wood** takes place **rapidly**.
5. Position of youngest layer of secondary phloem is just outside the vascular cambium.
6. Position of oldest layer of secondary phloem is just inside the primary phloem.
7. Position of youngest layer of secondary xylem is just inside the vascular cambium.
8. Position of oldest layer of secondary xylem is just outside the primary xylem.
9. If xylem is blocked then shoot will die first.

TYPES OF WOOD

I. On the basis of amount of parenchyma wood is classified into **two** groups.

1. Manoxylic wood : - Such type of wood contains more living parenchyma. It is soft and loose wood. eg. **Cycas**.

2. Pycnoxylic wood : - Such wood contains less amount of living parenchyma. It is hard wood. Such type of wood are found in most of the dicot plant.
Example : - *Pinus* (Chir), Mango, *Acacia* (Babool), *Tectona* (Teak), *Dalbergia* (Shisham).

II. On the basis of distribution of parenchyma wood is classified into three groups : -

1. Apotracheal : - In this type of wood **parenchyma is in scattered** form.
Example : Gymnosperm

2. Paratracheal wood : - In this wood parenchyma is arranged or distributed in the form of masses or groups.
Example : Dicotyledon plants.

3. Syntracheal wood : - In this wood **parenchyma is arranged around** the **vessels**.
Example : *Terminalia arjuna*.

III. Classification based on vessels : - On the basis of presence or absence of vessles, wood is classified in two categories –

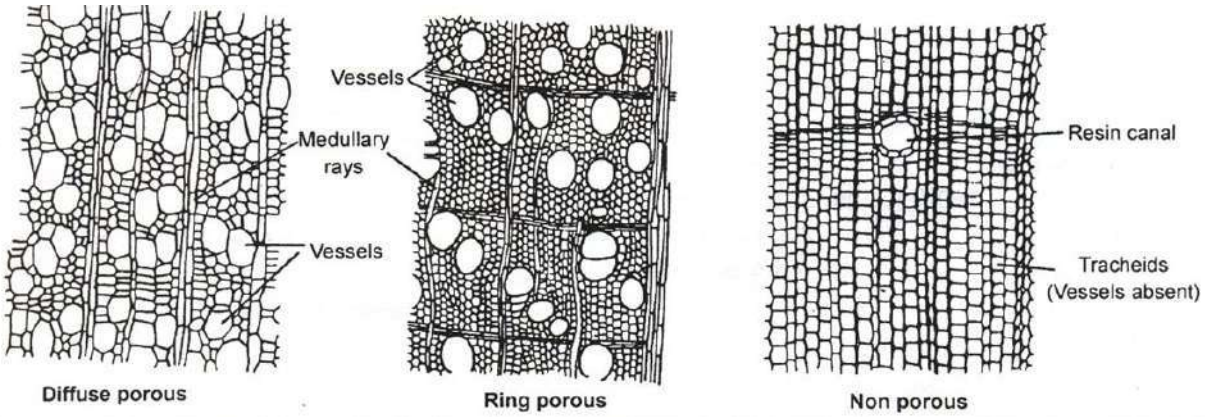
1. Non-porous wood : - Vessels are absent in such type of wood. **Example :** Gymnosperm

2. Porous wood : Vessels are present in such type of wood. On the basis of **arrangement** of **vessels** porous wood is divided into two groups.

(a) Ring porous wood : - Vessels are arranged in the form of a ring. Such wood conducts water more efficiently. Example : *Dalbergia*

(b) Diffused porous wood : Vessels are irregularly arranged in wood. Example : *Azadirachta*.

Non-porous wood is also called as **homoxylous wood** and porous wood is also called as **hetero xylous wood**.



Activity of Ray initial : - Periclinal divisions are also going on continuously in ray intials of vascular cambium. Some of the cells are formed towards inside and some of the cells are formed towards outside through these divisions and these cells are made up of parenchyma. Radial lines of cells of parenchyma are formed in the stem. These are called **Vascular rays or Sec. medullary rays.** They conduct **water** and **food** in **radial direction**. Order of development of vascular rays is both centripetal and centrifugal manner.

(c) Formation of Annual Rings : Annual rings are formed due to unequal activity of vascular cambium.

- The activity of cambium does not remain same, it is **changeable** through out whole year. Activity of vascular cambium is affected by physiological and environmental factors.
- In **winter** or **autumn** season the activity of the cambium is less and forms fewer xylary elements. Cells formed during this period, are small, thick walled darker with higher density and have narrow lumens. This is called **autumn wood** or **late wood**.
- The vascular cambium is highly active in **spring** or **summer** season and produce a large number of xylary element and cells of secondary xylem are larger, thin walled lighter in colour with a lower density and have wider lumen. This wood is known as **spring wood** or **early wood**.

Note :

1. The **autumn** and spring wood are formed in the form of rings. The ring of any type of wood is called **growth ring**. Thus **two growth** rings are formed in one year.
2. A ring of **autumn wood** and a **ring of spring** wood are collectively known as **Annual ring**. Thus an annual ring consists of two growth rings. The numbers of annual rings, formed in a tree give the idea of the age of the tree. The study of determination of age of the plant by this technique is called **Dendrochronology**.
3. The annual rings are counted from the base of the stem because basal part has maximum annual rings and upper part has less. Therefore counting from the basal region can give the correct idea.

- The width of annual ring is less in unfavorable conditions and more in favorable conditions. Thus the annual rings are also indicative of environment period, the tree has encountered perviously.

4. A piece is taken from the stem from the base of stem with the help of **increment borer** instrument. The annual rings are counted from that piece and again inserted (fitted) into the same stem at the same place.
5. More **distinct** annual rings are formed in that region where climatic variations are sharp.
6. More distinct annual rings are formed in **temperate** plants.
7. Distinct annual rings are not formed in tropical plants.
8. Distinct annual rings are not formed in India except **Himalayan** regions.
9. Least distinct annual rings are formed in **seashore** regions because the climate remains same through out the year.

10. More clear annual rings are formed in **deciduous** plants as compared to **evergreen** plants. (In temperate region)
11. In deserts annual rings are less distinct.

Secondary Growth in Extra Stelar Region :

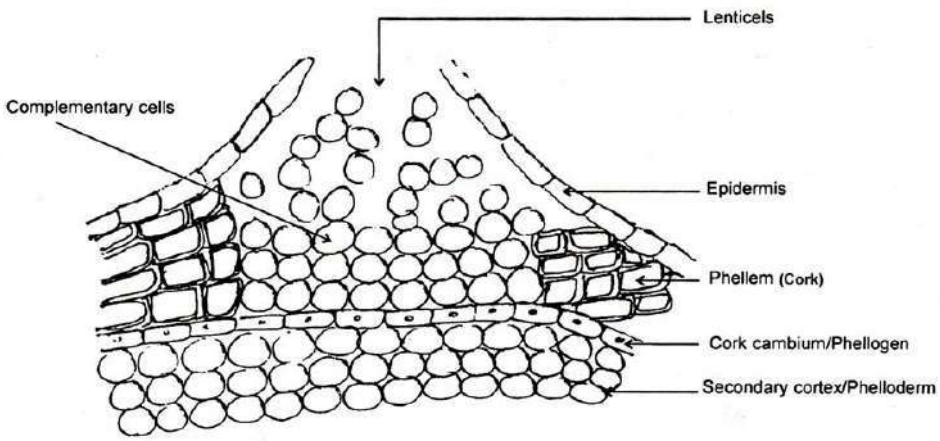
- Secondary growth takes place in extra stelar region due to the activity of cork cambium. Cork cambium is also known as Phellogen or Extrastelar cambium.
- Cork cambium arises from the hypodermis or from the outer layer of cortex because they become meristematic. Cork cambium is also formed in the form of a single layered ring. It forms secondary tissue in extra stelar region.
- Cork cambium forms some cells towards the outside (epidermis) and some cells towards the inside (cortex). Those cells formed towards outside, their middle lamella is suberized. Due to this, these cells become dead. These cells are known as Cork or Phellem. Those cells formed towards the inside, are differentiated into parenchyma and may contain chloroplasts. These are called secondary cortex or Phelloderm.

Phellem (cork) + Phellogen (cork cambium) + Phelloderm (secondary cortex) = Periderm

- Cork is formed in more quantity and secondary cortex is in less quantity because activity of Cork cambium is more towards outside. The maximum activity of cork cambium is in **winter** (Autumn) season.
- Ring of cork cambium remains living only for one year. Each year, a new cambium is formed below the previous cambium. This new cambium is derived from the secondary cortex.
- Commercial cork is obtained from *Quercus suber*.

  Rhytidome : All the tissues which occur outside the cork cambium are collectively termed as **rhytidome**. Rhytidome includes cork and tissues which become dead due to the pressure of cork.

  Lenticels: Most of the cells of phellem are dead. But at some places living cells are also found. Suberin is not deposited in these places. These places are known as **Lenticels**. Lenticels apprears on the outer surface of the plant either in small point or in the form of areas of protruberance. Lenticels are made up of scattered group of living cells. Usually they are formed below the stomata. These cells are known as **complementary cells/complementary tissue.**



Function :

1. The main function of lenticels is exchange of gases between plant and atmosphere.
2. Transpiration also takes place through the lenticles, is known as **Lenticular transpiration**.
3. Adventitious roots on cutting originate from the living cells of lenticels in vegetative reproduction.

Note :

- Lenticels are found in most of the **woody trees** but absent in woody climbers.
- Lenticles are present all over the plant body. They are also present on **fruits**.They are never found on leaves.

Bark :

- All the tissues situated out side the vascular cambium is called **Bark**. According to modern view bark includes both living and dead tissues. **Bark** has two parts.

  Outer layer of bark is called **Rhytidome** and inner layer of bark is **secondary** phloem.
- Bark that is formed early in the season is called early or soft Bark. Towards the end of season late or hard bark is formed.

KINDS OF BARK :

1. **Ring Bark : -** Continuous bark of equal thickening is called ring bark. It is formed around the stem in the form of a complete ring. In ring bark cork cambium is continuous.

   Example : - Bhojpatra **(Betula)** – A complete distinct ring bark is formed in this plant. Its bark was used as a **writing material**/as a paper in **ancient period**. Ring bark is also formed in **Eucalyptus**.
2. **Scaly Bark : -** Discontinuous bark of unequal thickening is called scaly bark. This bark is formed around the stem in the form of pieces or fragments. Highly obvious scaly bark is formed in *Psidium guajava*. Except this scaly bark is also formed in Neem (*Azadirachta*), Mango (*Mangifera indica*) and *Tamarindus* etc plants.

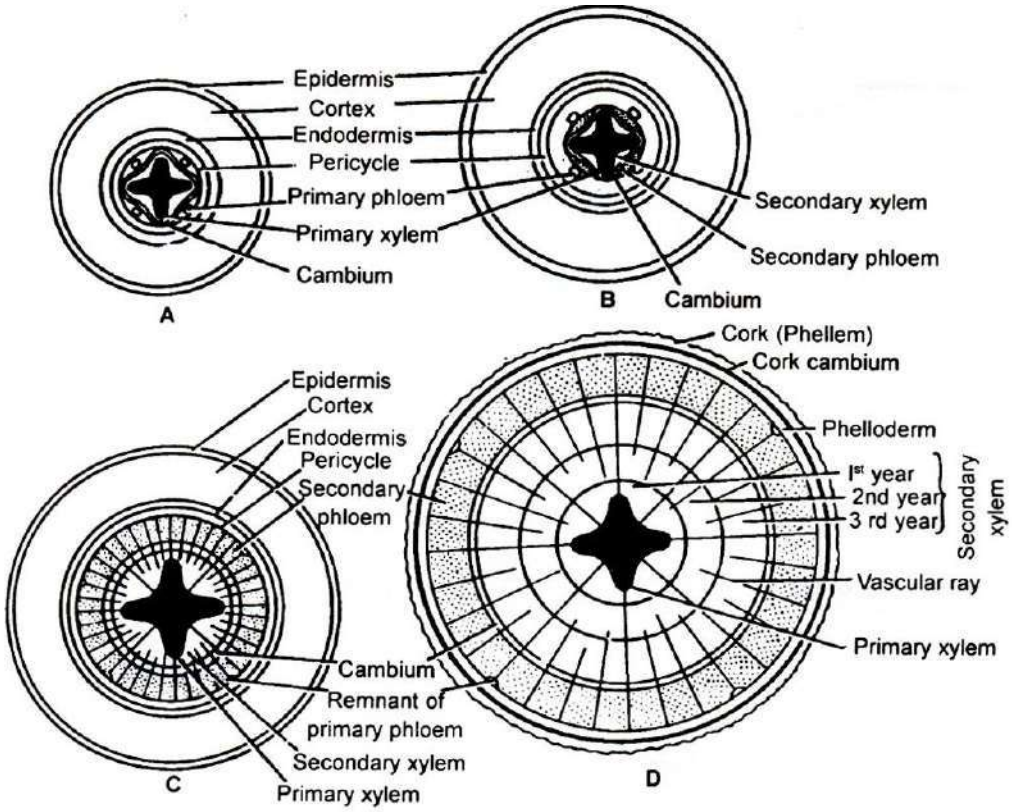
- If complete bark of tree is removed then plant becomes dead due to excessive water loss.
- If bark is removed in the form of ring at the base of main stem then root will die first due to lack of food.

SECONDARY GROWTH IN DICOT ROOT

- First of all, conjunctive tissue becomes meristematic during the secondary growth in a dicotyledon root and form separate **curved strips** of vasular cambium below phloem bundles. Then after, the cells of pericycle lying opposite to protoxylem also become meristematic to form additional strips of cambium. In this way a complete ring of vascular cambium is formed.

  The portion of vascular cambium formed by pericycle is less. The main portion of vascular cambium is formed by conjunctive tissue. Vascular cambiums in roots are secondary in origin.
- The activity of vascular cambium of root is the same as the activity of vascular cambium of stem. Secondary xylem is formed towards the inner side and secondary phloem is formed towards the outer side by vascular cambium. The portion of vascular cambium which is formed by pericycle is responsible for the formation of **pith rays.** These are made up of parenchyma. These pith rays are known as **primary medullary rays** (Multiseriate). A few medullary or pith rays are also formed from remaining vascular cambium. These are called **secondary medullary rays** (uniseriate). Thus two types of medullary rays are found in the secondary structure of roots.

Note : The presence of two types of medullary rays is basic characteristic feature of roots. Only secondary medullary rays are found in stem after the secondary growth. Both of them conduct **water** and **food in radial direction.**



DIFFERENT STAGES IN SECONDARY GROWTH OF DICOT ROOT

- Cork cambium is developed from the **pericycle** in roots. Cork is formed towards the outside and secondary cortex is formed towards the inner side by the cork cambium. Lenticles are also found in roots but less in number as compared to stem. Cortex completely degenerate in roots after the secondary growth of one or two years. This falls down due to the pressure of cork, whereas in stem, it degenerates after the long duration.

(i) Secondary growth is essential in roots to provide strength to the growing aerial parts of the plants and fulfill the requirement of water and minerals.

(ii) Annual rings are not formed in roots because these are not effected by the changes of environment.

(iii) Secondary growth is not found in monocot roots. Secondary growth present in *Yucca* and *Dracnea*.

(iv) In roots, all cambia are secondary in origin.

Wound Healing :

- When any plant part gets injured wound is formed there. Boundary of the wound is raised outside and composed of similar type of living cells (Parenchyma) called callus. Living cells of wound are responsible to form a cambium. This is called **wound Cambium**. It is also called **inducible cambium**. This newly formed cambium forms cork towards the outside. This cork covers the wound entirely. Wound cambium is a secondary lateral meristem.

Abscission : -

- Falling of any plant organ without harming plant is called as abscission.
- Abscission takes place due to formation of abscission layer at the base of plant organ and it is composed of parenchyma.
- ABA induces the formation of abscission layer.

- Middle lamella is dissolved and form abscission layer during abscission and primary walls also dissolve partially or completely. Sign of leaf fall on stem is called **leaf scar**. It is a type of wound. The living cells of leaf scar are responsible to form **cork cambium**. At the site of abscission **protective layer** is found which is **suberized.**

  Knots : Knot is formed when branches are embedded inside the main stem.

  Grafting : - Grafting is not possible in monocots because **cambium is absent** there.

ANOMALOUS SECONDARY GROWTH IN DICOT STEM

1. **Anomalus/abnormal position of vascular cambium : -**

   Normally vascular cambium is circular, but it is folded in stem of some plants later on these folds break and separate from each other. Each fold is responsible to form a complete vascular bundle. Many vascular bundles are formed in stem.

   Example : - *Thinouia, Serjania, Bauhinia*.

2. **Abnormal Activity of vascular cambium : -**

   Generally xylem and phloem is formed from the maximum part of the vascular cambium and medullary rays are formed from the few parts of vascular cambium. But in some plants parenchyma is formed from the maximum part of the vascular Cambium and rarely at some places xylem and phloem are formed.

   Example : - *Aristolochia, Vitis vinifera* (Grape).

3. **Sequential or successive ring of vascular cambium : -**

   In some of the plants, a new ring of vascular cambium is formed each year. This is formed out side the previous ring.

   Example : - *Mirabilis, Boerhaavia, Bougainvillea Cycas* etc.

4. **Formation of vascular cambium from pericycle : -**

   Vascular cambium is formed from the pericycle in plants of Amaranthaceae and Chinopodiaceae family. A complete ring of vascular cambium is formed from pericycle.

5. **Interxylary Cork : -**

   A cork layer that develops between the two growth rings of secondary xylem is called interxylary cork.

   Example : - *Artemesia tridentata.*

6. **Formation of cork cambium from Epidermis**

   Example : *Malus pumila, Solanum dulcamara, Quercus suber* (oak).

   The commerical cork is obtained from the plant *Quercus suber***.**

7. **Formation of cork cambium from pericycle : -** Example – *Clematis* &*Thuja*
8. **Formation of cork cambium from phloem : -** *Vitis* and *Berberis*

ANOMALOUS SECONDARY GROWTH IN MONOCOT STEM

- In some members of plants such as *Dracaena, Yucca, Agave, Aloe arboresence, Lomandra, Kingia, Sanseviera,* etc. vascular cambium is formed from the outer region of the ground tissues. Parenchyma is formed towards the outside by the vascular cambium and secondary vascular bundles are formed towards the inner side.
- In some plants, the **girth** of the stem increases without cambium. Such as – **Palm, Musa, Tulipa** etc. The apical meristem of these plants is of special type. This is known as **primary thickening meristem**. This apical meristem is repsonsible for the growth in both length and girth (thickness) of the plant.
- In Cycas and *Gnetum ula* successive ring of vascular cambium is found.
- In Thuja stem cork cambium is derived from pericycle.

Special Points :

Billiards's ball ⟶ ***Phytelophus*** *(Ivory Palm)*
Violin ⟶ Picea (Spruce)
Hardest wood ⟶ *Hardwickia binata*
Heaviest wood ⟶ *Guaiacum officinale*
Lightest wood ⟶ *Ochroma pyramidale* or *Ochroma lagopus*
Heaviest wood of India ⟶ *Acacia sundra*
Most durable soft wood ⟶ *Cedrus deodar*

IMPORTANT COMPARISON TABLES

Porous wood (Hard wood)	Non porous wood (Soft wood)
(i) This wood is found in angiosperms	It is found in Gymnosperms.
(ii) Vessels are present.	Vessels do not present.
(iii) This wood is hard.	It is soft.
(iv) Xylem fibres are present.	Xylem fibres are rarely present.
(v) Vessels are more in porous wood.	Xylem tracheids are dense.
(vi) It is also called heteroxylous wood	It is called homoxylous wood.

Duramen (Heart wood)	Alburnum (Sap wood)
(i) Duramen wood dark in colour.	Alburnum wood light in colour.
(ii) This wood does not conduct water.	Alburnum wood conduct the entire water.
(iii) In this wood, Tyloses are present.	In this wood tyloses are not present.
(iv) It gives the mechanical support to the plant.	It does not gives mechanical support.
(v) It is present in the central part of the tree stem.	It is found in outer part of stem.

Spring wood	Autumn wood
(i) Spring wood are generally light brown in colour.	Autumn wood are dark brown in colour.
(ii) In plant, its quantity is more.	In plant, its quantity is less.
(iii) Its vessel are broad and with large cavity.	Its vessels are small and with narrow cavity.
(iv) It is made up in favourable conditions.	It is made up in unfavourable conditions.
(v) It is produce from more activity of cambium.	It is produce from less activity of cambium.
(vi) In wood, the fibre are less present.	In wood, the fibre are more present.

EXERCISE – 1

MERISTEMATIC TISSUE

Q.1 Maximum absorption of water by the roots takes place through the region of.....
(1) Root cap (2) Meristematic zone
(3) Root hair (4) Mature cells

Q.2 Plastochron occurs in-
(1) Shoot apex (2) Root apex
(3) Shoot apex and root apex both
(4) Root cap

Q.3 Position of shoot apex and root apex is respectively-
(1) Sub terminal and terminal
(2) Terminal and sub terminal
(3) Both sub terminal
(4) Lateral and intercalary

Q.4 Which of the following is the example of sec. meristem-
(1) Procambium
(2) Intra fascicular cambium
(3) Accessory cambium
(4) Plerome

Q.5 Which of the following is the character of meristem-
(1) Well developed inter cellular spaces
(2) Thick cell walls
(3) Absence of vacuoles and prominent nucleus
(4) Presence of sec. cell wall

Q.6 Tunica-corpus theory proposed by-
(1) Foster (2) Hanstein
(3) Schmidt (4) Karl nageli

Q.7 How many histogens are found in monocot root apex-
(1) One (2) Two
(3) Three (4) Four

Q.8 Which of the following structure is to protect the shoot apex-
(1) Root - cap (2) Calyptra
(3) Primordial leaves (4) Dermatogen

Q.9 Which of the following factor induce the changes of vegetative shoot apex into reproductive shoot apex-
(1) Florigen (2) Light
(3) Florigen and light both
(4) None

Q.10 Which of the following is not a sec. lateral meristem-
(1) Vascular cambium of root
(2) Cork cambium
(3) Wound cambium
(4) Intra-fascicular cambium

Q.11 Which of the following is incorrect for reproductive shoot apex-
(1) It is formed at the time of flowering
(2) Little activity on flank and more activity on summit zone
(3) It is consumed in the formation of floral parts
(4) Cyclic plastochromic changes are present

Q.12 Leaf primordia grows into adult lamina by the activity of-
(1) Apical meristem (2) Marginal meristem
(3) First apical and then marginal meristem
(4) Lateral meristem

Q.13 Dividing tissue present in between xylem and phloem of primary stem in plants is-
(1) Secondary cambium
(2) Apical meristem
(3) Intrafascicular cambium
(4) Interfascicular cambium

PERMANENT TISSUE

Q.14 In stem vascular cambium & cork cambium form sec. tissues respectively in which region-
(1) Cortical region & vascular region
(2) Intrastelar region & extrastelar region
(3) Both in stelar region
(4) Both in extra region

Q.15 A secondary xylem is called porous wood when it posses -

(1) Pores (2) Vessels

(3) Only tracheids (4) Parenchyma cells

Q.16 Sieve tube & companion cell occur in the phloem of-

(1) Gymnosperm & monocots

(2) Gymnosperm and angiosperm

(3) Gymnosperm and dicots

(4) Dicots and monocots

Q.17 Position of sieve plates in Angiosperm and Gymnosperm respectively-

(1) Lateral wall and end wall

(2) Lateral wall and lateral wall

(3) End wall and lateral wall

(4) End wall & end wall

Q.18 Which of the following is a well differentiated plant tissues-

(1) Promeristem

(2) Vascular cambium

(3) Parenchyma

(4) Lateral meristem

Q.19 Position of stomata in bifacial & equifacial leaves is respectively-

(1) Astomatic and amphistomatic

(2) Amphistomatic and hypostomatic

(3) Hypostomatic and amphistomatic

(4) Hypostomatic and hypostomatic

Q.20 Seat of the origin of lateral roots or secondary root is-

(1) Endodermal cells against phloem

(2) Pericycle against protoxylem

(3) Cortical cells below roots hairs

(4) Piliferous layer

Q.21 Vessels differ from tracheids in-

(1) Presence of pitted end wall

(2) Presence of thick wall

(3) Absence of bordered pits

(4) Being syncytes

Q.22 Chloroplasts may occur in which of the following tissue-

(1) Parenchyma and sclerenchyma

(2) Parenchyma and sclereids

(3) Parenchyma and collenchyma

(4) Collenchyma and sclerenchyma

Q.23 Which of the following statement is true-

(1) Epidermis is always single layered

(2) Flank zone is more active in reproductive shoot apex

(3) Parenchyma and collenchyma tissues act as potential meristem

(4) Well developed vacuoles are found in sclerenchyma

Q.24 Fibre tracheids are-

(1) Libriform fiber (2) Phloem fiber

(3) Xylem fiber (4) Sclereids

Q.25 Bordered pits occurs in-

(1) Tracheids of monocots

(2) Sieve tube of monocots

(3) Sieve cell of dicot

(4) Companian cell of dicot

Q.26 Which of the following is not the character of stem-

(1) Conjoint, collateral V.B.

(2) Endarch condition

(3) Exarch condition

(4) Presence of cuticle

Q.27 The chief function of parenchymatous tissue is to-

(1) Synthesize food

(2) Storage of food

(3) Absorb water and minerales

(4) All the above

Q.28 A mature sieve tube is different from a vessel in-

(1) Absence of functional nucleus

(2) Being dead

(3) Absence of cytoplasm

(4) Absence of lignified wall

Q.29 Ectophloic siphonostele means-
(1) A condition in which xylem and phloem absent
(2) A condition when phloem ring present outside the xylem
(3) A condition when pericycle is not present in plant
(4) When phloem ring is present both the side of xylem

Q.30 When stelar system is composed of meristele it is called-
(1) Protostele (2) Siphonostele
(3) Atactostele (4) Dictyostele

Q.31 Which of the following is the example of living syncyte-
(1) Vessels
(2) Sieve tube
(3) Latex vessel
(4) Sieve tube & latex vessel

Q.32 External protective tissues are-
(1) Cortex and epidermis
(2) Cork and pericycle
(3) Cortex and pericycle
(4) Cork and epidermis

Q.33 The Cambium is made up of -
(1) Fusiform initials and Ray initials
(2) Secondary xylem and secondary phloem
(3) Hard bast and soft bast
(4) Bulliform cells and Periderm

Q.34 Para - rubber is obtained from latex of -
(1) *Calotropis*
(2) *Euphorbia*
(3) *Hevea brasiliensis*
(4) None of these

Q.35 Conjunctive tissue present-
(1) Between xylem and phloem strands of root
(2) Between metaxylem and protoxylem of stem
(3) Between protoxylem and metaxylem of root
(4) Between xylem and phloem of stem

Q.36 Identifying features in T.S. of stem and root-
(1) Presence of cortex and position of protoxylem
(2) Type of V.B. and presence of cambium
(3) Types of V.B. and position of protoxylem
(4) Presence and absence of epidermis

Q.37 Origin of vegetative branches and adventitious root is respectively-
(1) Endogenous and exogenous
(2) Exogenous and endogenous
(3) Both are exogenous
(4) Both are endogenous

Q.38 Formation of sec. xylem and sec. phloem in which order (respectively)-
(1) Centripetal and centrifugal
(2) Centrifugal and centripetal
(3) Both centrifugal
(4) Both centripetal

Q.39 Which tissues form wood-
(1) Secondary xylem
(2) Secondary xylem + sec. phloem
(3) Secondary xylem + sec. phloem + cambium
(4) Sec. xylem + primary phloem + primary xylem

Q.40 Grafting is not possible in monocot due to-
(1) Scattered V.B.
(2) Absence of cambium
(3) Presence of phloem
(4) Presence of xylem

Q.41 Bulliform cells are found in the leaves of-
(1) *Solanum tuberosum*
(2) *Tinospora cordiflolia*
(3) *Triticum aestivum*
(4) *Helianthus annus*

Q.42 Dermatogen, periblem, and plerome are-
(1) Intermediate tissue
(2) Meristematic tissue
(3) Permanent tissue
(4) Secondary tissue

Q.43 Which type of vascular bundle is found in the stem of *Pinus*-
(1) Conjoint, collateral and exarch
(2) Conjoint, collateral and endarch
(3) Radial and diarch
(4) Conjoint, bicollateral and endarch

Q.44 True statement for inter fascicular cambium is-
(1) Primary meristem
(2) Found in plant from embryonal stage
(3) Formed by dedifferentiation
(4) Present inside the V.B.

Q.45 Sugar transporting element in Gymnosperm and angiosperm are respectively-
(1) Sieve tube & sieve cell
(2) Tracheid and sieve tube
(3) Sieve cell & vessels
(4) Sieve cell and sieve tube

Q.46 Which of the following tissues does not contain chloroplast and vacuole-
(1) Palisad tissue (2) Spongy tissue
(3) Chlorenchyma (4) Vessel and tracheid

Q.47 Incorrect statement about vessels-
(1) Vessels are example of syncyte
(2) Lumen is continuous
(3) Multicellular with wide lumen
(4) It contain nucleus at maturity

Q.48 A tissue with spiral thickening in the cell wall capable of absorbing water from air is known as-
(1) Cork (2) Velamen
(3) Epidermis (4) Hypodermis

Q.49 Pericycle in root is for-
(1) Formation of lateral root
(2) Providing mechanical support
(3) Formation of vascular bundles
(4) Separating vascular bundles from cortex

Q.50 The correct situation of mesophyll in isobilateral grass leaf is-
(1) Palisade towards adaxial surface
(2) Palisade towards abaxial surface
(3) Undifferentiated mesophyll
(4) Palisade along both the surface

Q.51 Occurrence of vessels in xylem is the-
(1) Primitive character
(2) Advance character
(3) Character of ancestors
(4) Character of pteridophytes

Q.52 Which statement is wrong-
(1) Eustele is found in stem of dicot & Gymnosperms
(2) Protostele is most primitive type of stele
(3) Dictyostele is the most advance type of stele
(4) Bicollateral V.B. are found in stem of family cucurbitaceae

ANSWER KEY

EXERCISE – 1

Q.1	3	Q.2	1	Q.3	2	Q.4	3	Q.5	3	Q.6	3	Q.7	4
Q.8	3	Q.9	3	Q.10	4	Q.11	1	Q.12	3	Q.13	3	Q.14	2
Q.15	2	Q.16	4	Q.17	3	Q.18	3	Q.19	3	Q.20	2	Q.21	4
Q.22	3	Q.23	3	Q.24	3	Q.25	1	Q.26	3	Q.27	2	Q.28	1
Q.29	2	Q.30	4	Q.31	4	Q.32	1	Q.33	1	Q.34	2	Q.35	1
Q.36	3	Q.37	2	Q.38	1	Q.39	1	Q.40	2	Q.41	3	Q.42	2
Q.43	2	Q.44	3	Q.45	4	Q.46	4	Q.47	4	Q.48	2	Q.49	1
Q.50	3	Q.51	2	Q.52	3								

EXERCISE – 2

PRIMARY STRUCTURE

Q.1 In dicot root vascular cambium derived from conjuctive tissue form -
(1) Sec. xylem and sec. medullary rays
(2) Sec. phloem & sec. xylem
(3) Sec. xylem, sec. phloem, primary and sec. medullary rays
(4) Sec. xylem, sec. phloem and sec. medullary rays

Q.2 Mesophyll is differentiated in to palisade and spongy tissues in -
(1) Some dicot deaves
(2) All dorsiventral leaves
(3) All monocot leaves
(4) All the isobilateral leaves

Q.3 Shape of guard cells in monocot plants is-
(1) Kidney shape
(2) Bean seeds shape
(3) Dumb-bell shape or bone shape
(4) Oval

Q.4 In monocots and dicots the number of cotyledons are normally 1 and 2 respectively in gymnosperm the number of cotyledons are -
(1) 1 or 2 (2) 3 – 18
(3) 2 - 3 (4) Zero

Q.5 Which of the following pair is correctly matched-
(1) Bicollatered V.B. - maize root
(2) Collateral & closed V.B. - *Cucurbita* stem
(3) Collateral & open V.B. - sunflower root
(4) Radial V.B. - orchid root

Q.6 Pericycle and endodermis is absent in-
(1) Maize stem & sunflower stem
(2) Maize stem & root
(3) Maize stem (4) All of the above

Q.7 Which statement is correct-
(1) Collateral V.B. are always open
(2) Bicollateral V.B. are always open
(3) Bulliform cells are present in bifacial leaf
(4) Concentric V.B. are always open

Q.8 Which statement is correct-
(1) Roots of all plants are photosyntheti
(2) In dicot root pith well developed
(3) In monocot root and dicot stem pith is well developed
(4) Passage cells are found in pericycle

Q.9 Eustele is found in -
(1) All dicot and monocot stem
(2) All dicot root and monocot stem
(3) Dicot stem
(4) Stem of dicot & gymnosperm

Q.10 In vertical section of a typical dicot leaf phloem in mid vein is situated -
(1) Facing the upper epidermis
(2) Facing the lower epidermis
(3) Facing sideway
(4) All round the xylem

Q.11 In which Y-shaped primary xylem is found-
(1) Dicot leaf (2) Monocot stem
(3) Monocot root (4) Dicot stem

Q.12 Monocot leaves are characterised by-
(1) Bulliform cells are absent
(2) Phloem on abaxial side
(3) Permanently open stomata
(4) Lack of differentiation between palisade and spongy tissue

Q.13 A transverse section of material shows many alternate patches of xylem and phloem almost in ring with a prominent pith, this will be-
(1) Dicot root (2) Dicot stem
(3) Monocot stem (4) Monocot root

Q.14 Which of the following set of characters are found in dicot stem but not in monocot stem-
(1) Phloem parenchyma, endodermis and vessels
(2) Cortex, pith and companian cell
(3) Endodermis, pericycle and phloem parenchyma
(4) Conjoint, collateral V.B.

Q.15 Characteristic feature of quiescent centre is-
(1) Cells have low amount of DNA, RNA and protein
(2) Cells are normally inactive
(3) Cells have small nuclei
(4) All are correct

Q.16 Most primitive and most advance stele in pteridophyta respectively-
(1) Protostele and atactostele
(2) Protostele and dictyostele
(3) Protostele and eustele
(4) Eustele and atactostele

Q.17 Hypodermis of dicot stem and monocot stem respectively composed of-
(1) Sclerenchyma and collenchyma
(2) Collenchyma and sclerenchyma
(3) Only collenchyma
(4) Only sclerenchyma

SECONDARY GROWTH

Q.18 Function of phellogen is to form the -
(1) Secondary xylem and phloem
(2) Secondary cortex and phloem
(3) Cork and secondary cortex
(4) Cork and wood

Q.19 Distinct annual rings occurs in plants growing in-
(1) Tropical region
(2) Arctic region
(3) Regions with seasonal changes
(4) Regions where no seasonal changes

Q.20 The cells forming phellogen are-
(1) Collenchymatous
(2) Parenchymatous
(3) Parenchymatous or collenchymatous
(4) Sclerenchymatous

Q.21 The function of heart wood in plants-
(1) Mechanical support
(2) Conduction of food
(3) Conduction of water
(4) Storage of food

Q.22 The youngest layer of secondary xylem in a 5 yrs. old dicot stem lies-
(1) Just outside the cambium
(2) Just inside the cambium
(3) Adjacent the pith
(4) Adjacent to cortex

Q.23 Which part of wood is light coloured, young and functionally active-
(1) Heart wood (2) Sap wood
(3) Soft wood (4) None

Q.24 Sap wood is-
(1) Outer part of secondary xylem
(2) Inner part of secondary xylem
(3) Outer part of secondary phloem
(4) Inner part of secondary phloem

Q.25 Ballon like in growth of xylem parenchyma into the lumen of vessels is known as-
(1) Tunica (2) Tyloses
(3) Phellogen (4) Phelloderm

Q.26 Where young secondary xylem cell may be found in a seven year old dicot stem -
(1) Just outside cambium
(2) Just inside cambium
(3) Just outside cork cambium
(4) Just inside cork cambium

Q.27 Living mechanical tissue devoid of lignin is-
(1) Parenchyma (2) Collenchyma
(3) Sclerenchyma (4) All the above

Q.28 The cells of xylem of early wood formed during early spring have-
(1) Wide lumen, thick walls
(2) Wide lumen, thin walls
(3) Narrow lumen and thin walls
(4) Narrow lumen and thick walls

Q.29 Which of the following is not the character of stem-
(1) Conjoint, collateral V.B.
(2) Endarch condition
(3) Exarch condition
(4) Presence of cuticle

Q.30 Which of these exhibits secondary growth-
(1) Gametophytes of pteridium
(2) Gymnosperm's stem and monocot stem
(3) Root and stem of gymnosperm and dicot
(4) Stem and leaf of gymnosperm and monocot

Q.31 Tyloses occur in-
(1) Primary xylem only
(2) Secondary xylem only
(3) Secondary and primary xylem
(4) Secondary xylem and secondary phloem

Q.32 In a woody dicot stem which wood is physiologically most active-
(1) Duramen
(2) Albernum & duramen
(3) Sap wood & heart wood
(4) Albernum or sap wood

Q.33 The youngest layer of sec. phloem in a woody dicot stem is located-
(1) Just outside pith
(2) Just outside the cambium
(3) Just inner side of primary xylem
(4) Just outside the primary xylem

Q.34 Fascicular cambium is the example of-
(1) Primary meristem
(2) Secondary meristem
(3) Primary and secondary meristem both
(4) Dedifferentiation

Q.35 Which statement is true-
(1) Albernum is central portion of wood
(2) Duramen is meant for ascent of sap
(3) Tyloses mainly occur in duramen
(4) In woody plant cambium functions for few years

Q.36 Duramen or heart wood is-
(1) Physiologically inactive part of wood
(2) Dark in colour
(3) Non conducting part of xylem in old stem
(4) All the above

Q.37 Secondary growth is due to-
(1) Ground meristem (2) Procambium
(3) Intercalary cambium
(4) Vascular cambium

Q.38 With increasing secondary growth in trees-
(1) Sap wood increases
(2) Heart wood increases
(3) Both (1) and (2)
(4) Both increases in equal quantities

Q.39 In dicot stem cork cambium derived from-
(1) Outer layer of cortex
(2) Pericycle
(3) Endodermis (4) Epidermis

Q.40 Which factor most affects the activity of cambium-
(1) Humidity (2) Temperature
(3) Winter (4) Availability of water

Q.41 The formation of distinct annual rings in stem mainly depends upon-
(1) Formation of cork cambium
(2) Unequal activity of cork cambium
(3) Contrasting seasonal variation
(4) Formation of unequal amount of phloem & xylem

Q.42 Annual rings are formed due to activity of-
(1) Extra stelar cambium
(2) Intrastelar cambium
(3) Sec. xylem and sec. phloem
(4) Extra stelar & intrastelar cambium

Q.43 In dicot root a part of vascular cambium is derived from-
(1) Endodermis opposite to protoxylem
(2) Pericycle opposite to phloem
(3) Pericycle opposite to protoxylem
(4) Endodermis opposite to phloem

Q.44 In dicot root and stem ring of cork cambium is respectively-
(1) Primary & secondary
(2) Secondary & primary
(3) Secondary meristem
(4) None of these

Q.45 The initial cambium arch in root arise from cells located just-
(1) Outer to phloem (2) Outer to xylem
(3) Inner to phloem
(4) Outer to xylem & inner to phloem

Q.46 Interxylary or included cork is formed in wood of-

(1) *Chenopodium* (2) *Epibolium*

(3) *Amaranthus* (4) *Dracena*

Q.47 Wood of which plant contain only tracheids-

(1) *Tectona* (2) *Ephedra*

(3) *Cycas* (4) *Gnetum*

Q.48 In dicot root pericycle form-

(1) Secondary roots

(2) Cork cambium

(3) Vascular cambium

(4) Lateral roots, phellogen and some part of V.C.

Q.49 In one year how many growth rings are formed in root-

(1) Two (2) One

(3) Many (4) None

Q.50 Youngest layer of sec. xylem is adjacent to-

(1) Pericycle (2) Vascular cambium

(3) Cortex (3) Pith

Q.51 Which of the following statement is correct about phellogen of stem-

(1) Phellogen is primary in origin

(2) Phellogen is secondary in origin

(3) Phellogen is example of apical meristem

(4) Phellogen is composed of parenchymatous & sclerenchymatous tissue

ANSWER KEY

EXERCISE – 2

Q.1	4	Q.2	2	Q.3	3	Q.4	2	Q.5	4	Q.6	3	Q.7	2
Q.8	3	Q.9	4	Q.10	2	Q.11	2	Q.12	4	Q.13	4	Q.14	3
Q.15	4	Q.16	2	Q.17	2	Q.18	3	Q.19	3	Q.20	3	Q.21	1
Q.22	2	Q.23	2	Q.24	1	Q.25	2	Q.26	2	Q.27	2	Q.28	1
Q.29	3	Q.30	3	Q.31	2	Q.32	4	Q.33	2	Q.34	3	Q.35	3
Q.36	4	Q.37	4	Q.38	2	Q.39	1	Q.40	2	Q.41	3	Q.42	2
Q.43	3	Q.44	3	Q.45	3	Q.46	1	Q.47	3	Q.48	4	Q.49	4
Q.50	2	Q.51	2										

EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Fibres are obtained from **[JIPMER 2002]**

(1) Xylem, phloem and sclerenchyma

(2) Xylem, phloem, sclerenchyma and epidermis

(3) Xylem, parenchyma, epidermis

(4) Xylem, parenchyma, endodermis

Q.2 The quiescent centre in root meristem serves as a **[AIIMS 2003]**

(1) Site for storage of food which is utilized during maturation

(2) Reservoir of growth hormones

(3) Reserve for replenishment of damaged cells of the meristem

(4) Region for absorption of water

Q.3 The outermost primary meristem gives rise to **[CPMT 2001]**

(1) Epidermis (2) Procambium

(3) Ground meristem (4) All of the above

Q.4 Root cap regenerates or produced from **[MP PMT 2003]**

(1) Calyptrogen

(2) Pleurome

(3) Periblem and histogen

(4) Dermatogen

Q.5 Tunica corpus theory was proposed by **[MP PMT 2001]**

(1) Schmidt (2) Strasburger

(3) Nageli (4) Hofmeister

Q.6 Vascular cambium of the root is an example of **[BHU 2000; AIIMS 2000]**

(1) Apical meristem

(2) Intercalary meristem

(3) Secondary meristem

(4) Root apical meristem

Q.7 Vascular cambium and cork cambium are examples of **[J&K CET (Med.) 2002]**

(1) Lateral meristem

(2) Apical meristem

(3) Elements of xylem and phloem

(4) Intercalary meristem

Q.8 Quiescent centre is found in **[CPMT 1993, 2002]**

(1) Stem (2) Root

(3) Leaves (4) None of these

Q.9 Grass stem elongates by the activity of **[APMEE 2002; KCET 2003]**

(1) Primary meristem

(2) Secondary meristem

(3) Intercalary meristem

(4) Apical meristem

Q.10 The calyptrogen of the root apex forms **[MP PMT 2003]**

(1) Rhizoids (2) Root nodule

(3) Root hairs (4) Root cap

Q.11 Aerenchyma is found in **[JIPMER 2001; CPMT 2002]**

(1) Lithophytes (2) Hydrophytes

(3) Sciophytes (4) Xerophytes

Q.12 Parenchymatous tissue is characterised by the **[JIPMER 2002]**

(1) Presence of uniform thickening

(2) Presence of thickening in the corners

(3) Presence of intercellular spaces

(4) Presence of lignified walls

Q.13 The difference in phloem of gymnosperms and angiosperms is due to **[RPMT 2002]**

(1) Parenchyma (2) Sieve cell

(3) Companion cell (4) Fibres

Q.14 Cork cambium is a **[CET Chd. 2001; J&K CET 2002]**

(1) Secondary meristem

(2) Apical meristem

(3) Intercalary meristem

(4) Primary meristem

Q.15 The complex tissues include **[BVP 2003]**

(1) Scleroids (2) Sclerenchyma

(3) Secretory tissues (4) Collenchyma

Q.16 The cell wall of xylem cells is rich in **[MPPMT 2002]**

(1) Lipid (2) Protein

(3) Lignin (4) Starch

Q.17 Root cap is absent in **[RPMT 2002]**

(1) Lithophytes (2) Hydrophytes

(3) Xerophytes (4) Mesophytes

Q.18 Which meristem helps in increasing girth **[RPMT 2002]**

(1) Lateral meristem (2) Intercalary meristem
(3) Primary meristem (4) Apical meristem

Q.19 Vessels are the major conducting element mainly found in **[J&K CET (Med.) 2002; KCET 2003]**

(1)Xylem of angiosperms
(2) Xylem of gymnosperms
(3) Both (1) and (2) (4) None of these

Q.20 Trachieds and vessels related to **[CPMT 2003]**

(1) Xylem (2) Phloem
(3) Both (4) None of these

Q.21 Passage cells are found in **[AIIMS 2002]**

(1) Dicot stem (2) Aerial root
(3) Monocot root (4) Monocot stem

Q.22 Vessels are found in **[CBSE PMT 2002]**

(1) All pteridophyta (2) All angiosperms
(3) Some gymnosperm
(4) Both (2) and (3)

Q.23 Axillary bud and terminal bud are derived from the activity of **[CBSE PMT 2002]**

(1) Parenchyma (2) Lateral meristem
(3) Apical meristem (4) Intercalary meristem

Q.24 Cells of quiescent centre are characterised by **[CPMT 2003]**

(1) Dense cytoplasm and prominent nuclei
(2) Light cytoplasm and small nuclei
(3) Dividing regularly to add to the corpus
(4) Dividing regularly to add to tunica

Q.25 Apical meristem of root is present **[CPMT 2003]**

(1) Only in radicles
(2) Only in tap roots
(3) Only in adventitious roots
(4) In all the roots

Q.26 Vessels occur in **[CPMT 2002]**

(1) All angiosperms, all gymnosperms and some pteridophytes
(2) All angiosperms, and some gymnosperms
(3) Most angiosperms, a few gymnosperms and pteridophytes
(4) All pteridophytes

Q.27 Which is correct **[CBSE 2002]**

(1) Tracheids are unicellular with wide lumen
(2) Vessels are multicellular with wide lumen
(3) Tracheids are multicellular with narrow lumen
(4) Vessels are unicellular with narrow lumen

Q.28 Which of the following are simple tissues **[CPMT 2000]**

(1) Parenchyma, xylem and phloem
(2) Parenchyma, collenchyma and sclerenchyma
(3) Parenchyma, xylem and collenchyma
(4) Parenchyma, xylem and sclerenchyma

Q.29 Diffuse porous woods are characteristics of plants growing in **[CBSE PMT 2003]**

(1) Alpine regions (2) Cold winter regions
(3)Temperate regions (4) Tropical regions

Q.30 Porous wood contains mainly **[AIIMS 2001]**

(1) Fibres (2) Vessels
(3) Trachieds (4) Solid secretions

Q.31 Bordered pits are very common in **[Wardha 2002]**

(1) Monocotyledons (2) Gymnosperms
(3) Dicotyledons (4) Pteridophytes

Q.32 Which of the following is known as wood **[AFMC 2003]**

(1) Primary xylem (2) Secondary xylem
(3) Secondary phloem (4) Cambium

Q.33 Conducting part of phloem according to Haberlandt (1914) is **[J & K CET (Med.) 2002]**

(1) Hadrom (2) Leptom
(3) Sterom (4) Bark

Q.34 Epidermis in stem is produced from **[BHU 2002]**

(1) Protoderm (2) Procambium
(3) Ground meristem (4) Calyptrogen

Q.35 Trabaculae is the transformation of **[MP PMT 2003]**

(1) Pericycle (2) Endodermis
(3) Xylem (4) Phloem

Q.36 Which of the following is absent in the primary and secondary structure of stem of Pinus **[AIIMS 2000]**

(1) Seive tubes (2) Mucilage duct
(3) Companion cells (4) Phloem parenchyma

Q.37 Epiblema in roots is derived from **[BHU 2002]**
(1) Protoderm (2) Procambium
(3) Ground meristem (4) Calyptrogen

Q.38 Procambium forms **[DPMT 2001]**
(1) Only primary vascular bundles
(2) Only vascular cambium
(3) Only cork cambium
(4) Primary vascular bundles and vascular cambium

Q.39 Periblem produces **[MP PMT 2001]**
(1) Cortex (2) Pericycle
(3) Vascular strand (4) Both (2) and (3)

Q.40 Cells taking part in conduction of sap are **[Kerala 2000]**
(1) Sieve tubes (2) Tracheae
(3) Sieve cells (4) Stone cells

Q.41 Function of vessels is **[BHU 2000]**
(1) Conduction of water and mineral
(2) Conduction of food
(3) Mechanical strength
(4) All of the above

Q.42 Why cambium is considered as lateral meristem **[RPMT 2002]**
(1) Because it gives rise to lateral branches
(2) Because it increases the girth of a plant
(3) Because it increases the length of a plant
(4) None of these

Q.43 Aerenchyma is helpful in plants by **[BVP 2003]**
(1) Providing buoyancy in hydrophytes
(2) Promoting photosynthesis
(3) Giving mechanical strength to plants
(4) Giving flexibility to plants

Q.44 The chief function of sieve tubes is **[MPPMT 2003]**
(1) To translocate the organic materials manufactured in the leaves
(2) To conduct minerals
(3) To transport water from root to leaves
(4) To help the plant in forming wood

Q.45 At maturity, which of the following is non-nucleated **[RPMT 2002; Wardha 2002]**
(1) Sieve cell (2) Companion cells
(3) Palisade cell (4) Cortical cell

Q.46 Which combination of tissues acts together to provide the support to the hypocotyl of a seedling **[BVP 2003]**
(1) Xylem and phloem fibres
(2) Epidermis and parenchyma
(3) Xylem and parenchyma
(4) Epidermis and collenchyma

Q.47 Senescence and death are essential in the functioning of **[Pb. PMT 2000]**
(1) Sieve tubes
(2) Companion cells
(3) Both (1) and (2)
(4) Xylem and Sclerenchyma cells

Q.48 The layer of cells outside the phloem meant for giving rise to the root branches is called **[Kerala CET (Med.) 2003]**
(1) Cambium (2) Corpus
(3) Endodermis (4) Pericycle

Q.49 The lateral roots generally originate in **[DPMT 2003]**
(1) Endodermal cells lying against phloem
(2) Cortex
(3) Pericycle cells lying against protoxylem
(4) Cork cambium

Q.50 In free floating plant, the stomata are **[AFMC 2000]**
(1) Absent
(2) Present on upper surface
(3) Present on both the surface
(4) Present on lower surface

Q.51 Cuticle is secreted by **[CPMT 2002]**
(1) Epidermis (2) Endodermis
(3) Both (1) and (2) (4) Hypodermis

Q.52 Which of the following do not have stomata **[AIIMS 2000]**
(1) Xerophytes
(2) Mesophytes
(3) Hydrophytes
(4) Submerged hydrophytes

Q.53 Passage cells are present in **[KCET (Med.) 2000]**
(1) Epidermis (2) Endodermis
(3) Xylem
(4) Lenticels and hydathodes

Q.54 Velamen tissue in orchids is found in **[RPMT 2002]**

(1) Shoot (2) Root

(3) Leaves (4) Flowers

Q.55 Which of the following have sunken stomata **[RPMT 2002]**

(1) Nerium (2) Mangifera

(3) Hydrilla (4) Zea mays

Q.56 Vascular bundles in the stem of Cucurbita or Lagenaria are **[BHU 2001]**

(1) Collateral (2) Bicollateral

(3) Radial (4) Inverted

Q.57 The bicollatoral vascular bundle is the characteristic feature of plants belonging to the family **[BHU 2001]**

(1) Cruciferae (2) Liliaceae

(3) Cucurbitaceae (4) Malvaceae

Q.58 Passage cells occur in **[AIIMS 2002]**

(1) Monocot root (2) Dicot root

(3) Monocot stem (4) Both (1) and (2)

Q.59 Stomata in Water Lily and Podostemon occur respectively **[BHU 2002]**

(1) Lower leaf surface and absent

(2) Upper leaf surface and absent

(3) Both leaf surface and upper part

(4) Absent in both

Q.60 Root hairs are found **[Kerala CET (Med.) 2003]**

(1) In the zone of maturation

(2) Adventitious roots

(3) On the root cap

(4) Apical meristem

Q.61 A concentric amphivasal (leptocentric) vascular bundle is one in which **[MPPMT 2001]**

(1) Centrally located phloem is surrounded by the xylem or xylem surrounds phloem

(2) Centrally located xylem is surrounded by phloem

(3) Xylem is flanked by phloem on the interior and exterior side only

(4) Phloem is flanked by the xylem on interior side only

Q.62 Vascular bundles in which phloem is found on both sides of xylem are called (in which of the following phloem occurs on two patches) **[BVP 2003]**

(1) Collateral

(2) Bicollateral (Amphiphloic)

(3) Radial

(4) Amphicribral

Q.63 Pericycle in roots is responsible for **[KCET (Med.) 2000]**

(1) Formation of lateral roots

(2) Providing mechanical support

(3) Formation of vascular bundle from cortex

(4) Formation of vascular bundle from endodermis

Q.64 Monocot stem has **[RPMT 2002; BHU 2002]**

(1) Bicollateral closed vascular bundles

(2) Bicollateral open vascular bundles

(3) Collateral open vascular bundles

(4) Collateral closed vascular bundles

Q.65 In monocot roots which types of vascular bundles are found **[BHU 2003]**

(1) Collateral, conjoint and closed

(2) Radial V.B. with exarch xylem

(3) Bicollateral, conjoint and closed

(4) Radial V.B. with endarch xylem

Q.66 Exarch and polyarch vascular bundles occur in **[MP PMT 2000]**

(1) Monocot stem (2) Monocot root

(3) Dicot stem (4) Dicot root

Q.67 Vascular bundles are scattered in **[Kerala CET (Med.) 2002]**

(1) Bryophytes (2) Dicot root

(3) Dicot stem (4) Monocot stem

Q.68 Dorsiventral leaf has **[Kerala CET (Med.) 2002]**

(1) Stomata on both side

(2) Stomata on lower surface

(3) Stomata on upper surface

(4) No stomata

Q.69 In the leaf vascular bundles are found in the **[Kerala CET (Med.) 2003]**

(1) Veins (2) Palisade tissue

(3) Lower epidermis (4) Upper epidermis

Q.70 In a dicotyledonous stem, the sequence of tissues from the outside to the inside is **[AIIMS 2003]**

(1) Phellem - Pericycle - Endodermis - Phloem
(2) Phellem - Phloem - Endodermis - Pericycle
(3) Phellem - Endodermis - Pericycle- Phloem
(4) Pericycle - Phellem - Endodermis - Phloem

Q.71 Hypodermis in monocotyledonous stem is **[Pb. PMT 2000]**

(1) Parenchymatous (2) Chlorenchymatous
(3) Collenchymatous (4) Sclerenchymatous

Q.72 In a dorsiventral leaf, protoxylem and metaxylem are located respectively **[RPMT 2002]**

(1) Abaxial and adaxial sides
(2) Adaxial and abaxial sides
(3) Adaxial and adaxial sides
(4) Abaxial and adaxial sides

Q.73 In a longitudinal section of a root, starting from the tip upward, the four zones occur in the following order **[CPMT 2004]**

(1) Cell division, cell enlargement, cell maturation, root cap
(2) Cell division, cell maturation, cell enlargement, root cap
(3) Root cap, cell division, cell enlargement, cell maturation
(4) Root cap, cell division, cell maturation, cell enlargement

Q.74 Intrafascicular cambium is situated in **[BVP 2003]**

(1) Out side the vascular bundles
(2) In medullary rays
(3) Inside the vascular bundles
(4) In between the vascular bundles

Q.75 The waxy substance associated with cell walls of cork cells is or cork cells are impervious to water because of the presence or what is deposited on cork cells **[MP PMT 2000]**

(1) Cutin (2) Suberin
(3) Lignin (4) Hemicellulose

Q.76 If four radial vascular bundles are present, then the structure will be **[CPMT 2002]**

(1) Monocot stem (2) Monocot root
(3) Dicot stem (4) Dicot root

Q.77 The functional xylem of dicot tree is **[AFMC 2001]**

(1) Sap wood (2) Hard wood
(3) Heart wood (4) Autumn wood

Q.78 Tyloses thickenings are seen in **[CPMT 2001]**

(1) Phloem cells
(2) Ray parenchyma only
(3) Collenchyma
(4) Ray parenchyma and xylem cells

Q.79 Main function of lenticel is **[CBSE PMT 2002]**

(1) Transpiration (2) Guttation
(3) Bleeding (4) Gaseous exchange

Q.80 Heart wood or duramen is **[KCET (Med.) 2001]**

(1) Outer region of secondary xylem
(2) Inner region of secondary xylem
(3) Outer region of secondary phloem
(4) Inner region of secondary phloem

Q.81 Wood is a common name of **[J & KCET (Med.) 2002]**

(1) Phloem (2) Secondary xylem
(3) Cambium (4) Vascular bundles

Q.82 Cambium is most active in **[AFMC 2003]**

(1) Summer (2) Winter
(3) All seasons (4) Snow areas

Q.83 Sap-wood is **[AFMC 2001]**

(1) Outer functional part of secondary xylem
(2) Inner nonfunctional part of secondary xylem
(3) Outer as well as inner part of secondary xylem
(4) None of the above

Q.84 Exchange of gases in old stems takes place from **[CPMT 2001]**

(1) Stomata (2) Hydathodes
(3) Lenticels (4) Passage cells

Q.85 Vascularisation in plants occurs through **[CPMT 2000]**

(1) Differentiation of procambium followed by primary phloem and then primary xylem
(2) Differentiation of procambium followed by development of xylem and phloem
(3) Simultaneous differentiation of procambium, xylem and phloem
(4) Differentiation of procambium is immediately followed by development of secondary xylem and secondary phloem

Q.86 Tyloses are **[BHU 2000]**

(1) Wound healing secretions

(2) Responsible for plugging the lumen of vessels

(3) Special epidermal hairs covering stomata in xerophytes

(4) Callus secretion on sieve plates

Q.87 Removal of ring wood of tissue outside the vascular cambium from the tree trunk kill it because **[CPMT 2002]**

(1) Water can not move up

(2) Food does not travel down and root become starved

(3) Shoot become starved

(4) Annual ring are not produced

Q.88 Leaves are situated on **[AFMC 2003]**

(1) Nodes (2) Internodes

(3) Tip (4) None of these

Q.89 Which of the following cell is totipotent **[KCET (Med.) 2000; AFMC 2000]**

(1) Meristem (2) Sieve tube

(3) Collenchyma (4) Xylem vessel

Q.90 Raphides are needle-like crystals of calcium oxalate which are specially found in **[CPMT 2000]**

(1) Pistia (2) Rose

(3) Asparagus (4) Dahlia

Q.91 Commercial cork is obtained from **[BHU 2003]**

(1) Mango (2) Oak (Quercus suber)

(3) Ficus religiosa (4) Pinus

Q.92 Wound healing is due to **[CPMT 2000]**

(1) Primary meristem (2) Secondary meristem

(3) Ventral meristem (4) All of the above

Q.93 Which of the following tissues is present in the leaves of Pinus to conduct water and food **[AFMC 2002]**

(1) Xylem

(2) Phloem

(3) Transfussion tissue

(4) Conducting tissue

Q.94 Protosteles are found in **[MPPMT 2002]**

(1) Bryophyta (2) Gymnosperms

(3) Pteridophyta (4) Angiosperms

Q.95 The most primitive type of stele is **[CPMT 2001]**

(1) Eustele (2) Solenostele

(3) Protostele (4) Siphonostele

Q.96 Stele consists of **[JIPMER 2000]**

(1) Phloem (2) Xylem

(3) Pericycle (4) All the above

Q.97 Lightest wood is **[JIPMER 2002]**

(1) Cereus giganteus (2) Ochroma lagopus

(3) Hardwickia binata (4) Cycas

Q.98 Inulin and raphide crystals are which type of plant products **[CPMT 2001]**

(1) Excretory (2) Inorganic

(3) Respiratory (4) Reserve material

Q.99 Which one of the following shows origin and evolution of steles **[CPMT 2001]**

(1) Bryophytes (2) Pteridophytes

(3) Gymnosperms (4) Angiosperms

Q.100 The stems of hydrophytic plants are soft and weak because of the poor development of **[JIPMER (Med,) 2002]**

(1) Pith and supporting parenchyma

(2) Phloem and companion cells

(3) Xylem and supporting tissue

(4) Cortex and endodermis

INTERNAL STRUCTURE OF ANGIOSPERMOUS PLANTS

MERISTEMS

Q.101 Tunica corpus theory was proposed by [**MPPMT 2001 ,Orissa 2007]**

(1) Schmidt (2) Nageli

(3) Hanstein (4) Wolf

Q.102 Crok cambium represents **[CETChd. 2001]**

(1) Secondary meristem

(2) Primary meristem

(3) Intercalary meristem

(4) Apical meristem

Q.103 Cambium produces growth in **[RPMT 2005]**

(1) Branches (2) Girth

(3) Pith (4) Cortex

Q.104 Vascular bundles grow from **[WB 2009]**
(1) Protoderm (2) Periderm
(3) Ground meristem (4) Procambium

Q.105 Tunica coropus theory is connected with **[Orissa 2009]**
(1) Root apex (2) Root cap
(3) Shoot apex (4) Secondary growth

Q.106 Which meristem helps in increasing girth? **[CET Chd. 2006]**
(1) Lateral meristem / cambium
(2) Intercalary meristem
(3) Primary meristem
(4) Apical meristem

Q.107 Procambium forms **[WB 2007]**
(1) Only primary vasular bundles
(2) Only vascular cambiu
(3) Only cork cambium
(4) Primary vascular bundles and vascular cambium

Q.108 Quiescent centre occurs in **[CPMT 2002, 2005, WB 2010]**
(1) Shoot apex (2) Root apex
(3) Both A and B (4) Meristematic tissue

Q.109 Intercalary meristem produces **[Kerala 2004, Har. PMT 2007]**
(1) Secondary growth
(2) Primary growth
(3) Apical growth
(4) Secondary thickeing
(5) Secondary overgrowth

Q.110 Histogen tissues are classified on the basis of **[Manipal 2005]**
(1) Plane of division
(2) Type of cells they form
(3) Position
(4) Origin

Q.111 Meristematic cells are characterised by **[Manipal 2005]**
(1) Thin cell walls and large intercellular spaces
(2) Thin cell walls and no intercellular spaces
(3) Thick cell walls and large intercellular spaces
(4) Thick cell walls and small intercellular spaces

Q.112 Quiescent centre is region of root apex which is
(1) Actively dividing
(2) Water absorption area
(3) Inactive cells
(4) Root hair cells

Q.113 Which one is not formed from procambium? **[Wardha 2005]**
(1) Xylem
(2) Phloem
(3) Intrafascicular cambium
(4) Interfascicular cambium

Q.114 ..... is an exmple of secondary meristem **[COMED- K's 2006]**
(1) Xylem (2) Phloem
(3) Phloem (4) Cork cambium

Q.115 Outermost primary meristem forms **[AMUPMDC 2006]**
(1) Epidermis (2) Procambium
(3) Ground meristem (4) All the above

Q.116 Vascullar cambium of dicot stem is **[Manipur 2006]**
(1) Apical meristem (2) Intercalary meristem
(3) Local meristem (4) Secondary meristem

Q.117 Cells of quiescent centre have lower concentration of **[CET Chd. 2006]**
(1) DNA (2) Proteins
(3) RNA (4) All the above

Q.118 Length of petiole increases by the activity of **[CPMT 2007]**
(1) Apical meristem (2) Lateral meristem
(3) Intercalary meristem
(4) All the above

Q.119 Intercalary meristem is derivative of **[KCET 2008]**
(1) Promeristem (2) Primary meristem
(3) Lateral meristem (4) Secondary meristem

Q.120 Dividing cells not yet committed to become specific cell type are **[CPMED- K's 2008]**
(1) Epidermal cells (2) Ground cells
(3) Periderm cells (4) Meristem cells

Q.121 Shoot apical meristem occurs over the tip of **[Orissa 2008]**

(1) Root (2) Radicle
(3) Plumule (4) Mesocotyl

Q.122 In dicot stems, vascular cambium is formed from **[Orissa 2008]**

(1) Procambium (2) Cambium
(3) Promeristem (4) Protoderm

Q.123 Cambium is lateral meristem that takes part in **[MHTCET 2008]**

(1) Internodal growth
(2) Axial growth
(3) Growth of Branches
(4) Increasing girth of stem and root

Q.124 Vascular tissues of flowering plant develp from **[CBSE 2008]**

(1) Dermatogen (2) Periblem
(3) Plerome (4) Phellogen

Q.125 Length of different internodes in culm of sugarcane is variable due to **[CBSE 2008]**

(1)Shoot apical meristem
(2) Position of axillary buds
(3) Intercalary meristem
(4) Size of leaf lamina at the node below each internode

Q.126 Lateral meristems are **[KCET 2009, 2010]**

(1) Phellogen and procambium
(2) Procambium and dermatogen
(3) Fascicular cambium and procambium
(4) Fascicular cambium and cork combium

Q.127 Interfascicular cambium is **[COMED- K's 2009]**

(1) Intercalary meristem
(2) Secondary meristem
(3) Apical meristem
(4) Noncalary meristem

Q.128 What is correct answer of **Assertion (A)** and **Reason (R)** **[EAMCET 2009]**

A.: Apical and intercalary meristem contribute to the growth in length while the lateral meristems bring increase in girth in Mazie.

R.: Apical and intercalary meristems always increase the height of plants

(1) Both **A** and **R** are true with **R** being correct eplanation of **A**
(2) Both **A** and **R** are true but **R** is not the correct eplanation of **A**
(3) **A** is true but **R** is false
(4) **A** is false but **R** is trye

Q.129 Histogens are components of **[COMED - K's 2010]**

(1) Secondary phellogen
(2) Apical meristem
(3) Lateral meristem
(4) Intercalary meristem

Q.130 Which one of the following is not a lateral meristem **[CBSE 2010]**

(1) Interfascicular cambium
(2) Phellogen
(3) Intercalary meristem
(4) Intrafascicular cambium

Q.131 Meristem that is parallel to the longitudinal axis of the plant is **[JKCMEE 2010]**

(1) Procambium
(2) Intercalary meristem
(3) Phellogen
(4) Apical meristem

PERMANENT TISSUES

Q.132 The tissue which has dead cells in the functional state is **[CET Chd. 2009]**

(1) Collenchyma (2) Sclerenchyma
(3) Parenchyma (4) Phloem

Q.133 Albuminous cells occurs in **[COMED- K's 2008]**

(1) Xylem (2) Phloem
(3) Cortex
(4) Conjunctive parenchyma

Q.134 Which group possesses vessels in its xylem **[Har. PMT 2005]**

(1) Pteridophytes (2) Angiosperms
(3) Gymnosperms (4) Both B and C

Q.135 The only plant cells without nucleus among the following are **[CET Chd. 2009]**

(1) Cambium
(2) Xylem vessels elements
(3) Root hairs (4) Companion cells

Q.136 Epidermal fibres of economic importance belong to **[MPPMT 2009]**

(1) Cotton (2) Flax
(3) Hemp (4) Coir

Q.137 Sieve tubes are constituent of **[WB 2008]**

(1) Wood (2) Vascular cambium
(3) Phellem (4) Bast

Q.138 A closed collateral bundle is one where **[Orissa 2008, AFMC 2010]**

(1) Xylem and phloem occur on different radii
(2) Collateral bundle without cambium
(3) Xylem and phloem are separated by cambium
(4) Collateral bundle with cambium

Q.139 Anatomically Jute fibres are **[MPPMT 2004, COMED-K's 2008]**

(1) Xylem fibers (2) Cortial fibers
(3) Pith fibers (4) Phloem fibers

Q.140 Jute of commerce is got from **[MPPMT 2001, DPMT 2009]**

(1) Primary phloem (2) Secondary pholem
(3) Secondary xylem (4) Primary xylem

Q.141 Which is correct

(1) Tracheids are unicellular with wide lumen
(2) Vessels are multicellular with wide lumen
(3) Tracheids are unicellular with narrow lumen
(4) Vessels are multicellular with narrow lumen

Q.142 Which one of the following statements pertaining to plant structure is correct? **[AIIMS 2005]**

(1) Cork lacks stomata but lenticels carry out transpiration
(2) Passage cells help in transfer of food from cortex to phloem
(3) Sieve tube elements possess cytoplasm but no nuclei
(4) The shoot apical meristem has a quiescent centre.

Q.143 Identify the plant tissue in which lignin is absent **[KCET 2005]**

(1) Collenchyma (2) Sclerenchyma fibres
(3) Sclereids (4) Xylem tracheids

Q.144 Pith or central part of ground tissue is made of **[JKCMEE 2005]**

(1) Collenchyma (2) Parenchyma
(3) Chlorenchyma (4) Sclerenchyma

Q.145 Vascular bundles having phloem on the periphery of both outer and inner cambium are **[DPMT 2005]**

(1) Bicollateral closed (2) Bicollateral open
(3) Radial (4) Biradial

Q.146 Find out the correct ones in the following table: **[EAMCET 2005]**

	Tissue Structure	**Features**	**Function**
1.	Collenchyma	Cell wall with water content	Photosynthesis in young stems
2.	Parenchyma	Suberised cell walls	Storage of food
3.	Sclerenchyma	Lignified cell walls	Mechanical strength
4.	Digestive glands	Dense cytoplasm without water	Breaking substrate

(1) 1 and 2 (2) 2 and 3
(3) 1 and 4 (4) 1 and 3

Q.147 Living part of xylem is **[RPMT 205]**

(1) Xylem tracheids (2) Xylem vessels
(3) Parenchyma (4) None of the above

Q.148 Which is least differentiated? **[Manipal 2005]**

(1) Simple tissues
(2) Parenchyma
(3) Circulatory tissues
(4) Complex tissues

Q.149 The term parenchyma was coined by **[Manipal 2005]**

(1) Hooke (2) Schleiden
(3) Grew (4) Mettenius

Q.150 P-protein occurs in **[CPMT 2005]**

(1) Sieve tube elements
(2) Tracheids
(3) Vessels
(4) Phloem parenchyma

Q.151 Companion cells are fiound in **[Manipur 2005, MPPMT 2010]**

(1) Epidermis (2) Cambium
(3) Xylem (4) Phloem

Q.152 Common feature in vessel elements and sieve tube elements is **[CBSE 2006]**

(1) Enucleate condition

(2) Presence of p-protein

(3) Thick secondary wall

(4) Pores on lateral walls

Q.153 In sieve elements, the possible functionof P-proteins is **[AIIMS 2006]**

(1) Autolytic enzymes

(2) Sealing mechanism on wounding

(3) Providing energy for active translocation

(4) Deposition of callose on sieve plates

Q.154 Bicollateral conjoint vascular bundle possess **[Kerala 2006]**

(1) Xylem and phloem on alternate radii

(2) Phloem surrounds xylem

(3) Xylem surrounds phloem

(4) Xylem and phloem on same radius with two groups of phloem, on the two side of xylem

(5) Xylem and phloem on same radius with one group of phloem outside xylem

Q.155 Match the columns **[Kerala 2006]**

Column I	**Column II**
(a) Xylem vessels	1. Store food material
(b) Xylemtracheids	2. Obliterated lumen
(c) Xylem fibre	3. Perforated plates
(d) Xylem parenchyma	4. Chisel–like ends

(1) a – 3, b – 4, c – 2, d – 1

(2) a – 4, b – 3, c – 2, d – 1

(3) a – 3, b – 2, c – 1, d – 4

(4) a – 2, b – 1, c – 4, d – 3

(5) a – 1, b – 2, c – 3, d – 4

Q.156 Bordered pits are elongated transversely and arranged in vertical series. The pattern is known as **[CET Chd. 2006]**

(1) Scalariform pitting

(2) Intervascular pitting

(3) Reticulate thickening

(4) Oblique pitting

Q.157 Trichomes take part in **[JKCMEE 2007]**

(1) Transpiration and exchange of gases

(2) Protection and reduction of transpiration

(3) Exudation of water drops

(4) Desiccation

Q.158 Simple sieve plate occurs in **[JKCMEE 2007]**

(1) Cucurbita (2) Vitis

(3) Pyrus (4) Prunus

Q.159 Lacunate collenchyma is found in the stem of **[JKCMEE 2007]**

(1) Leucas (2) Monstera

(3) Cucurbita (4) Sambucus

Q.160 Angiosperm lacking vessels is **[JKCMEE 2007]**

(1) Mangifera (2) Dillenia

(3) Magnolia (4) Drimys

Q.161 Sclereids found in seed coat of pulses are **[COMED-K's 2007]**

(1) Marcrosclereids (2) Brachysclereids

(3) Osteosclreids (4) Asterosclereids

Q.162 Xylem produced through centrifugal differentiation is **[COMED - K's 2007]**

(1) Exarch (2) Endarch

(3) Measarch (4) Centrarch

Q.163 Which is wrong about sieve tube elements **[Kerala 2007]**

(1) Peripheral cytoplasm and large vacuole

(2) Perforated end wall becomes impregnated with lignin

(3) P-proteins occurs evenly distributed throughout lumen

(4) Absence of nucleus at maturity

(5) Tube – like structures present in longitudnal series

Q.164 Collenchyma is **[CPMT 2007]**

(1) Living with no reserve food

(2) Living with protoplasm

(3) Dead and hollow

(4) Dead with reserve food

Q.165 Vessels and companion cells occur in **[MPPMT 2007]**

(1) Thallophytes (2) Bryophytes

(3) Pteridophytes (4) Angiosperms

Q.166 Which ones are correct **[Kerala 2008]**

(a) Uneven thickeing of cell wall is characteristic of sclerenchyma

(b) Periblem forms cortex of stem and root

(c) Tracheids are chief water conducting elements in gymnosperms

(d) Commercial cell is devoid of nucleus at maturity

(e) Commercial cork is obtained from Quercus suber

(1) b, c, e (2) a, d

(3) b, e (4) c, d

(5) a, b, c

Q.167 In a vascular bundle, xylem shows centripetal develpment. It is **[KCET 2008]**

(1) Centrarch (2) Mesarch

(3) Endarch (4) Exarch

Q.168 Which pair has lignin in both **[WB 2008]**

(1) Tracheid and collenchyma

(2) Sclerenchyma and sieve tube

(3) Sclerenchyma and tracheids

(4) Parenchyma and endodermis

Q.169 Parenchymatous cells filling the space between dermal and vascular tissue is **[Orissa 2008]**

(1) Ground tissue

(2) Epidermal tissue

(3) Pith (4) Vascular bundles

Q.170 Match the column

Column I	**Column II**
(a) Extrafoliar nectaries	1. Acharas
(b) Schizogenous cavities	2. Tropaelum
(c) Laticiferous ducts	3. Passiflora
(d) Hydathodes	4. Eucalyptus
	5. Pinus

(1) a – 3, b – 1, c – 2, d – 4

(2) a – 3, b – 5, c – 1, d – 2

(3) a – 2, b – 1, c – 3, d – 4

(4) a – 5, b – 2, c – 1, d – 3

Q.171 Senescence is an active developmental cellular processes in the growth and functioning of a flowering plant, is indicated in **[CBSE 2008]**

(1) Annual plants (2) Floral parts

(3) Leaf abscission

(4) Vessels and tracheids

Q.172 Tissue cells commonly found in friut walls of nuts and pulp of some fruits like guava are called **[AMU 2009]**

(1) Fibres (2) Sclereids

(3) Tracheids (4) Vessels

Q.173 At maturity sieve plates become impregnated with **[Kerala 2009]**

(1) Cellulose (2) Suberin

(3) Callose (4) Lignin

(5) Pectin

Q.174 Choose the correct options **[Kerala 2009]**

(a) Thread like cytoplasmic strands, running from one cell to other are known as plasmodesmata

(b) Xylem and phloem constitute the vascular bundle of the stem

(c) First formed xylem elements are described as metaxylem

(d) Radial bundles are mainly found in leaves

(1) a, b true c, d wrong

(2) d true a, b, c wrong

(3) d true a, b, d wrong

(4) b true a, c, d wrong

(5) a true b, c, d wrong

Q.175 Which one consists of living cells **[MPPMT 2009]**

(1) Vessels (2) Tracheids

(3) Companion cells (4) Sclerenchyma

Q.176 Annular and spirally thickened conducting element generally develop in protoxylem when root or stem is **[CBSE 2009]**

(1) Widening (2) Differentiating

(3) Maturing (4) Elongating

Q.177 Which one is enucleated **[CPMT 2009]**

(1) Companion cell (2) Sieve cell

(3) Tracheid (4) Vessel

Q.178 Which of the following is a complex tissue **[CPMT 2010]**

(1) Parenchyma (2) Collenchyma

(3) Xylem (4) Sclerenchyma

Q.179 Compare the statements A and B

A : Sclerenchyma cells do not have plasmodesmata

B : Cell walls of some permanent tissue are heavilly lignified.

(1) Statement a is correct and b is wrong

(2) Both the statements a and b are wrong

(3) Both the statements a and b are correct

(4) Statement a is wrong and b is correct

Q.180 The activity of sieve tubes is remotely controlled by the protoplasm of **[COMED - K's 2010]**

(1) Phloem parenchyma

(2) Companion cells

(3) Phloem fibres

(4) Both phloem parenchyma and phloem fidres

Q.181 Find the incorrect statement **[AMU 2010]**

(1) Root hairs are unicellular elongations

(2) Trichomes are unicellular elongations

(3) Trichomes are mutlicellular elongations

(4) Root hairs absorb water and minerals

Q.182 The arrangement of xylem in stem is **[Orissa 2010]**

(1) Endarch (2) Mesarch

(3) Exarch (4) Both A and B

Q.183 Which of the following is not part of epidermal tissue system **[Keerala 2010]**

(1) Trichomes (2) Companion cells

(3) Guard cells (4) Subsidiary cells

(5) Root hairs

Q.184 Which of the following statements is true **[Kerala 2010]**

(1) Collenchyma occurs in layers below epidermis

(2) Xylem parenchyma cells are living, thin walled and lignified

(3) Sclerenchyma cells are usually dead and without protoplasts

(4) Companion cells are specialised sclerenchyma cells

(5) Phloem fibres are generally present in primary phloem

Q.185 Transport of food material in higher plants takes place through **[CBSE Main 2010]**

(1) Companion cells (2) Sieve elements

(3) Tracheids (4) Transfusion tissue

Q.186 Cotton fibre is basically a type of **[WB 2010]**

(1) Trichome (2) Scale

(3) Dried seed coat (4) Nonglandular hair

ANATOMY OF PLANT PARTS

Q.187 Heart wood is **[HPPMT 2010]**

(1) Outer part of secondary xylem

(2) Inner part of secondary xylem

(3) Outer part of secondary phloem

(4) Inner part of secondary phloem

Q.188 As the secondary growth takes place (proceeds) in a tree, thickness of **[KCET 2006]**

(1) Heart wood increases

(2) Sap – wood increases

(3) Both increases

(4) Both remain the same

Q.189 The bark of tree commonly comprises **[CET Chd. 2006]**

(1) All the tissue outside the vascular cambium

(2) All the tissue outside the cork cambium

(3) Only the cork

(4) The cork and secondary cortex

Q.190 Well developed pith is found in **[KCET 2008]**

(1) Monocot root and monocot stem

(2) Monocot stem and dicot root

(3) Monocot root and dicot stem

(4) Dicot root and dicot stem

Q.191 Cork is formed from **[AFMC 2005]**

(1) Cork cambium (phellogen)

(2) Vascular cambium

(3) Phloem (4) Xylem

Q.192 Function of cork cambium is to producce **[Orissa 2010]**

(1) Secondary xylem and secondary phloem

(2) Cork and secondary cortex

(3) Secondary cortex and phloem

(4) Cork

Q.193 Monocot root differs from dicot root in having **[RPMT 2005]**

(1) Open vascular bundles

(2) Scattered vascular bundles

(3) Well developed pith

(4) radially arranged vascular bundles

Q.194 Where do the casparian bands occur **[Orissa 2005, RPMT 2006]**

(1) Epidermis (2) Endodermis

(3) Pericyle (4) Phloem

Q.195 Growth / annual rings are formed by the actively of **[Manipur 20007]**

(1) Cambium (2) Xylem

(3) Phloem

(4) Both xylem and phloem

Q.196 Tyloses occur in **[KCET 2010]**

(1) Secondary xylem (2) Secondary phloem

(3) Callus tissue (4) Cork cells

Q.197 Exchange of gases between air and internal tissue of older corky stem takes place through **[HPPMT 2007, Kerala 2010]**

(1) Sieve tube (2) Pits

(3) Stomata (4) Lenticels

Q.198 In roots, lateral branches grow from **[DPMT 2003, KCET 2007]**

(1) Epiblema (2) Pericycle

(3) Cortex (4) Endodermis

Q.199 Sunken stomata occur in **[Orissa 2008]**

(1) Mesophytes (2) Xerophytes

(3) Hygrophytes (4) Hydrophytes

Q.200 Mesophyll is differentiated into palisade and spongy tissues in **[Orissa 2008]**

(1) Extermely xerophytic leaves

(2) Hydrophytic leaves

(3) Monocot leaves

(4) Dicot leaves

Q.201 Bulliform or motor cells occur in **[Har. PMT 2007]**

(1) Upper epidermis of dicot leaves

(2) Upper epidermis of monocot leaves

(3) Lower epidermis of monocot leaves

(4) Lower epidermis of dicot leaves

Q.202 Poyarch and exarch condition is found in **[MPPMT 2000, CPMT 2007]**

(1) Monocot stem (2) Monocot root

(3) Dicot stem (4) Dicot root

Q.203 Meristem present in a vascular bundle is **[MPPMT 2007]**

(1) Fascicular / Intrafascicular cambium

(2) Intrafascicular cambium

(3) Phellogen

(4) Procambium

Q.204 Fusiform intials produce **[MPPMT 2007]**

(1) Vascular rays

(2) Primary phloem

(3) Tracheary elements

(4) Ray parenchyma

Q.205 Outer lighter colured / alburnum region of wood is **[JKCMEE 2008, Kerala 2009]**

(1) Autumn wood (2) Spring wood

(3) Heart wood (4) Sapwood

Q.206 In monocots **[CPMT 2010]**

(1) Leaves have reticulate venation

(2) Stems annual rings

(3) Seeds have two storage organs

(4) Stems have scattered conducting starnds

Q.207 Cork cambium is also called **[Har. PMT 2005, BV 2006]**

(1) Phelloderm (2) Phellem

(3) Periderm (4) Phellogen

Q.208 Periderm is produced by **[JKCMEE 2007]**

(1) Vascular cambium

(2) Fascicular cambium

(3) Phellogen

(4) Intrafascicular cambium

Q.209 Common features between lenticles and hydathodes are **[AMUPMDC 2006]**

(1) Allow exchange of gases

(2) Always remain closed

(3) There is no regulation of their opening and closing

(4) They occur on the same organ of the plant

Q.210 Endodermis of dicot stem is also called **[AMU 2009]**

(1) Bundle sheath (2) Starch sheath

(3) Mesophyll (4) Water channel

Q.211 Endodermis is part of **[BV 2006]**

(1) Medulla (2) Stele

(3) Cortex (4) Exodermis

Q.212 Functional xylem of dicot tree is **[COMED K's 2009]**

(1) Sap wood (2) Autumn wood

(3) Heart wood (4) Hard wood

Q.213 Tyloses are thickenings seen in **[AMUPMDC 2006, BHU 2008]**

(1) Ray parenchyma (2) Collenchyma

(3) Phloem cells

(4) Ray parenchyma and xylem cells

Q.214 Casparian strips contain **[HPPMT 2005]**

(1) Cutin (2) Pectin

(3) Suberin (4) Wax

Q.215 A monocot showing secondary growth is **[CET Chd. 2010]**

(1) Coconut (2) Sugarcane

(3) Mazie (4) Yucca

Q.216 Scattered vascular bundles occur in **[Kerala 2002, Orissa 2007]**

(1) Pteridophytes (2) Gymnosperms

(3) Monocots (4) Dicots

(5) Bryophytes

Q.217 Vascular cambium of stem is **[JKCMEE 2004, Kerala 2008]**

(1) Primary meristem

(2) Partly primary and partly secondary

(3) Secondary meristem

(4) Intercalary meristem

Q.218 Growth rings are formed by the activity of **[CPMT 2004, Pb. PMT 2007]**

(1) Extrastelar cambium

(2) Intrastelar cambium

(3) Interstelar cambium

(4) Both B and C

Q.219 Inner darker, harder portion of secondary xylem that cannot conduct water in older dicot stem is called **[KCET 2005, BHU 2006]**

(1) Alburnum (2) Bast

(3) Duramen (4) Wood

Q.220 Epiblema is the name of **[DPMT 2005]**

(1) Epidermis of leaf

(2) Epidermis of stem

(3) Epidermis of dicot root

(4) Epidermis of both dicot and monocot roots

Q.221 Choose the correct combination of labelling of the lenticel **[Kerala 2005]**

(1) a – pore, b – complementary cells, c – cork, d – cork cambium, e – secondary cortex

(2) a – pore, b – secondary cortex, c – cork, d – cork cambium, e – complementary cells

(3) a – pore, b – cork cambium, c – secondary cortex, d – cork, e – complementary cells

(4) a – pore, b – cork , c – complementary cells, d – cork cambium, e – secondary cortex

(5) a – pore, b – cork , c – cork cambium, d – secondary cortex, e – complementary cells

Q.222 Correct sequnce of layers from outside to inside of a typical monocot root is **[CPMT 2005]**

(1) Epiblema, endodermis, cortex, pericycle

(2) Pericycle, cortex, endodermis, epiblema

(3) Epiblema, cortex, endodermis, pericycle

(4) Epiblema, pericycle, cortex, endodermis

Q.223 **(A) :** All the endodermal cells of the root do not contain casparian thickenings on their radial walls and transverse walls.

(R) : Passage cells are found in endodermis. **[EAMCET 2005]**

(1) Both (A) and (R) are true. (R) is correct explanation of (A)

(2) Both (A) and (R) are true. (R) is not correct explanation of (A)

(3) (A) is true but (R) is false

(4) (A) is false but (R) is true

Q.224 Identify correct order of components with reference to their arrangement from outside to inner side in a woody dicot stem **[EAMCET 2005]**

1. Secondary cortex 2. Autumn wood

3. Secondary phloem 4. Phellum

(1) 2, 3, 1, 4 (2) 4, 1, 3, 2

(3) 1, 2, 4, 3 (4) 3, 4, 2, 1

Q.225 Palisade parenchyma is present on both sides in **[RPMT 2005]**

(1) Nerium (2) Eucalyptus

(3) Wheat (4) Both A and B

Q.226 Tyloses are baloon-like ingrowths in vessels developing from adjoining **[Pb. PMT 2005]**

(1) Parenchyma through pits in vessel wall

(2) Parenchyma through general surface of vessel wall

(3) Fibers through general surface of vessel wall

(4) Fibers through pits in vessel wall

Q.227 Casparian thicknings ocur in the cells of **[KCET 2006]**

(1) Pericycle of stem (2) Endodermis of stem

(3) Pericycle of root (4) Endodermis of root

Q.228 Large nearly empty, colourless cells present on upper surface of grass leaf are **[Kerala 2006]**

(1) Accessory cells (2) Bulliform cells

(3) Palisade parenchyma

(4) Spongy parenchyma

(5) Passage cells

Q.229 Which of the following is/are not true? **[Kerala 2006]**

(a) Cork cambium is otherwise called phellogen

(b) Cork is otherwise called phellem

(c) Secondary cortx is otherwise called periderm

(d) Cork cambium, cork and secondary cortex are collectively called phelloderm

(1) b and d only (2) b and c only

(3) c and b only (4) a and b only

(5) a and d only

Q.230 Collateral open vascular bundles and eustele are found in **[RPMT 2006]**

(1) Dicot root (2) Dicot stem

(3) Monocot stem (4) Monocot root

Q.231 Radial vascular bundles occur in **[RPMT 2006]**

(1) Dicot root (2) Monocot root

(3) All roots (4) Dicot stem

Q.232 Vascular cabium produces **[RPMT 2006]**

(1) Secondary xylem and secondary phloem

(2) Secondary xylem only

(3) Secondary Phloem only

(4) Primary xylem and primary phloem

Q.233 Phellogen is also known as **[BHU 2007]**

(1) Vascular cambium (2) Periderm

(3) Cork cambium (4) Apical cambium

Q.234 Which one is/are not true **[Kerala 2007]**

(a) Crok cambium is called phellogen

(b) Crok is called phellogen

(c) Secondary cortex is called periderm

(d) Secondary cambium, cork and secondary cortex are collectively called phelloderm

(1) a and d only (2) a and b only

(3) b and c only (4) b and d only

(5) a and d only

Q.235 Cambium ring consists of **[COMED - K's 2007]**

(1) Interfascicular cambium

(2) Intrafascicular cambium

(3) Both A and B (4) Phelloderm

Q.236 Endodermis takes part in **[CPMT 2007]**

(1) Providing protection

(2) Preventing water loss from stele

(3) Maintaining rigidity

(4) All the above

Q.237 In autumn and winter, cambium produces **[Orissa 2007]**

(1) Sap wood (2) Heart wood

(3) Early wood (4) Late wood

Q.238 Cells of grass leaves which help in minimising cuticular transpiration are **[Orissa 2007]**

(1) Bulliform cells (2) Guard cells

(3) Subsidiary cells (4) Endodermal cells

Q.239 Cork cambium is **[Orissa 2007]**

(1) Primary meristem (2) Apical meristem

(3) Secondary meristem

(4) Intercalary meristem

Q.240 Secondary growth is best observed in **[CBSE 2007]**

(1) Teak and Pine (2) Deodar and Fren

(3) Wheat and Maiden Hair Fern

(4) Sugarcane and Sunflower.

Q.241 Passage cells are thin walled cells found in **[CBSE 2007]**

(1) Phloem elements to serve as entry points
(2) Testa of seeds for emergence of embryonal axis
(3) Central area of style for passage of pollen tube
(4) Endodermis of roots to facilitate rapid transport of water from cortex to pericycle

Q.242 Find out the correct and incorrect statements **[Kerala 2008]**

(a) In dicot root, the vascular bundles are collateral and endarch
(b) Innermost layer of cortex in a dicot root is endodermis
(c) In dicot root, phloem and xylem bundles are separated by conjunctive tissue

(1) a true, b, c false (2) b true, a, c false
(3) a false, b, c true (4) b false, a, c true
(5) c true, a, b false

Q.243 Closing layers of lenticels show deposition of **[COMED - K's 2008]**

(1) Cutin (2) Lignin
(3) Pectin (4) Suberin

Q.244 What differentiates a dicot leaf from monocot leaf **[BHU 2008]**

(1) Stomata only on upper side
(2) Differentiation of palisade and spongy parenchyma
(3) Parallel venation
(4) Stomata on upper and lower sides

Q.245 Cellular layers from outside to inside in old dicot stem are **[KCET 2008]**

(1) Epidermis, phellem, phellogen, phelloderm
(2) Epidermis, hypodermis, cortex,endodermis
(3) Epidermis, phellogen, phellem,endodermis
(4) Epidermis, hypodermis, phellogen, phelloderm

Q.246 Older resin–clogged central secondary xylem and younger outer secondary xylem are respectively known as **[COMED - K's 2008]**

(1) Alburnum and duramen
(2) Duramen and alburnum
(3) Autumn wood and springwood
(4) Springwood and autumn wood

Q.247 Which character is not associated with plant where Shull studied inbreeding depression while Miller and Letham extracted a hormone from its seeds **[EAMCET 2008]**

(1) Atactostele in stem
(2) Bundle sheath in leaf
(3) Chromosome number 30 in endosperm
(4) Medulla absent in root

Q.248 Condition found in roots of a plant having assimilatory submerged roots and spongy petioles **[EAMCET 2008]**

(1) Tetrarch (2) Triarch
(3) Monarch (4) Mature stem

Q.249 Cuticle is absent in **[DPMT 2009]**

(1) Mesophytes (2) Young roots
(3) Leaves (4) Mature stem

Q.250 In an annual ring, the light coloured part is **[DPMT 2009]**

(1) Heart wood (2) Sapwood
(3) Early wood (4) Late wood

Q.251 What is true about heartwood **[KCET 2009]**

(a) It does not help in water conduction
(b) It is also called alburnum
(c) It is dark in colour but is very soft
(d) It has tracheary elements which are filled with tannins, resins, etc

(1) b, c, d (2) a, b, c
(3) b, d (4) a, d

Q.252 Pith parenchyma generally lacks **[COMED-K's 2009]**

(1) Vacuole (2) Chloroplasts
(3) Mitochondria (4) Nucleus

Q.253 Tetrarch bundles occur in **[COMED-K's 2009]**

(1) Leaf of Cicer arietinum
(2) Leaf of Pisum sativum
(3) Root of Cicer arietinum
(4) Root of Zea mays

Q.254 Which is not part of periderm **[COMED-K's 2009]**

(1) Phellogen (2) Cork
(3) Secondary cortex (4) Wood

Q.255 Lenticels are patches of **[Orissa 2009]**

(1) Loose cells in leaves
(2) Loose cells on bark for aeration
(3) Subsidiary cells of stomata
(4) Cells for respiration of epiphytes

Q.256 Conjoint and closed vascular bundles with no phloem paranchyma are observed in
(1) Monocot stem (2) Dicot stem
(3) Monocot root (4) Dicot root

Q.257 Match the column and choose the correct combination **[Kerala 2009]**

Column I	Column II
(a) Endodermis	1. Companion cell
(b) Stomata	2. Lenticel
(c) Sieve tube	3. Palisade cell
(d) Periderm	4. Passage cell
(e) Mesophyll	5. Accessory cell

(1) a – 4, b – 5, c – 2, d – 1, e – 3
(2) a – 5, b – 3, c – 1, d – 2, e – 4
(3) a – 2, b – 5, c – 3, d – 4, e – 1
(4) a – 4, b – 5, c – 1, d – 2, e – 3
(5) a – 4, b – 2, c – 5, d – 3, e – 1

Q.258 In Barley stem, vascular bundles are **[CBSE 2009]**
(1) Open and scattered
(2) Closed and scattered
(3) Closed and radial (4) Open and in a ring

Q.259 Palisade parenchyma is absent in leaves of **[CBSE 2009]**
(1) Gram (2) Soyabean
(3) Sorghum (4) Mustard

Q.260 Anatomically fairly old dicotyledonous root is distinguised from dicotyedonous stem by **[CBSE 2009]**
(1) Position of protoxylem
(2) Absence of secondary xylem
(3) Absence of secondary pholem
(4) Presence of cortex

Q.261 Arrange the following in the order of their location from periphery to centre in the entire dicotyledonous plant body **[EAMCET 2009]**
(a) Fusiform cells (b) Trichoblasts
(c) Collocytes (d) Tylosis
(1) b, c, a, d (2) a, b, c, d
(3) d, a, b, c (4) c, b, a, d

Q.262 Vascular bundle of monocot is **[CPMT 2010]**
(1) Scattered (2) Closed
(3) Endarch (4) All the above

Q.263 A structure absent in monocot is **[AFMC 2010]**
(1) Sieve tubes (2) Pith
(3) Cambium (4) Vessels

Q.264 Which of the following is not correct **[AMU 2010]**
(1) Early wood is characterised by a large number of xylary elements
(2) Late wood is characterised by a large number of xylary elements
(3) Early wood is characterised by vessels with narrower cavities
(4) Late wood is characterised by vessels with narrower cavities

Q.265 Medullary rays are made up of **[AMU 2010]**
(1) Fibres
(2) Tracheids
(3) Sclerencyma cells
(4) Parenchymatous cells

Q.266 Heart wood differs from sapwood in **[CBSE 2010]**
(1) Absence of vessels and parenchyma
(2) Having dead and non-conducting elements
(3) Being susceptible to pests and pathogens
(4) Presence of rays and fibres

Q.267 Ground tissue includes **[CPMT 2011]**
(1) All tissues external to endodermis
(2) All tissues except epidermis and vascular bundles
(3) Epidermis and cortex
(4) All tissues internal to endodermis

Q.268 The cork cambium, cork and secondary cortex are collectivelty called **[CPMT 2011]**
(1) Phelloderm (2) Phellogen
(3) Periderm (4) Phellem

Q.269 The common bottle cork is a product of : **[AIPMT Pre 2012]**
(1) Phellogen (2) Xylem
(3) Vascular Cambium (4) Dermatogen

Q.270 Closed vascular bundles lack : **[AIPMT Pre 2012]**
(1) Conjunctive tissue (2) Cambium
(3) Pith (4) Ground tissue

Q.271 Water containing cavities in vascular bundles are found in : **[AIPMT Pre 2012]**

(1) Maize (2) Cycas

(3) Pinus (4) Sunflower

Q.272 Companion cells are closely associated with : **[AIPMT Pre 2012]**

(1) Vessel elements (2) Trichomes

(3) Guard cells (4) Sieve elements

Q.273 As compared to a dicot root, a monocot root has : **[AIPMT Mains 2012]**

(1) More abundant secondary xylem

(2) Many xylem bundles

(3) Inconspicuous annual rings

(4) Relatively thicker periderm

ANSWER KEY

EXERCISE – 3

Q.1	1	Q.2	3	Q.3	4	Q.4	4	Q.5	1	Q.6	3	Q.7	1
Q.8	2	Q.9	3	Q.10	4	Q.11	2	Q.12	3	Q.13	3	Q.14	1
Q.15	3	Q.16	3	Q.17	2	Q.18	1	Q.19	1	Q.20	1	Q.21	3
Q.22	4	Q.23	3	Q.24	2	Q.25	4	Q.26	3	Q.27	2	Q.28	2
Q.29	4	Q.30	2	Q.31	2	Q.32	2	Q.33	2	Q.34	1	Q.35	2
Q.36	3	Q.37	1	Q.38	1	Q.39	1	Q.40	2	Q.41	1	Q.42	2
Q.43	1	Q.44	1	Q.45	1	Q.46	4	Q.47	4	Q.48	4	Q.49	3
Q.50	2	Q.51	1	Q.52	4	Q.53	2	Q.54	2	Q.55	1	Q.56	2
Q.57	3	Q.58	4	Q.59	2	Q.60	1	Q.61	1	Q.62	2	Q.63	1
Q.64	4	Q.65	2	Q.66	2	Q.67	4	Q.68	1	Q.69	1	Q.70	3
Q.71	4	Q.72	2	Q.73	3	Q.74	3	Q.75	2	Q.76	4	Q.77	1
Q.78	4	Q.79	2	Q.80	2	Q.81	2	Q.82	1	Q.83	1	Q.84	3
Q.85	2	Q.86	2	Q.87	2	Q.88	1	Q.89	1	Q.90	1	Q.91	2
Q.92	1	Q.93	3	Q.94	3	Q.95	3	Q.96	4	Q.97	2	Q.98	4
Q.99	2	Q.100	3	Q.101	1	Q.102	1	Q.103	2	Q.104	4	Q.105	3
Q.106	1	Q.107	1	Q.108	2	Q.109	2	Q.110	2	Q.111	2	Q.112	3
Q.113	4	Q.114	4	Q.115	1	Q.116	3	Q.117	4	Q.118	3	Q.119	2
Q.120	4	Q.121	3	Q.122	1	Q.123	4	Q.124	3	Q.125	3	Q.126	4
Q.127	2	Q.128	4	Q.129	2	Q.130	3	Q.131	3	Q.132	2	Q.133	2
Q.134	2	Q.135	2	Q.136	1	Q.137	4	Q.138	2	Q.139	4	Q.140	2
Q.141	2	Q.142	3	Q.143	1	Q.144	2	Q.145	2	Q.146	4	Q.147	3
Q.148	2	Q.149	3	Q.150	1	Q.151	4	Q.152	1	Q.153	2	Q.154	4
Q.155	1	Q.156	1	Q.157	2	Q.158	1	Q.159	3	Q.160	4	Q.161	1
Q.162	4	Q.163	2	Q.164	2	Q.165	4	Q.166	1	Q.167	3	Q.168	3
Q.169	1	Q.170	2	Q.171	3	Q.172	2	Q.173	3	Q.174	1	Q.175	3
Q.176	4	Q.177	2	Q.178	3	Q.179	3	Q.180	2	Q.181	1	Q.182	1
Q.183	2	Q.184	3	Q.185	2	Q.186	4	Q.187	2	Q.188	3	Q.189	1
Q.190	3	Q.191	1	Q.192	2	Q.193	3	Q.194	2	Q.195	1	Q.196	1
Q.197	4	Q.198	2	Q.199	2	Q.200	4	Q.201	2	Q.202	2	Q.203	1
Q.204	3	Q.205	4	Q.206	4	Q.207	4	Q.208	3	Q.209	1	Q.210	2
Q.211	3	Q.212	1	Q.213	4	Q.214	3	Q.215	4	Q.216	3	Q.217	2
Q.218	4	Q.219	3	Q.220	4	Q.221	1	Q.222	3	Q.223	4	Q.224	2
Q.225	4	Q.226	1	Q.227	4	Q.228	2	Q.229	3	Q.230	2	Q.231	3
Q.232	1	Q.233	3	Q.234	1	Q.235	3	Q.236	2	Q.237	4	Q.238	1
Q.239	3	Q.240	1	Q.241	4	Q.242	3	Q.243	4	Q.244	2	Q.245	1
Q.246	2	Q.247	4	Q.248	3	Q.249	2	Q.250	3	Q.251	4	Q.252	2
Q.253	3	Q.254	4	Q.255	2	Q.256	1	Q.257	4	Q.258	2	Q.259	3
Q.260	1	Q.261	1	Q.262	4	Q.263	3	Q.264	2	Q.265	4	Q.266	2
Q.267	2	Q.268	3	Q.269	1	Q.270	2	Q.271	1	Q.272	4	Q.273	2

Q.1 Bullifonn cells are present in
(1) Bundle sheath (2) Mesophyll
(3) Vascular bundles (4) Epidermis

Q.2 Black wood is obtained from
(1) Dalbergia (2) Albizzia
(3) Manihot (4) Salvia

Q.3 Kranz anatomy is seen in
(1) Euphorbia hirta (2) Citrus indica
(3) Mangifera indica (4) Zeamays

Q.4 The chief function of pholem is the conduction of
(1) Food (2) Mineral
(3) Water (4) Air

Q.5 Secondary phloem remains functional generally
(1) Less than 1 year
(2) More than 1 year
(3) For 1 year
(4) As long as plant lives

Q.6 Casparian strips are the characteristics of
(1) Cortex (2) Endodermis
(3) Pericycle (4) Pith

Q.7 The vascular cambium and cork cambium are the examples of
(1) Apical meristem (2) Lateral meristem
(3) Intercalary meristem
(4) Elements of xylem and phloem

Q.8 Transverse section of a plant is stained with safranin and fast green. What is the colour of the phloem?
(1) Red (2) Green
(3) Pink (4) Orange

Q.9 Root cap in monocots is formed by
(1) Dermatogen (2) Calyptrogen
(3) Vascular cambium
(4) Wound cambium

Q.10 Porous wood contains
(1) Vessels (2) Fibres only
(3) Tracheids (4) Sieve tubes

Q.11 Passage cells are found in
(1) Dicot stem (2) Monocot leaf
(3) Aerial root (4) Monocot stem

Q.12 In a dicotyledonous stem, the sequence of tissues from the outside to the inside is
(1) Phellem - pericycle. - endodermis - phloem
(2) Phellem - phloem - endoderm is - pericycle
(3) Phellem - endodermis - pericycle – phloem
(4) Pericycle - phellem - endodermis - phloem

Q.13 The quiescent centre in root meristem serves as a :
(1) Site for storage of food which is utilized during maturation
(2) Reservoir of growth hormones
(3) Reserve for replenishment of damaged cells of the meristem
(4) Region for absorption of water

Q.14 In a plant organ which is covered by periderm and in which the stomata are absent, some gaseous exchange still takes place through
(1) Aerenchyma (2) Trichomes
(3) Pneumatophores (4) Lenticels

Q.15 Companion cells in plants are associated with
(1) Vessels (2) Sperms
(3) Sieve elements (4) Guard cells

Q.16 Cork cambium results in the formation of cork which becomes impermeable to water due to the accumulation of
(1) Resin (2) Suberin
(3) Lignin (4) Tannin

Q.17 Which one of the following statements pertaining to plants primary structure is correct?
(1) Cork lacks stomata, but lenticels carry out transpi ration
(2) Passage cells help in transfer of food from cortex to phloem
(3) Sieve tube elements possess cytoplasm but no nuclei
(4) The shoot apical meristem has a quiescent centre

Q.18 In the sieve elements, which one of the following is the most likely function of P-proteins?
(1) Deposition of callose on sieve plates
(2) Providing energy for active translocation
(3) Autolytic enzymes
(4) Sealing mechanism on wounding

INSTRUCTIONS FOR Q.NO.11 TO 14

In the following questions, a statement of **assertion (A)** is followed by a statement of **reason (R).**

(1) If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark (A).

(2) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark (2).

(3) If Assertion is true statement but Reason is false, then mark (3).

(4) If both Assertion and Reason are false statements, then mark (4).

Q.19 **A :** In woody stems, the amount of heart wood continues to increase year after year.
R : The activity of the cambial ring continues uninterrupted.

Q.20 **A :** Thick cuticle is mostly present in disease resistant plants.
R : Disease causing agents cannot grow on cuticle and cannot invade the cuticle.

Q.21 **A :** Vascular cambium is considered as lateral meristem.
R : It gives rise to lateral shoots.

Q.22 **A :** Monocot stem bear collateral open vascular bundles.
R : If cambium is absent, such vascular bundles are called open type.

Q.23 **A :** The collenchyma is thick walled living tissue.
R : The collenchyma is thickened due to the depositioft of pectin.

Q.24 **A :** Water and mineral uptake by root hairs from the soil occurs through apoplast until it reaches endoderm is.
R : Casparian strips in endodermis are suberized.

Q.25 **A :** Long distance flow of photoassimilates in plants occur through sieve tubes.
R : Mature sieve tubes have parietal cytoplasm and perforated sieve plates.

Q.26 **A :** In angiosperms, the conduction of water is more efficient because their xylem has vessels.
R : Conduction of water by vessel elements is an active process with energy supplied by xylem parenchyma rich in mitochondria.

Q.27 **A :** Apical meristem of root is subterminal.
R : At the terminal end of root, root cap is present.

Q.28 **A :** In stem, pericycle take active part in secondary growth.
R : In root, pericycle take active part in secondary growth.

Q.29 **A :** Annual ring do not occur in dicot trees growing on sea shore.
R : There is little climate variation.

Q.30 **A :** Tyloses are more abundant in Duramen.
R : They provide rigidity & strength to heart wood.

Q.31 **A :** Radial vascular bundles are found in roots.
R : Xylem & phloem occur in separate bundles and lie on different radii alternating with each other.

Q.32 **A :** Open vascular bundles are found in dicot stem & gymnosperm.
R : Cambium is absent in between xylem & phloem.

Q.33 **A :** Amphivasal vascular bundles are found in some monocots.
R : Xylem lie in centre surrounded by phloem.

Q.34 **A :** Histogen theory is not applicable to shoot apex.
R : The shoot apex is not clearly divided into three layers.

Q.35 **A :** Aerenchyma help in buoyancy to hydrophyte plants.
R : The large air chambers are present in aerenchyma.

Q.36 **A :** Collenchyma forms the hypodermis of dicotyledon stems.
R : This the reason for flexibility of dicotyledon stems.

Q.37 **A :** Various types of pits are formed in sclerenchyma.
R : The deposition of lignin in sclerenchyma.

Q.38 **A :** Annual ring are absent in monocot plants.
R : Absence of cambium in monocot plants.

Q.39 **A :** The seed coat of legume plants becomes hard.
R : The presence of macrosclerids in seed coat of legume plants.

Q.40 **A :** Primary meristem present in plants from embryonic.
R : Primary meristem is responsible only for primary growth.

Q.41 **A :** Xylem is more developed in xerophytes.
R : Major part of xylem is living in xerophytes

Q.42 **A :** Epidermis has meristematic potentialities.
R : The epidermis can resume active cell division and helps in the healing of wounds.

Q.43 **A :** Vascular supply to leaf is called leaf trace.
R : The leaf trace extends between the leaf base and point where it merges with stem.

Q.44 **A :** Protosteles have always pith in the centre.
R : Protosteles are of two types called haplosteles and actinosteles.

Q.45 **A :** Parenchyma is a collection of similar cells that perform a common function.
R : Parenchyma is a simple tissue.

Q.46 **A :** In the hydrophytes the xylem is not differentiate into different types of cells.
R : Xylem provides support and helps in the conduction of water which is not very important in hydrophytes.

Q.47 **A :** Phloem transports prepared food material from leaves to all parts of the plants.
R : In phloem there are some values which stop the flow from down wards to upwards.

Q.48 **A :** Oil glands are mostly schizogamous.
R : Oil glands are formed by dissolution of cells.

Q.49 **A :** Tunica is a type of rib meristem.
R : It's cells divide only in one plane.

Q.50 **A :** Corpus of shoot apex is the example of mass meristem.
R : Cell of corpus divide in two planes.

Q.51 **A :** Intra fascicular cambium is primary in origin.
R : Intra fascicular cambium located in between vascular bundle.

Q.52 **A :** In monocot grafting is not possible.
R : In monocots vascular bundle are closed.

Q.53 **A :** In true xerophytes major part of xylem is dead.
R : True xerophytes grows in water stress condition and dead tissues more developed in water stress condition.

Q.54 **A :** Collenchyma is living mechanical tissue.
R : Collenchyma is non lignified tissue with localised thickening.

Q.55 **A :** Ground tissue system is the largest tissue system of plants.
R : Cortex is a part of ground tissue system.

Q.56 **A :** Vessels are made up of row of cells placed one above the another with their intervening walls (septa) absent due to dissolution.
R : Sieve tubes are tubular channels. In tracheids walls are thick.

Q.57 **A :** There is large deposition of lignin in the lumen of tracheids.
R : The lumen of tracheids is narrow.

Q.58 **A :** In bark all the cells are dead.
R : Bark constitutes secondary cortex, epidermis, cork etc.

ANSWER KEY

EXERCISE – 4

Q.1	4	Q.2	1	Q.3	4	Q.4	1	Q.5	3	Q.6	2	Q.7	2
Q.8	2	Q.9	2	Q.10	1	Q.11	3	Q.12	3	Q.13	3	Q.14	4
Q.15	3	Q.16	2	Q.17	3	Q.18	4	Q.19	1	Q.20	1	Q.21	3
Q.22	4	Q.23	2	Q.24	1	Q.25	1	Q.26	3	Q.27	1	Q.28	4
Q.29	1	Q.30	1	Q.31	1	Q.32	3	Q.33	3	Q.34	1	Q.35	3
Q.36	1	Q.37	1	Q.38	1	Q.39	1	Q.40	2	Q.41	3	Q.42	1
Q.43	2	Q.44	4	Q.45	1	Q.46	1	Q.47	3	Q.48	3	Q.49	1
Q.50	3	Q.51	3	Q.52	1	Q.53	1	Q.54	1	Q.55	2	Q.56	2
Q.57	1	Q.58	3										

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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Structural Organisation in Animal

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ANIMAL TISSUE

INTRODUCTION

- **Tissue :** A group of cells similar in structure, function and origin.

  In a tissue cells my be dissimilar in structure and function but they are always similar in origin.

  – Word animal tissue was coined by – **Bichat**
  – N. Grew coined the term for Plant Anatomy.
  – Study of tissue – **Histology**
  – Histology word was given by – **Mayar**
  – Father of Histology – **Bichat**
  – Study of tissue is also called **Microscopic anatomy.**
  – Founder of microscopic anatomy – **Marcello Malpighi**

  Based on **functions & location** tissues are classified into four types :

Type	Origin	Function
1. Epithelial tissue	Ectoderm, endoderm, mesoderm	Protection, secretion, absorption etc.
2. Connective tissue	Mesoderm	Support, binding, storage, protection, circulation.
3. Muscular tissue	Mesoderm	Contraction and movement
4. Nervous tissue	Ectoderm.	Conduction and control

EPITHELIAL TISSUE

Word epithelium is composed of two words
Epi – Upon
Thelio – grows
A tissue which grows upon another tissue is called **Epithelium.**

– Cells are either single layered or multilayered.
– Cells are compactly arranged and there is no intercellular matrix.
– Cells of lowermost layer always rest on a non living basement membrane.
– Cells are capable of division and regeneration throughout the life.
– Free surface of the cells may have fine hair **cilia** or **microvilli** or may be smooth.
– Epithelial tissue is non-vascularised.

Due to absence/less of intercellular spaces blood vessels, lymph vessels are unable to pierce this tissue so blood circulation is absent in epithelium. Hence cells depend for their nutrients on underlying connective tissue.

Between epithelium & connective tissue, a thin non living acellular basement membrane is present which is highly permeable.

Basement membrane consist of 2 layers.

(a) **Basal lamina :** made up of glycoprotein, and secreted by epithelium cells.

(b) **Fibrous lamina :** Formed of collagen and reticular fibres suspended in mucopoly-saccharide which is matrix of connective tissue.

– So basement membrance is secreted by both epithelium and connective tissue.
Mucopolysaccharide is present in the form of Hyaluronic acid which is composed of 2 components–N acetyl glucosamine & glucuronic acid. Both these components are found in alternate form.

– NAG – GA – NAG –

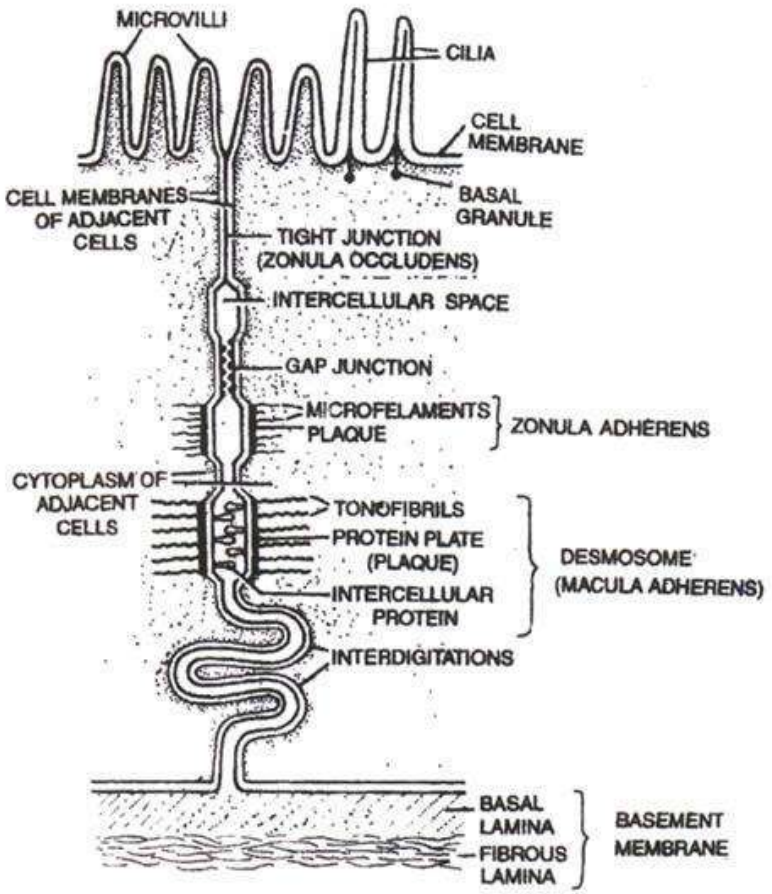
– **Specialized junctions between epithelial cells : -**

– To provide mechanical support for the tissue plasma membrane of adjacent epithelial cells modified to form following structures called as Intercellular Junctions.

→ **Tight junctions (Zonula occludens) :** help to prevent substances from leaking across the tissue. Plasma membranes in the apical parts become tightly packed together or are even fused.

→ **Interdigitations :** These are interfitting, finger like processes of the cell membranes of the adjacent cells.

→ **Intercellular Bridges :** These are minute projections that arise from adjacent cell membrances. They make contact with one anther.



Showing microvilli, cilia, cell junctions and basement membrane

→ **Gap Junctions :** Facilitate the cells to communicate with each other by connecting the cytoplasm of adjoining cells, for rapid transfer of ions, small molecules and sometimes big molecules.

→ **Intermediate Junctions (= Zonula adherens) :** These usually occur just below tight junctions. The intercellular space at these places contains a clear, low electron density fluid. There is a dense plaque like structure on cytoplasmic side of each plasma membrane from which fine microfilaments of actin (protein) extend into the cytoplasm. There is no intercellular filaments between the adjacent cell membranes. There is an adhesive material at this point. They probably serve anchoring functions.

→ **Desmosomes (=Macula adherens) :** Perform cementing to keep the neighbouring cells together. These are like zonula adherens but are thicker and stronger and are disc like junctions. They have intercellular protein. The plaque-like structures (= protein plate) are much thicker. The microfilaments which extend from microfilaments are called **tonofibrils.** Desmosomes serve anchoring function. **Hemidesmosomes** (single sided desmosomes) are similar to desmosomes, but the thickening of cell membrane is seen only on one side. Hemidesmosomes join epithelial cells to basal lamina (outer layer of basement membrane).

– **Specialised functional structures shown by Epthelial Cells : -**

Plasma membrane of free end get modified to form 3 types of functional structures.

- **Microvilli :**
  - Minute protoplasmic process which are not non motile, non contractile.
  - Help in absorption, secretion, excretion
  - Increase surface more than 20 times.

  Present in the wall of Intestine, Gall bladder, Proximal convoluted tubule etc.
- **Cillia or Kinocilia**
  - Long cylindrical protoplasmic process.
  - Motile and contractile
  - Movement of cilia is always in uniform direction.
  - Originated from basal granule or kinetosome.
  - Diameter of cilia is same from base to apex.
  - In internal structure of cilia 9 + 2 arrangement of microtubules is present.
  - They helps in conduction

  e.g. – Fallopian tube.
  - Trachea.
  - Uterus.
  - Uterus.
  - Ependymal epithelium : (Inner lining of ventricles of brain & central canal of spinal cord. Function of cilia is to conduct substances in CSF.)
- **Steriocilia**
  - Long cytoplasmic process
  - Non motile, non contractile
  - Basal granule is absent
  - Plasma membrane is thick & rigid.
  - Base of stereocilia is broad & apical part is narrow so they are conical in shape.
  - They increase surface area .

  eg. Epididymis

  Vasadeferens
- **Origin of Epithelial Tissue**

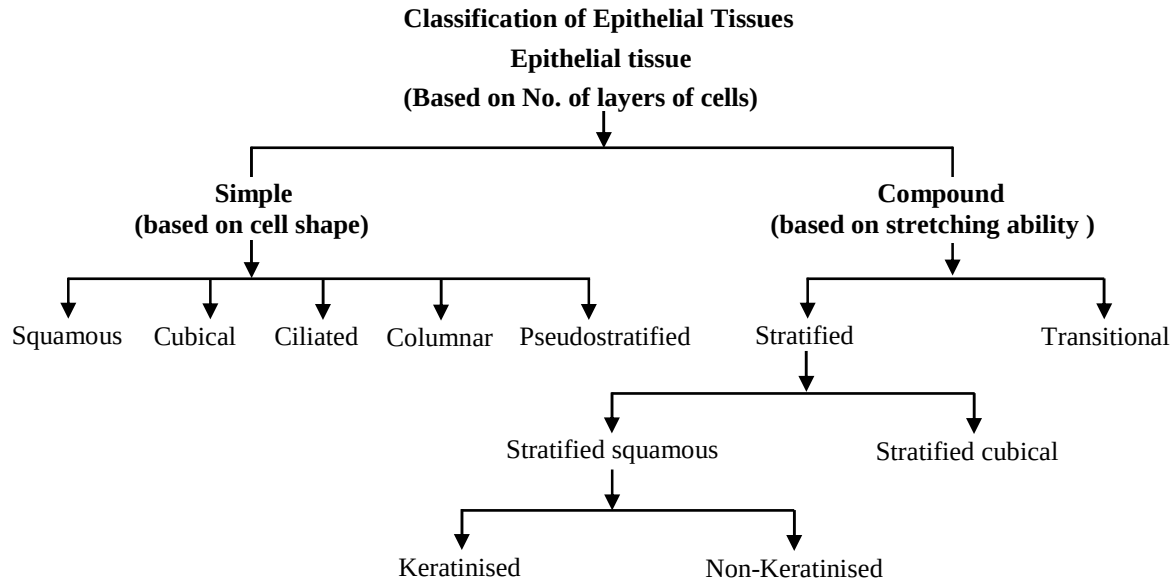
  It is the only tissue which originated from all the three primordial germinal layers.

  eg. (i) Ectodermal – Epidermis (stratified squamous epitheliium)

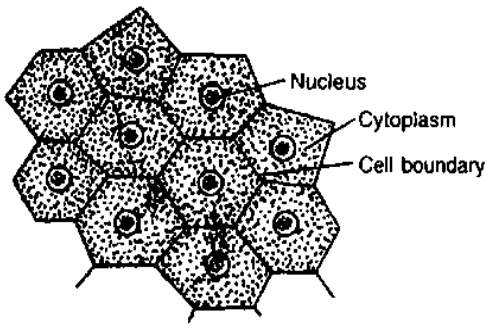
  (ii) Mesodermal – Mesothelium (simple squamous Epithelium)

  (iii) Endodermal – Endothelium (simple squamous Epithelium)

Types of Epithelial Tissue

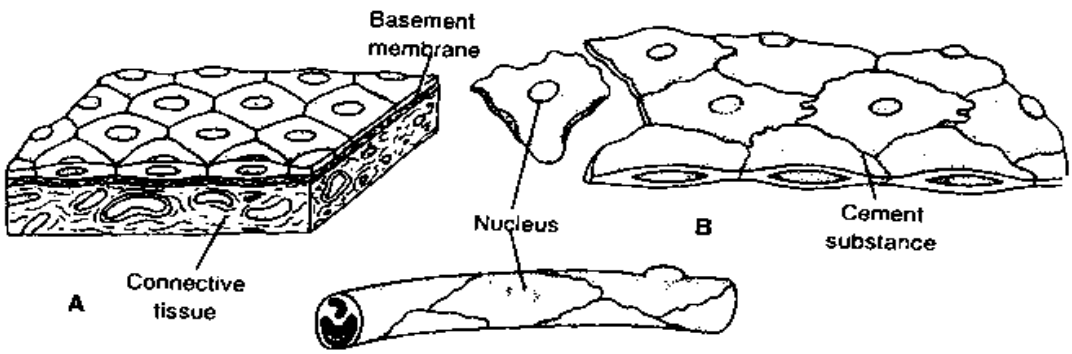


- **SIMPLE SQUAMOUS EPITHELIUM**



(Simple squamous epithelium)

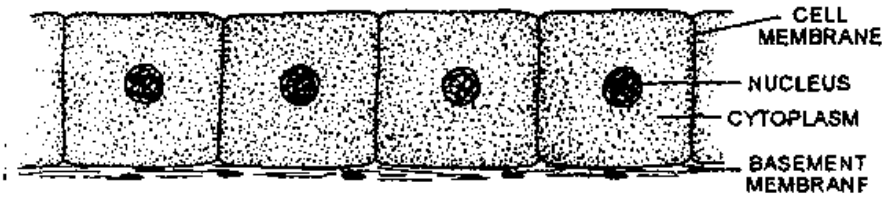
- Unilayered.
- Cells are flat or scale like in shape
- A flattened/rounded nucleus present.
- Cells are more in width and less in length so in verticle section they appear rectangular in shape.
- It is also called **pavement epithelium** due to its tile like appearance.
- Also called **Tesselated epithelium** due to its wavy appearance.
- This epithelium is associated with **filtration & diffusion**



e.g. – Bowman's capsule (Podocyte)

– Descending limb & thin part of ascending limb of loop of Henle.
– Rete Testis
– Alveoli of lungs (Pneumocytes)
– Small bronchioles
– Mesothelium – Covering of coelom is called as mesothelium. (Tesselated)
– Visceral & Parietal peritoneum. Visceral and parietal pleura, Visceral and Parietal pericardium.
– Endothelium – Inner lining of blood vessels and lymph vessels. (Tesselated)
– Inner lining of heart wall (Tesselated).

- **SIMPLE CUBOIDAL EPITHELIUM**
  – Basement membrane is present.
  – Cells are cube like in shape
  – A rounded nucleus is present in the centre of cell.
  – Cells are same in length & width so they appear square shaped in vertical section.

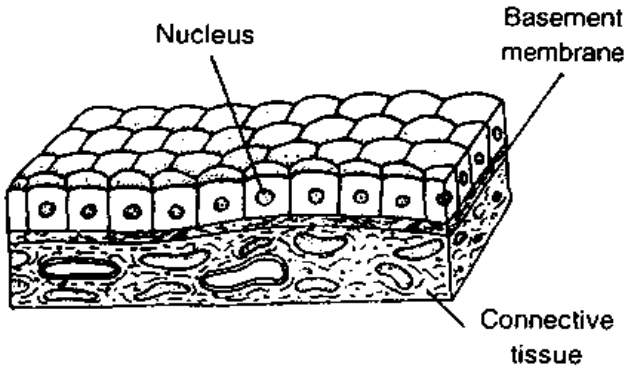


(Simple cuboidal epithelium)

– This epithelium helps in absorption, secretion & excertion.

It also form gametes in gonads.

Mostly cuboidal cells are found in glands.



eg. – Vesicles of Thyroid gland
– Acini of Pancreas
– Pancreatic duct
– Secretory unit of sweat glands

Sweat glands are coiled tubular glands in structure. Coiled part of this gland has secretory unit in the form of simple cuboidal epithelium is present while in secretory duct of this gland **stratified cuboidal epithelium** is present.

– Secretory duct of salivary glands
(secretory unit of salivary glands is composed is **stratified cuboidal epithelium.**)
– Iris

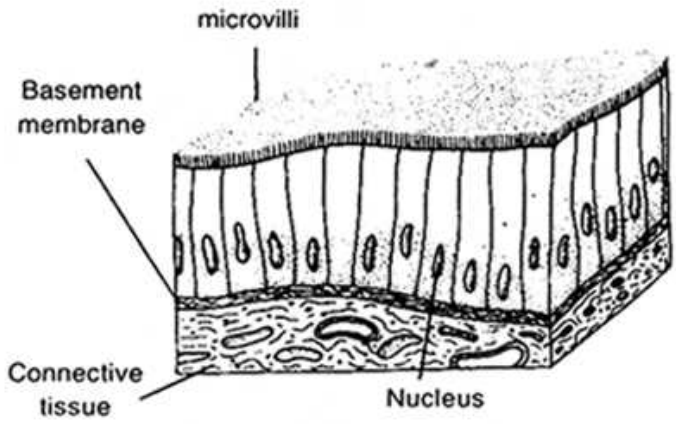
– **Choroid**
– **Ciliary body of eye**
– **Thick part of ascending limb of loop of henle**
– **DCT**

– In gonads this epithelium is also called as **Germinal epithelium** (testis & ovaries) where cuboidal cells divide to form egg & sperm.
– It is found in peripheral region of ovary & seminiferous tubules in Testis.

Modifications :

Brush bordered cuboidal epithelium where microvilli are present on free and cuboidal cells
eg. – Found in PCT of nephron.
Ciliated cuboidal epithelium when cilia present on free end of cuboidal cells then
Found in certain part of nephron and in collecting duct.

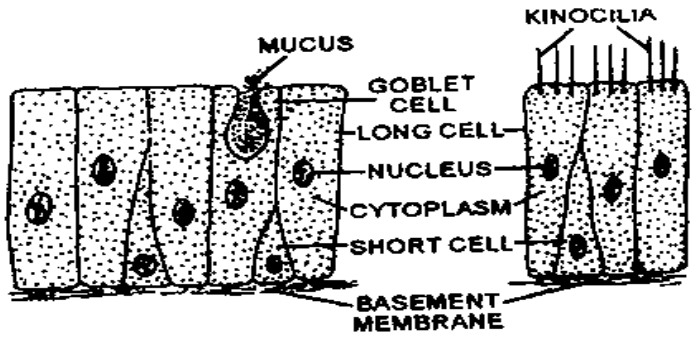
- **SIMPLE COLUMNAR EPITHELIUM**
  – Basement membrane is present.
  – Cells are pillar or column like in shape.
  – Elongated nucleus is present at the base of cell.
  – It helps in absorption and secretion.
  e.g., **Bile Duct, Liver**



Modifications :

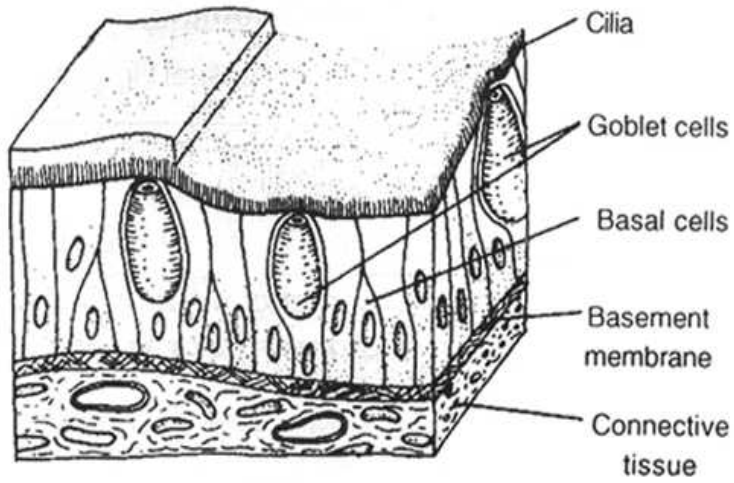
- **Brush Bordered Columnar epithelium :**
  Microvilli are present at free end of epithelium.
  e.g. Gall bladder
- **Gladndular columnar epithelium :**
  Unicellular mucous secreting **goblet cells** are also present in between columnar cells.
  eg. Stomach, Colon, Rectum
- **Glandular Brush bordered columnar epithelium :**
  Microvilli present on free end of columnar cells & in between these cells goblet cells are also present.
  e.g., Duodenum, IIeum, Caecum.
- **Ciliated Columnar epithelium :**
  Cilia are present on free end of columnar cells.
  e.g. Fallopian Tube, Ependymal epithelium
- **Steriociliated columnar epithelium :** Steriocilia present on free end of columnar cells.
  e.g. Epididymis, Vasa Deferens

- **PSEUDOSTRATIFIED EPITHELIUM**
  – It appears billayered as two types of cells are present
  i.e. Long cells
  Short cells.
  – But all the cells are present on single basement membrane so its unilayered.



(Pseudostratified columnar & ciliated columnar)

– All these cells are pillar like in shape so it is also modification of columnar epithelum.
– In long cells, elongated nucleus is present at the base of cell & are ciliated Short cells have rounded nucleus present in the centre of cell, lack cilla and secrete mucus.



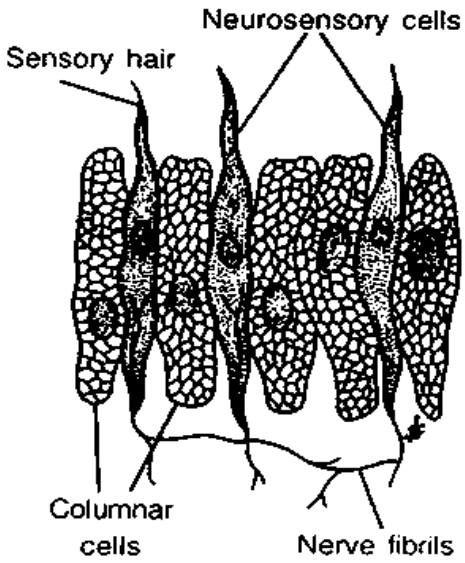
Modification

- **Pseudostratified Non-ciliated Epithelium** eg, Parotid Salivary gland middle part of male urethra.
- **Pseudostratified ciliated glandular epithelium :**
  In this epithelium cillia are present at free end of long cells and goblet cells are also present in this epithelium.
  e.g. Trachea, Bronchi
  Respiratory epithelium of nasal chambers.

Special Types of Epithelium

(a) Neuro sensory epithelium :
In between piller shaped supporting cells modified sensory cells are present. On the free end sensory hair is present. Base of these cells is attached with sensory nerve.

e.g. – Gustatory Epithelium – Cover taste bud of tongue and receive taste sensation.
– Olfactory epithelium – Schneidarian membrane receive smell sensation.
– Stato – acoustic – Lining of internal ear.
– In retina of eye receive optic sensation.



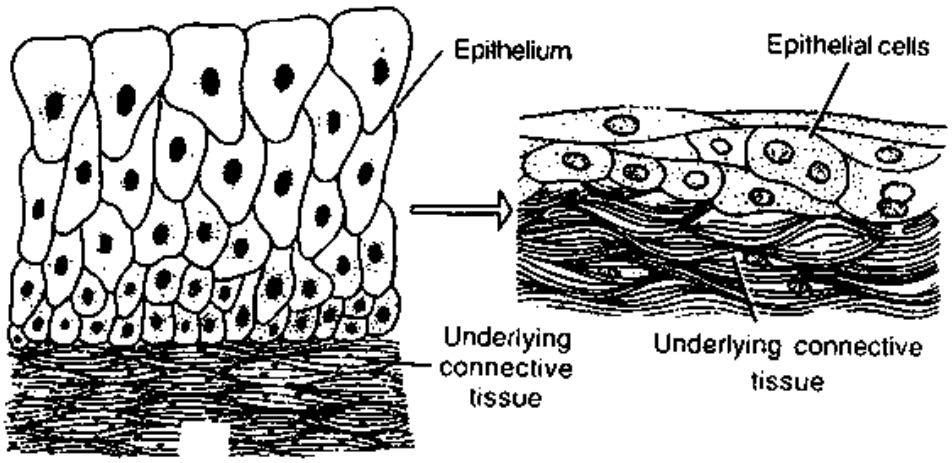
(b) Myoepithelium : Around mammary and sweat gland
(c) Pigmented epithelium (Cuboidal) : In Retina of eye

COMPUND EPITHEliUM

(1) Transitional epithelium – Stretcheable.
(also called Plastic epithelium)

(2) Stratified epithelium – Non-stretcheable.

- **TRANSITIONAL EPITHELIUM (UROTHELIUM)**
  - It is only tissue in which basement membrane is absent. So innermost layer directly rest upon underlaying connective tissue.



  - In this epithelium 4-6 layer of cells are present.
  - Inner most layer of cells is composed of **cube like cells.**
  - Middle 2-4 layers are composed of pear shaped or umbrella shaped cells.
  - Outermost 1 or 2 layers are of oval shaped cells.
  - These different shape of cells appears only in resting stage. When this tissue is stretched, all the cell become flattened.
  - At outermost layer a thin cuticle is present which makes this tissue water proof.
  - Cells are interconnected by interdigitation.

  e.g. – Renal Pelvis, Ureter, Urinary Bladder, Proximal part of male urethra.

- **STRATIFIED EPITHELIUM**
  - Stratified epithelium possess many layer of epithelial cells, the deepest layers is made up of **cuboidal** cells. On the basis of shape of the cells of outermost layer it is of four types.

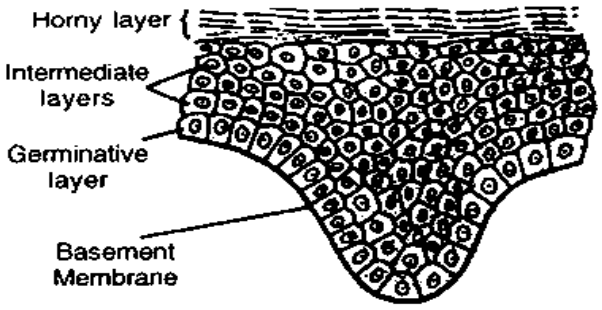
  (1) **Stratified squamous epithelium**
  (2) **Stratified cubical epithelium**
  (3) **Stratified columnar epithelium**
  (4) **Stratified ciliated columnar epithelium**

- **STRATIFIED SQUAMOUS EPITHELIUM**
  - Innermost layer of cells are of cuboidal or columnar shaped.
  - These cells have high Mitotic index
  - They divide to form layer of Stratified epithelium so this layer is called as **Germinativum** layer. Middle layers are made up of polygonal cells.
  - These cells are interconnected with Desmosomes which provide rigidity or mechanical support.

– Cells of outermost layer are scale like flat cells. On the basis of presence or absence of Keratin protein in the outer most cells this epithelium is of two types :

(a) Keratinized Stratified squamous epithelium .

Hard water proof keratin protein is present in scaly cells and cells become non nucleated dead cells.



(Stratified squamous)

e.g. – Epidermis of skin, Scale, Horn, Nails, Feathers

(b) Non Keratinized Stratified squamous epithelium .

Keratin protein is absent. Cells are nucleated & Living.

e.g., Buccal cavity or oral cavity of mammals, Inner lining of cheeks, Inner lining of lips, Lining of hard palate, Lining of Tonsils, Lower part of soft palate, Pharynx, Oesophagus, Anal canal, Lining of vagina, Cornea of eye

- **STRATIFIED CUBICAL EPITHELIUM**

– Outermost layer of cells are cube like & cells are nucleated & living.

– Middle layer – polygonal shaped cells.

e.g. – Secretory duct of seat glands, mammary glands and sebaceous gland.
– Secretory unit of salivary glands, sebaceous gland.
– Female Urethra ; part of anal canal.
– Conjunctiva of eye.

- **STRATIFIED COLUMNAR EPITHELIUM**

It consists of columnar cells in both superficial basal layers. Cells are nucleated. Cilia absent on free end.

e.g., – Distal part of male urethra, Epiglottis

FUNCTIONAL CLASSIFICATION OF EPITHELIAL TISSUE

Functionally epithelial tissues can be classified as follows :

(a) Germinal epithelium : It is present in testis and ovaries. Its cells produce **Sperms** and **Ova**.

(b) Pigmented epithelium : It is present in retina of eye. It possess pigment which give colour to the retina.

(c) Sensory epithelium : It is found in retina of eye, internal ear, nasal chamber and tongue. It perceives stimuli and conducts impulses.

(d) Glandular epithelium : It is present in glands and secrete fluid (Secretion)

(e) Absorptive epithelium : It is found in nephron of kidneys, stomach, intestine, It helps in absorption of food in stomach and intestine and liquid materials in nephron.

GLANDS OF EPITHELIUM

- A cell or group of cells which secrete chemical substances are called glands.
- All glands are composed of Epithelium tissue.
- Glands originate from all three germinal layers.
- The cells are generally columnar or cuboidal.

- **TYPES OF GLANDS**

(A) On the basis of number of cells

icellular gland consist of isolated glandular cells. Life an of 2-3 days
;., Mucosa of stomach, Intestine, Trachea, Nasal amber (Goblet cells), Paneth cells (Intestine)

(b) Multicellular glands Consist of cluters of cells.
Formed by invagination of Epithelial cells. e.g. Rest glands

(B) On the basis of Shape of secretory units

(1) Tubular glands
- (A) Simple gland
  - (i) S. Tubular glands
    eg. Intestine glands
    (Crypts of leiberkuhn)
  - (ii) S. coiled tubular
    - Sweat glands
  - (iii) S. branched tubular
    - Sweat glands of armpit
    - Gastric glands
- (B) Compound tubular glands
  Eg. - Brunner's gland
  - Mammary glands of Prototheria.
  - Inactive mammary glands of eutheria

(2) Saccular/Alveolar glands
- (A) Simple Glands
  - (i) Simple Alveolar
    eg. Cutaneous glands of frog
    - Poison glands
    - Mucous glands
  - (ii) Simple branched alveolar
    eg. Most sebaceous glands
- (B) Compound Sacccular glands
  eg. - Sublingual gland
  - Submandibular gland
  - Few sebaceous glands

(3) Compound tubulo Alveolar
- Active mammary glands
- Parotid gland
- Cowper's gland
- Pancreas

(C) On the basis of presence of secretory duct glands are of 3 types

(a) **Endocrine glands –** Secretory duct absent
(b) **Exocrine gland –** Secretory duct present.
(c) **Heterocrine/mixed gland** – Both endocrine & exocrine parts are present.

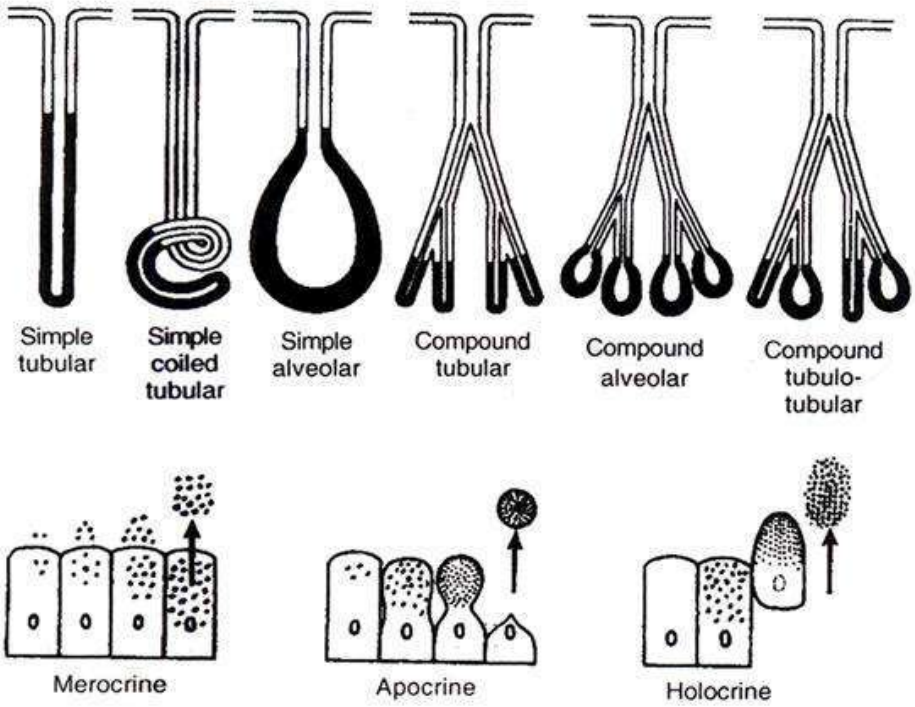
(D) On the basis of nature of secretion – 3 types of glands are there.

(a) **Eccrine/Acrine/Merocrine gland** –
In these glands secretory cells secrete substances by simple diffusion (Exocytosis). No part of cytoplasm is destroyed in secretion.

e.g. Maximum sweat glands of humans, Paws of rabbit, Goblet cells, Salivary gland, Tear gland, Intestinal gland, Mucous gland.

(b) **Apocrine gland** – In this type of glands secretory products are collected in apical part of secretory cell Apical portion is also shed along with secretory matter.
Secretory cells gain their lost part of cytoplasm by process of regeneration.

– Mammary glands.
Sweat gland of Arm pit, pubic region, skin around anus, lips, nipples etc.
Largest sweat gland of body are found around nipples. – Areola mamme.



In Rabbit seat glands of this type are found on lips and skin around lips.

(c) **Holocrine glands –**
The production or secretion is shed with whole cell leading to its destruction. i.e
e.g. Sebaceous, meibomian & Zeis gland.

(E) On the basis of secretory matter

(i) Serous glands	(ii) Mixed glands	(iii) Mixed glands
Secretion-Watery fluid	Secretion : Mucous/gelatinous	Secretion : Watery + Mucous
Eg. Sweat glands	Eg. Goblet cell	Eg. Pancreas, gastric glands

CONNECTIVE TISSUE

– All connective Tissue in the body are developed from Mesoderm.
– O. Hartwig called them **Mesenchyme** because they originated from embryonic mesoderm.
– Only connective Tissue consititute **30%** of total body weight.
(Muscle – 50%, Epithelium – 10% Nervous – 10%)
– On the basis of **matrix** connective tissue is of 3 types

1. Connective Tissue Proper – Matrix soft and fibrous

2. **Connective Tissue Skeleton** – Dense and mineralized matrix. Due to deposition of minerals it becomes hard.
3. **Connective tissue Vascular –** Liquid and fibres free matrix

1. CONNECTIVE TISSUE PROPER

Connective Tissue Proper is composed of three components (A) Different types of cells, (B) Fibres, (C) Matrix.

(A) CELLS OF CONNECTIVE TISSUE PROPER

- **FIBROBLAST CELLS**

– Largest cell of connective tissue proper.
– Maximum in number.
– Cell body and nucleus both are oval shaped.
– Branched cytoplasmic process arise from these cells so they appear irregular in shape.
– Rich in rough ER because main or primary function is to produces fibres. Fibres are composed of protein.
– Chief matrix producing cells.
– Old fibroblast cells (fibrocyte) are inactive cells.
– These are also considered as undifferentiated cells of conn. Tissue because they can be modified into **Osteoblast** & **Chondrioblast** cells to produce bone & cartilage.

Function : (1) To produce fibres (2) To secrete matrix.

- **PLASMA CELL - CART WHEEL CELL**

– Less in number
– Amoeboid in shape
– Chromatin material is arranged like spokes in wheel so they are also called as **Cart wheel cells.**
– According to research these cells are formed by the division of lymphocytes. So they are also called as **clone of lymphocytes.**

Function : Produce, Secrete & transport antibody.

- **MAST CELLS/MASTOCYTES**

– Numerous , amoeboid and small in size.
– Structurally and functionally similar to basophils.
– 2-3 lobed S-shaped nucleus
– Cytoplasm contains basophilic granules which can be stained with basic dye Methylene Blue.
– It is important cell of connective tissue proper as they perform important functions.

(a) Histamine – Histamine is a protein, a vasodilator

– Increase permeability of blood capillaries.
– Take part in allergy and inflammatory reactions.

(b) Secotonin -

– Also called as 5-Hydroxy tryptamine
– It is a protein, a vasoconstrictor & decrease blood circulation but increases blood pressure.
– A the site of cut or injury serotonin decrease blood loss.

(c) Heparin –

A mucopolysaccharide, a natural anti-coagulant, prevents clotting of blood in blood vessels by preventing the conversion of prothrombin into thrombin.

- **ADIPOSE CELLS/FAT CELLS**

– Oval shaped stores fat.
– Fat is collected in the form of fat globule formed by the fusion of small oil droplets.
– On the basis of number of fat globules adipocytes are of two types.

(a) Monolocular adipocytes/ White fat tissue-cell

– In these cells single large and central fat globule is present.
– nucleus & Cytoplasm is peripheral and Cytoplasm is less in amount.
– Due to compression of fat globule, nucleus become flattened in shape . These adipocytes form **White Fat.**

(b) Multilocular adipocytes/Brown fat tissue cell

– In these cell 2-3 fat globules are distributed in the cytoplasm around nucleus
– Cytoplasm is more in quantity.
– Nucleus is rounded & found in the centre
– These adipocytes form **Brown Fat.**

- **MESENCHYMAL CELLS**

– Less in numbers . Small sized with cytoplasmic process having irregular shape.
– Oval shaped nucleus
– These are undifferentiated cells of connective tissue because they can transform into any cell of connective Tissue proper. (Totipotent in nature)
Function : To form other cells of connective tissue.

- **MACROPHAGES/HISTEOCYTE/CLASMATOCYTES.**

– It is 2nd largest in size and in number.
– Amoeboid in shape with bean or kidney shaped nucleus.
– Cytoplasm quantity is more agranular but due to presence of more number of lysosome it appears granular.
– Phagocytic in nature, destroy bacteria & viruses by phagocytosis. They arises by the fusion of monocytes
– Also called as **scavenger cells** of connective tissue because they destroy dead or damaged cells to clean connective tissue.

Macrophages are named differently in different organs.

Lung	–	Dust cells
Liver	–	Kupffer cells
Blood	–	Monocytes
Brain	–	Microgleal cells
Thymus gland	–	Hessels granules
Spleen	–	Reticular cells

- **LYMPHOCYTES**

– Less in number and small in size having amoeboid shape.
– A large nucleus is present cytoplasm is present as peripheral layer. Cytoplasm quantity is less.
– Produce, transport & secretes antibodies.
– They divide to form plasma cells of connective tissue proper.

(B) FIBRES

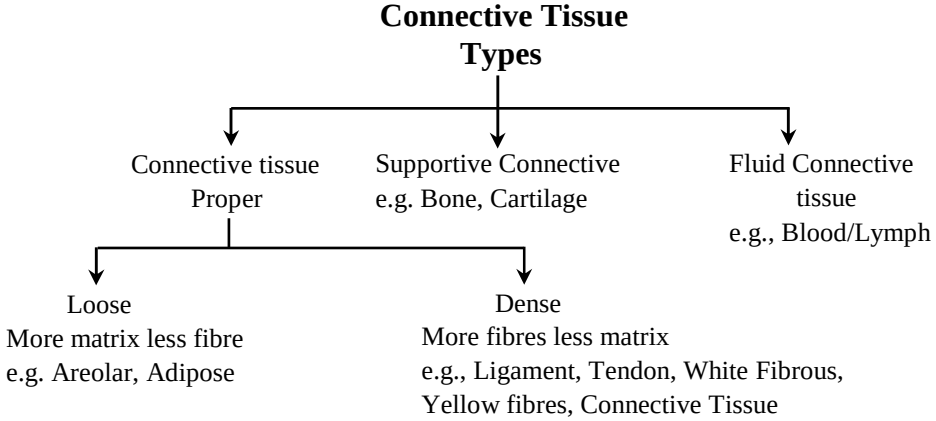
- **Collagen fibres (White fibres)**
  - They are shining white fibres composed of collagen protein (Tropocollagen).
  - It is present in maximum quantity in vertebrates, (only collagen fibres constituted one third part of connective tissue fibres in human beings.)
  - They are wavy & tough fibres always arranged in bundle called fascia.
  - On boiling they convert into gelatin.
  - They can be digested by Pepsin enzyme.
- **Elastic fibres – (Yellow fibres)**
  - Precursor in colour and composed of elastin protein.
  - They are branched fibres but always arranged singly. Branches of these form network.
  - In these fibres maximum elasticity is present.
  - They are highly resistant to chemicals.
  - When boiled they do not dissolve.
  - They can be digested by **trypsin** enzyme.
- **Reticular Fibres : -**
  - Precursor of Collagen fibres, delicate with no elasticity
  - Also known as Arzyrophil fibre since they can be stained with silver salts.
  - They are composed of recticulin protein highly branched fibres which always form dense network.
  - These are mainly distributed in lymphoid organs like spleen or lymph nodes.

(i) Collagen fibers or white fibres	(ii) Elastic Fibres or Yellow fibres	(iii) Reticular fibres
Bright white, madeup collagenprotein Unbranched and wavy Not elastic	Yellow, Made up of Elastin protein. Single and branched. Maximum elastic. Ex-Ligament that connect bone to bone	Made up of reticulin Protein Freely branched Non-elastic fibres

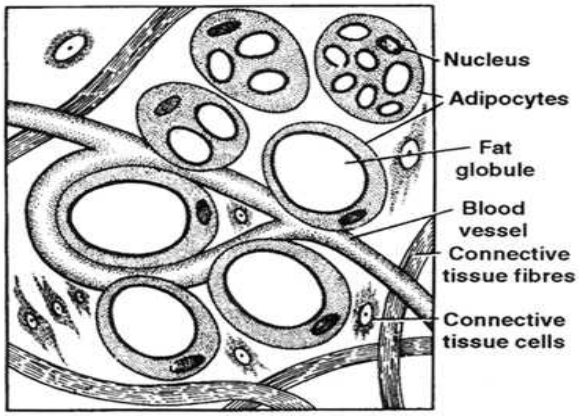
(C) MATRIX

Matrix is composed of Mucopolysaccharide which is present in the form of Hyaluronic acid.

TYPE OF CONNECTIVE TISSUE PROPER



Connective Tissue Proper



Adipose connective tissue

Loose Connective Tissue : It consists of cells scattered within an amorphous mass of proteins that forms a ground substance. The gelatinous material is strengthened by a loose scattering of protein fibres such as collagen, elastin, which makes tissue elastic and reticulin which supports the tissue by forming a collagenous meshwork.

- **AREOLAR CONNECTIVE TISSUE**
  - Also known **spongy** tissue.
  - It is most widely distributed tissue in the body.
  - In this tissue maximum intercellular space or substances/matrix is present.
  - Due to irregular arrangement of bundle of collagen fibres many gaps are present. These spaces called **Areolae.**
  - In areolae other components of connective tissue are distributed like fibres, cell & matrix.
  - Few elastic fibres are present but reticular fibres are completely absent.
  - Mast cells, Macrophage & Fibroblast contain mone amount.
  - It occurs beneath the epithelia of many visceral organs skin and in the walls of blood vessels.
  - Fibroblast is the main cell.

  e.g., Tela Subcutanea – A thin continuous layer which connect skin with underlying skeletal muscles (Pannicules carnosus). In mammals skin is tightly attached with muscles.

  While in frog it is present in the form of septum so skin is loosely attached with muscles.

  Endomysium – Around single muscles fibre.

  Perimysium – Around bundle of muscle fibre.

  Outside of semniferous Tubules.

  Medulla of ovary

  Sub mucosa of trachea, Bronchi, Intestine

  ➡ **The areolar tissue joins different tissues and forms the packing between them and helps to keep the organs in place and in normal shape.**

- **ADIPOSE CONNECTIVE. TISSUE**
  - Modification of Areolar connective tissue. But in areolae major component is adipocytes which store fats.
  - Blood vascular system is also present in this tissue.

– If this tissue is treated with alcohol (organic solvent) Fat will be dissolved completely and adipocytes will become vacuolated.
– This tissue can be stained with sudan solution.
– On the basis of adipocytes 2 type of fats are found in animals.
(A) White fat (B) Brown fat

(A) White fat – It is composed of monolocular adipocytes in which single large fat globule & peripheral cytoplasm is present. Due to less amount of cytoplasm, Mitochondria are also less in number, so they produce less energy.

- **e.g. Panniculas adiposus –** A thin continuous layer of white fat under the dermis of skin which is also called **hypodermis** of skin.
  Panniculas adiposus is absent in rabbit. Fat collected in form of adipose connective tissue is a discontinuous layer.
- **Blubber –** Thick layer of white fat found under dermis of skin. Found in whale, seal, elephants. Maximum thickness of this layer is found in Blue whale (80 cm)
- **Hump of camel**
- **Tail of marino sheep**
- **Yellow Bone marrow.**

(B) Brown fat – It is composed of multilocular adipocytes in which many fat globules are present. Cytoplasm is more in amount. Due to more number of mitochondria, it produces 20 times more heat than white fat. Brown colour of fat is due to Cytochrome Pigment.

– Cold resistance device in new born baby is due to presence of brown fat. It accounts for 5-6 percent of body wt.
– It cannot be substituted for food.
– In hibernating animals during hibernation they obtain energy from stored brown fat.
– When fat is oxidized it produce water & energy.

Dense Connective Tissue – Fibres and fibroblasts are compactly packed in the dense connective tissues. Orientation of fibres show a regular or irregular pattern and are called dense regular and dense irregular tissues.

In the dense regular connective tissues, the collagen fibres are present in rows between many parallel bundles of fibres e.g. tendons and ligaments.

Dense irregular connective tissue has fibroblasts and many fibres (mostly collagen) that are oriented in different directions. This tissue is present in the skin, in perimysium, perineurium and bones as periosteum.

- **WHITE FIBROUS CONNECTIVE TISSUE**

– Bundle of collagen fibres are more in quantity & other components of connective tissue proper are less in quantity. It has great tensile strength.
– Yellow fibres & reticular fibres are completely absent.
– Its presence at joints between skull bones makes them immovable.
– On the basis of arrangement of fibres and matrix this tissue occurs in two forms –

Cord

1. Bundle of collagen fibres & matrix are distributed in regular parttern (alternate pattern).
2. Fibroblast cells are arranged in a series. Mast cells are scattered in matrix.

eg. Tendon connects muscles & bones.

Strongest tendon of the body is **Tendocalcaneus Tendon.** This tendon connects Gastrocnemius muscles of shank with calcaneum bone of ankle.

Sheath – In this form there is no regular pattern of fibres & matrix. Cells and fibres are criss – crossed arranged.

eg. – Pericardium

Periosteum – Outer covering of bone.

Perichondrium – Outer covering of cartilage.

Perichondrium – Covering of muscle.

Epimysium – Around Kidney.

Renal capsule – Covering of spleen.

Tunica Albugenia – Covering of Testis.

Splenic capsule – Covering of spleen.

Duramater – Otermost covering of brain.

Cornea of eye

Trachea

Bronchi

Oesophagus.

Glison's capsule – Around lobe of liver.

- **YELLOW FIBROUS CONNECTIVE TISSUE**
  - Yellow fibres are more in quantity but collagen fibres are also present.
  - Reticular fibres are absent.
  - On the basis of distribution of fibres & matrix they are of two types.

Cord : - Bundle of collagen fibres & matrix distributed in a regular pattern & in matrix yellow fibres form network.

eg. Ligaments – A structure which connects Bones.

- Strongest Ligament of body is **IIio-fermoral ligament** connects IIium bone of pelvic girdle with femur bone of Hind limb.
- In quardrupeds like cow & buffalo strongest ligament is **ligamentum nuchea** present in the between two cervical vertebrae.

Sheath – Irregular distribution of fibres and matrix with Elastic fibre.

eg. **– Wall of Alveoli of lungs**

Wall of small bronchioles

Wall of lymph vessels & Blood vessels

True vocal cords

Difference between Tendon and Ligament

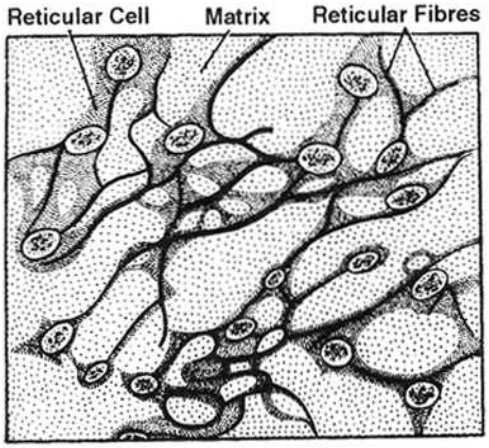
S.No.	Tendon	Ligament
1.	It is composed of white fibrous tissue	It is composed of yellow elastic tissue
2.	Fibroblasts lie in almost continous rows.	Fibroblasts lie scattered
3.	It joins a skeleton muscle to a bone	It joins a bone to another bone
4.	It is tough and inelastic	It is strong but elastic

- **RETICUlAR FIBROUS /LYMPHOID TISSUE**
  - It is mostly found in lymphoid organs.
  - Matrix of this tissue is like lymph.

– Reticular fibres are more in amount & form dense network around star shaped reticular cells. (Phagocytic in function)
– Lymphocyte cells are also more in number.
– Provide support and strength and form the stroma (Frame work) of soft organs.

e.g. **– Spleen**

– **Lymph nodes (Tonsils, Peyer's Patches).**
– **Cortex of ovary.**
– **Endosteum (covering of bone marrow cavity)**



Reticular tissue

– **Lamina Propria, Trachea, Bronchi , Intestine**

- **MUCOID CONNECTIVE TISSUE**

Also called **Embryonic** Tissue because it is mainly found during embryonic life.

– Matrix is in abundance.
– Few collagen fibres & fibroblast cell may be present.
– Matrix is composed of jelly like material called **Wharton's Jelly.**

eg. **– Umbilical cord (connect Placenta with foetus), Viterous humor – In vitreous body of eye, Comb of cock.**

- **PIGMENTED CONNECTIVE TISSUE**

It is a modification of areolar connective tissue but in areolae pigmented cells are more in number known as **Chromatophores** with provide colouration.

Melanophore – Melanin – Black
Guanophore – Guanine – White
Xanthophore – Xanthophil –Yellow

eg. – **Dermis of frog skin**
– Iris & choroids of eye.

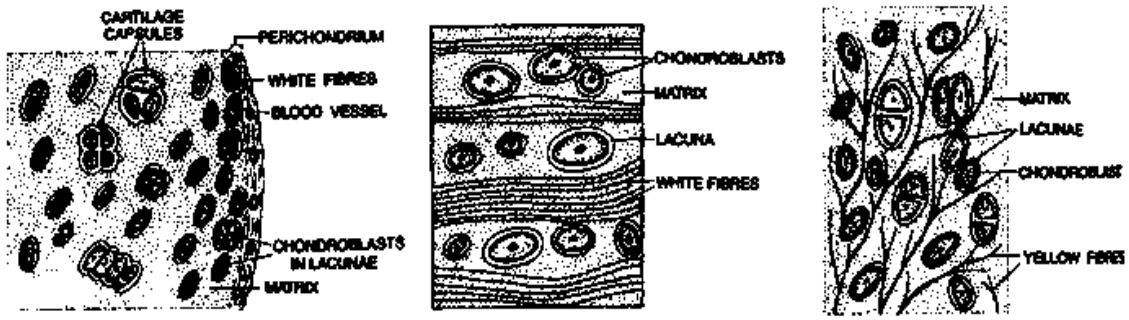
SUPPORTIVE CONNECTIVE TISSUE

– Matrix is dense mineralized. Due to deposition of minerals it becomes hard.
– Also known as **Skeletal Tissue** from skeleton of body.
– It is of 2 types

(1) Cartilage – Solid, semi-rigid, flexible conn. tissue.
(2) Bone – Solid, rigid conn. tissue.

CARTILAGE

- Outer most covering of cartilage is called **Perichondrium** which is composed of white fibres connective tissue.
- Cartilage producing cells are arranged on periphery known as **Chondrioblast.**
- These are active cell & divide to form chondriocytes, and synthesize the matrix of cartilage.
- Mature cells of cartilage are called **Chondriocytes.**
- They are found in vacuole like space in matrix called Lacuna. In which 2-3 Chondrocytes are present.
- **Chondrioclast** are cartilage destrolying cells.
- Maxtrix of cartilage is called **Chondrin** composed of Chondromucoprotein having Chondroitin-6-sulphate and Mucopolysaccharide (Hyaluronic acid)
- Matrix of cartilage provides rigidity & elasticity to cartilage.
- Blood circulation is absent in the matrix of cartilage.



Hyaline cartilage **White fibrous cartilage** **Yellow elastic fibrocartilage**

Type of Cartilage – There are following types of cartilage.

(A) Hyaline Cartilage.

(B) Fibrous Cartilage – (a) Elastic cartilage (b) white fibrous cartilage

(C) Calcified Cartilage.

(A) Hyaline cartilage

- Most of the part of embryonic skeleton is composed of this cartilage. Therefore, maximum bones of body are cartilaginous bones because they are developed from cartilage.
- Outermost covering **Perichondirum** is present.
- Matrix of this cartilage is **glass like** clear or hyaline matrix. Fibres are completely absent in the matrix of this cartilage. Only few collagen fibres may be present.
- Colour of matrix is bluish and it is transluscent.
  eg. – **Nasal septum.**
- **'C' shaped rings of trachea and Bronchi.** (Incomplete in dorsal surface)
- **Sternal part of ribs**. (Costal cartilage)
- **Larynx : Thyroid, Cricoid, Arytenoid.** Maximum part of Larynx is composed of hyaline cartilage.
- **Articular cartilage –** At the junction of two long bones on articular surface. At the end of long bone periosteum is absent and Hyaline cartilage is present known as Articular cartilage.

(B) Fibrous cartilage

(a) Elastic cartilage

- Perichondrium is present.
- In the matrix yellow fibres form network so it is highly flexible cartilage of body
- Colour of matrix is pale yellow.
  e.g. – **Tip of Nose**
  – **Ear Pinna**

- **Epiglottis**
- **Larynx –** Cartilage of santorini of larynx
- **Wall of Eustachian tube**

(b) White fibrous cartilage

- Perichondrium is absent because complete white fibrous connective tissue is converted into cartilage.
- In matrix bundle of collagen fibres are more in quantity so it is **strongest cartilage.**

  e.g. **Pubic symphysis**

  Pubis bone (Half part of pelvic girdle osinnomineta) are interconnected by pubic symphysis.

  Intervertebral disc

  A pad of cushion like structure which absorb mechanical shock and jerks and protect vertebral column. Central part of this disc is soft called as Nucleus pulposus. (remnant of embryonic Notochord)

  Slight elongation of body after death or in sleeping posture is due to relaxation of this disc.

(c) Calcified cartilage

- It is modified hyaline cartilage but due to deposition of calcium salts its matrix becomes hard like bones.
- It is **hardest cartilage** of the body
- Ca salt deposits in the form of Hydroxy apatite $Ca_{10}(PO_4)_6(OH)_2$.

  Eg. – Pubis of frog's pelvic girdle.
- Supra scapula of pectoral girdle
- Head of Femur & Humerus

Differences between Bone and Cartilage

Bone	Cartilage
1. Matrix is composed of a tough, inflexible material, the ossein.	**1.** Matrix is composed of a firm, but flexible material, the chondrin.
2. Matrix is always impregnated with calcium salts.	**2.** Matrix may be free or impregenated with calcium salts.
3. Bone cells lie in lucunae singly.	**3.** Cartilage cells lie in lacunae singly or in groups of two or four.
4. Osteocytes are irregular and give off branching processes in the developing bone.	**4.** Chondroblasts are oval and devoid of processes.
5. Lacunae give off canaliculi.	**5.** Lacunae lack canaliculi.
6. There are outer and inner layers of special bone forming cells, the osteoblasts, that produce new osteocytes, which secrete new lamellae of matrix.	**6.** There are no special cartilage-forming cells. Cartilage grows by division of all chondroblasts.
7. Matrix occurs largely in concentric lamellae.	**7.** Matrix occurs in a homogenous mass.
8. Bone is highly vascular.	**8.** Cartilage in nonvascular.
9. Bone may have bone marrow at the centre.	**9.** No such tissue is present.

BONE

- Study of Bone – **Osteology**
- Process of bone formation – **Ossification**
- Hardest Tissue – Bones
- (Softest Tissue – Blood.)
- Hardest substance – Enamel. (It is not a group of cell but it is formed by the secretion of ameloblast cells of teeth.)
- Outermost covering of bone is **Periosteum** composed of white fibrous connective tissue.

– Bone producing cell called **Osteoblast.** They divide to form **Osteocyte** & synthesize organic part of matrix.
– Mature cell of bone is called **Osteocyte** which is found in Lacuna. Only one osteocyte is found in lacuna.
– Bone destroying cells are **Osteoclast** cells.

Matrix

It consist of two parts.

Inorganic Part – 65 – 68%

$Ca_3(PO_4)_2$ – 80% max. rest 20% $CaCO_3$, $Mg_3(PO_4)_2$, Flourides.

Organic part – 32-35%

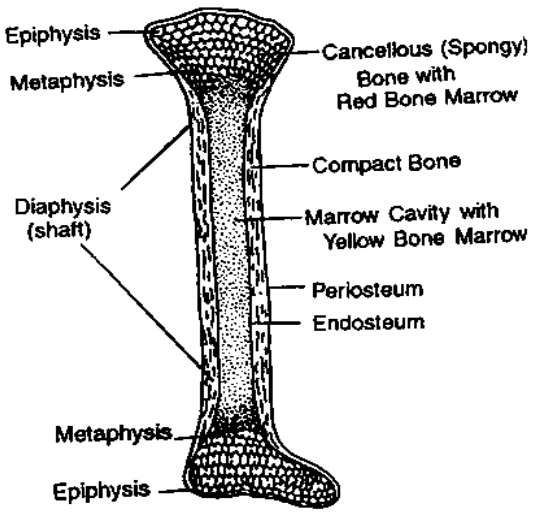
Ossein in which bundle of collagen fibres suspended in sulphated mucopolysaccharide.

Sharpey's fibre – extra bundle of collagen fibres which are present in the outermost layer of matrix called Sharpey fibres. They are also found in the cement of teeth which provide extra mechanical support to bone & teeth.

Structure of long bone :

Long bone has three region :

(a) Epiphysis (b) Diaphysis (c) Metaphysis



(Long Bone)

(a) Epiphysis

– Ends of long bone is called **Epiphysis.** This pat is composed of spongy bone. If this part is present at the joint then on articular surface **Periosteum** is absent & Articular cartilage (Hyaline cartilage) is present.
– Cavity is present in the form of **Trabeculae** filled with red bone marrow.
– It is composed of myeloid Tissue which produce blood corpuscles so epiphysis act as a **Haemopoietic** organ.

(b) Diaphysis

– Middle part of shaft of long bone is diaphysis which is composed of **compact bone.**
– In this region hollow cavity is present called bone marrow cavity filled with yellow bone marrow composed of white fat. Function is storage of fat.
– If required in anaemic condition YBM is replaced by RBM.
– A the time of birth RBM is 70 ml while in adult it is 4000 ml.

(c) Metaphysis

- It form little part between epiphysis & Diaphysis.
- In this region **epiphyseal plate** is present which is made up of osteoblast cells. They divide to form osteocyte and also synthesize matrix of bone, so epiphysial plate is responsible for elongation of bone.
- After complete development of long bone this plate is destroyed. So a complete developed bone shows 2 regions while in a developing bone 3 regions are found.

SPECIAL POINTS

Spongy Bones

- Haversian system is absent. Marrow cavity is present in the form of Trabeculae filled with RBM. So all spongy bones of body are haemopoietic
  e.g. Ribs, Pubis, Sternum, Vertebrae, Clavicle, End of long Bones, Scapula

Compact Bone

Haversian system is present.
e.g. Diaphysis of long bone.

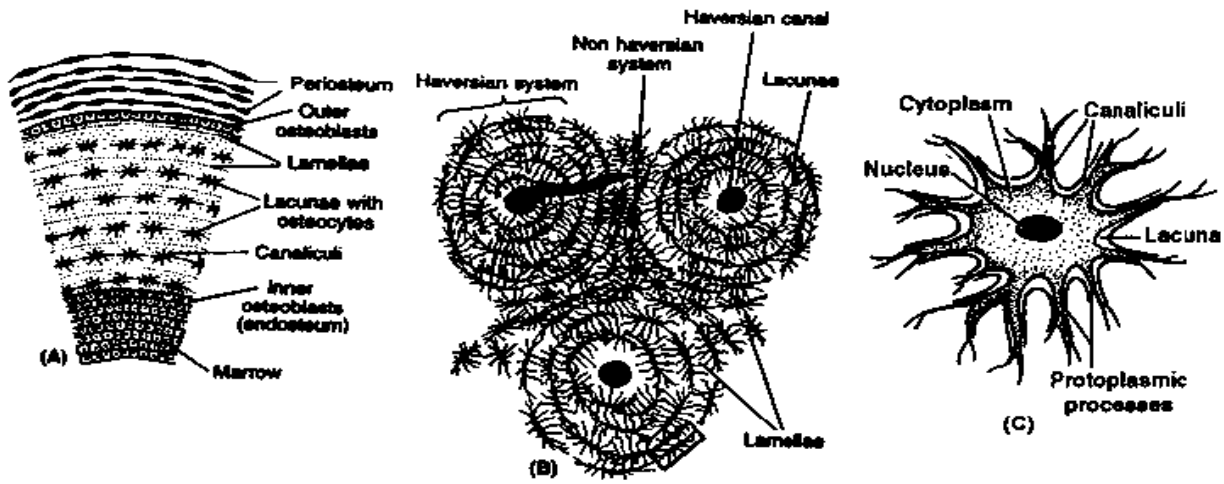
Dipolic/Heterotypic

- Middle part of bone is composed of spongy bone, in which Trabeculae is filled with RBM. This bone is covered by compact bone on upper & lower surface.
  e.g. All flat bones of skull.

Pneumatic Bone

- In the matrix air filled spaces are present so bone become light in weight.
  e.g. Bones of birds.

INTERNAl STRUCTURE OF MAMMALS BONE



(A) T.S. of amphibian bone, (B) T.S. of mammalian bone, (C) An osteocyte

It has following major structures.

1. Periosteum 2. Matrix 3. Endosteum 4. Bone marrow cavity

(1) PERIOSTEUM

- Outermost covering consists of two layers.
- Outer layer consist of WFCT in which blood circulation is present.

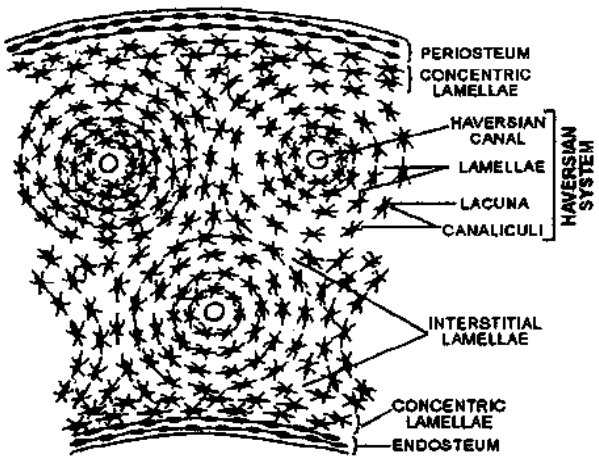
– Inner layer – consists of single layer of osteoblast cells. These cells are cube like in shape in which oval shaped nucleus & basophilic granules are present in cytoplasm.
– They divide to form osteocyte and secrete layer of matrix.

(2) Matrix

It is composed of inorganic & organic compounds.

– In the matrix of bone 2 types of canals are present.

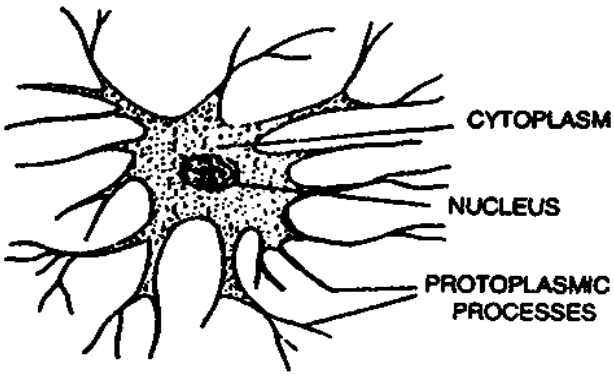
(a) Haversian canal **(b) Volkmann's canal**



(T.S. of Mammalian long bone)

Haversian canals are central Longitudenal canals which are arranged parallel to long axis of bone. In this canals 1 or 2 blood capillaries and nerve fibres are present.

– Volkman canals are transverse/horizontal or oblique canals.
– Haversian canals are interconnected by means of volkmann's canal.
– Matrix of bone is synthesized in the form of layer called **Lamellae.** On the basis of arrangement 3 types of lamellae are present in the matrix.
  (i) Haversian lamellae
  (ii) Interstitial lamellae
  (iii) Circumferential lamellae.
– Haversian lamellae are Concentric layers of matrix which are present around Haversian Canal.
– Between these lamellae layer of Osteocyte cells are also present.
– Haversian canal, Haversian lamellae & Osteocyte form **Haversian** system or **Osteon.**



Bone Cell

– Presence of Haversian system is a typical feature of **mammalian** compact bones.
– Osteocyte are present in the lacuna.Each Osteocyte is inter connected with adjacent Osteocyete by their cytoplasmic process.
– Cytoplasmic process of Osteocyte are present in the canals of lacuna called as **canaliculi.**

– Interstitial lamellae are present in the space between 2 haversian systems

Circumferential lamellae are of 2 types.

(i) Outer circumferential lamellae :

– These are present around all haversian system.

– These are peripheral layers of matrix.

(ii) Inner circumferential lamellae

– Present around bone marrow cavity.

(3) ENDOSTEUM

Endosteum consist of 2 layers.

(a) Towards bone marrow cavity lined with layer of reticular fibrous connective tissue.

(b) Towards matrix of bone line with layer of Osteoblast cell. They divide to form osteocyte & synthesize matrix. So growth of bone is bidirectional (Periphery and central region). While Growth of cartilage is unidirectional.

(4) BONE MARROW CAVITY

– In the central region hollow cavity is present which is filled with YBM. It is composed of white fat & its function is collection of fats or storage of fats.

• **TYPE OF BONES**

On the basis of development or location of ossification bones are four types :

1. Cartilagenous bones/Replacing /Endochondral bone

– These bones are developed from cartilage or they are formed by the ossification of cartilage.

– In the formation of these bones 2 types of cells are required.

A. Chondrioclast – Which reabsorb cartilaginous matter.

B. Osteoblast – Which deposit bony matter into cartilage so cartilage is replaced by bone. Hence these bone are also called as replacing bones.

e.g. Maximum bones of our body like limb bones (Fore & Hindi), Ribs ; vertebrae; Girdle bones except clavicle.

2. Membranous bones/Dermal bones/Investing bones

– These bones are developed from the connective tissue of dermis or formed by ossification in the connective tissue of dermis.

e.g. Sternum, Nasal Bone, Clavicle, Vomer Bone, Skull bones.

Flat bones of skull – Parietal Bone, Frontal, Larymal, Temporal

Bones of upper Jaw – Maxilla, Palatine

Bones of lower Jaw – Mandible (Human)/Dentary (other mammals)

3. Sesamoid Bones

– These bones are developed by the ossification of tendons at the joints.

e.g., Pisciform (wrist bone) of man and rabbit. (One out of 8 carpals in man and 1 out of 9 carpals in Rabbit).

– Patella (knee bone) Largest sesamoid bone. (Patella and two fabillae in rabbit)

– Fibulla (of Tibia – Fibulla)

4. Visceral Bones

– If ossification take place in the visceral organs then visceral bones are formed. These are rare bones, found in few animals. In rabbit & man these bones are absent.

e.g. **Os Cardis** **:** Present in inter ventricular septum of Deer's heart
Os Palpebrae **:** In the eyelid of crocodile
Os Penis (Baculum) : In the Penis of rodents, rat, shrew, Bat, Whale, Tiger.
Os rostralis **:** In the snout of pig.
Os falciparum **:** Palm of mole

Differences between Cartilaginous, Dermal, Sesamoid and Visceral bones

Cartilaginous (Endochondrial) bone	Dermal (Intramembranous) bone	Sesamoid bone	Visceral bone
These are formed by ossification directly on the cartilages and formation involves deposition of body matter by osteoblasts and resorption by osteoclast.	These are formed by ossification in the dermis of the skin.	These are formed by ossification at the joints of the bones or on the tendon and ligament.	They are formed in the soft organs.
These are elongated and hard bones Examples : Vertebrae, humerus, femur and fibula.	These are membrane-like bones. Examples : skull bones, phalanges, clavicles.	These are small sized disc like bones. Example : patella bone (knee cap).	Examples : oscordis, ospenis, osclitoris.

Differences between Spongy bone and Compact bone

Characters	Spongy bone	Compact bone
Arrangement of lamellae	There is no regular Haversian system so have spongy texture.	Have regular Haversian system
Occurrence	In skull bones, ribs, centrum of vertebrae and epiphyses of long bones	In the shaft (diaphysis) of long bones
Marrow cavity	Broad	Narrow
Type of bone marrow	Red marrow in the spaces between lamellae	Yellow marrow in marrow cavity
Function	Marrow forms RBCs and Granular WBCs	Marrow stores fats

Table : Difference between a Dried bone and a Decalcified bone

Dried bone	Decalcified bone
(i) It is a bone that has been dried by subjecting to a high temperature	(i) It is a bone that has been treated with dilution HCl.
(ii) It does not have the bone marrow. Bone marrow cavity is empty.	(ii) It has the bone marrow.
(iii) It contains mineral matter.	(iii) It contains only the organic matter.
(iv) Living structures are absent.	(iv) Living structures are present.

FLUID CONNECTIVE TISSUE

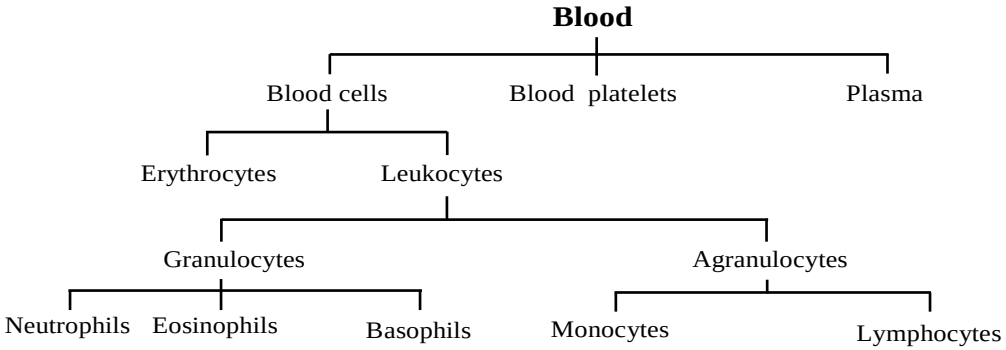
There are two types of Fluid connective tissue :

(1) Blood (2) Lymph

Matrix is liquid & fibre free

1. BLOOD :

COMPOSITION OF BLOOD



– Study of Blood – **Haematology**
– Process of blood formation **Haemopoiesis.**
– Colour – Red
– PH – 7.4 (Slightly alkaline)
– By weight – 7 to 8% of body weight
– By volume – 5 – 6 litres in male and 4-5 litres in female.
– Blood is a false connective tissue because

a. Cells of blood have no power of division.
b. Fibres are completely absent in blood.
c. Matrix of blood is produced and synthesized by liver and lymphoid organs.

- **Composition of Blood**

  Liquid Part – Matrix – Plasma 55%

  Solid Part – Blood corpuscles – 45% (RBC, WBC & Platelets) [Formed Elements]

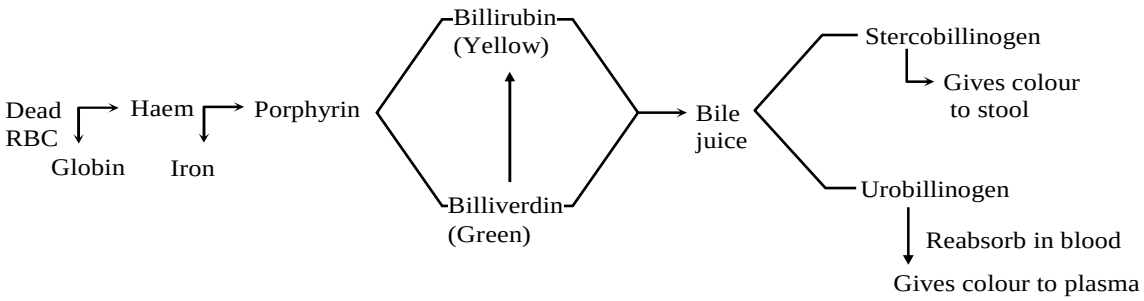
  Packed cell volume – (PVC)% volume or Total number of blood corpuscles is blood.

  Haematocrit Volume : - % volume or only number of RBC in blood.

  PVC ≈ HV because 99% of Packel cell volume is completed by RBC & in rest 1% WBC & Platelets are present.

PLASMA

– Matrix of blood is called Plasma.
– It is pale yellow in colour due to Urobillinogen. (Billirubin)



- **Composition of plasma**

  Water : 90% - 92%

  Solid part : 8 – 10%

  In which inorganic and organic compounds are present.

- **Inorganic part of plasma -** 0.9% in which -

1. Ions – Na^+ , K^+, Ca^{++}

Cl^- , HCO_3^+, SO_4^{--}, PO_4^{---}

Cl^- , > Na^+

2. Salts – NaCl, KCl, $NaHCO_3$, $KHCO_3$

Maximum : NaCl (also called as common salt.)

3. Gases – O_2, CO_2, N_2

Each 100 ml of plasma contains 0.29% O_2, 0.5% N_2, 5% CO_2

Present in dissolved form

- **Organic Part of Plasma** – 7% - 9%

Proteins 6 – 7% Maximum

Albumin → 4% (Max.)

– Produced and synthesized by liver

– Responsible to maintain BCOP (28 – 32 mm Hg.)

Globulin : - 1.5% – 2.5 %

– Ratio of Albumin & Globulin is 2 : 1.

– Produce and secreted by liver and Lymphoid organs.

– Transport or carry substance in body.

– Destory bacteria virus & toxic substances.

– In blood 3 types of Globulins are present.

(i) **α-Globulin** – Produced by liver.

e.g. Ceruloplasmin – Cu carrying protein.

(ii) **β-Globulin –** Produced by liver

e.g. Transferin – Fe carrying protein.

(iii) **γ-Globulin –** Produced by Lymphoid organs

Present in the form of antibodies which destroy Bacteria, Virus & Toxic substance. Also called **Immunoglobulins .**These are of 5 types. (Ig, G, IgA, IgM, IgD, IgE)

Prothrmbin – 0.3% Produced by liver

Fibrinogen – 0.3% Prodcued by liver

– Largest plasma protein .

– Help in blood clotting.

- **Digested Nutrients**

Amino acid

Glucose (Blood Glucose level – 80-100 mg %) → If exceeds 180 mg/100ml = appears in urine = Glucosuria

Fatty acid → 70 – 110 m/dl = Fasting Glucose

Glycerole → 110 – 140 mg/dl = Glucose PP

Cholesterole (Blood Cholesterol level - 80–180 mg/100ml)

vitamins

- **Waste Products**

  Urea, Uric acid, Creatine, Creatinine

  Normal blood urea level 17-30 mg%

  If blood urea becomes more than 40 mg this condition is called **Uremia** in which R.B.C. become irregular in shape called **burr cell** which are destroyed in spleen so uremia is a type of anaemia.

- **Anticoagulant**

– Heparin-A Mucopolysacchride which prevent clotting of blood in blood vesels.

- **Defence compounds**

1. **Lysozyme :** A protein which act as an enzyme which dissolve cell wall of the Bacteria & destroy them.
2. **Properdin :** Large protein molecules which destroy toxins synthesize by Bacteria or Virues so act as anti-toxin

- **Hormones**

– Secreted by endocrine glands which are transported by blood plasma.

BLOOD CORPUSCLES

- **Erthrocytes (Red blood Corpuscles)**

– Mammalian RBC's are Biconcave, circular & non nucleated.

– At the time of origin nucleus is present in the RBC but it degenerates during maturation process.

– Biconcave shape of RBC increase surface area.

– Due to absence of nucleus & presence of biconcave shape more Haemoglobin can be filled in RBC.

Exception :- Camel & Lama are mammals with bioconvex, oval shaped & nucleated RBC.

– In RBC Endoplasmic Reticulum is absent so endoskeleton is composed of structural protein, fats and Cholesterol

present in the form of network called **stromatin** which is a spongy cytoskeleton.

– Plasma Membrane of RBC is called **Donnan's membrane.** It is highly permeable to some ions like Cl & HCO_3 ions and impermeable to Na^+ & K^+ inos. It is called Donnan's phenomenon.

– Due to presence of stromatin spongy cytoskeleton & flexible Plasma Membrane RBC (7. 5μ) can pass through less diameter blood capillaries (5μ)

– In RBC higher cell organelles like Mitochondria & Golgi complex is absent.

– Due to absence of Mitochondria anaerobic respiration takes place in RBC.

– In RBC enzyme of glycolysis process are present, while enzyme of Kreb's cycle are absent.

– In RBC carbonic anhydrase enzymes is present which increases rate of formation & dissociation of carbonic acid by 5000 times. (Fastest catalyst (with zinc))

– Antigen of blood group is present on the surface of RBC.

– If Rh Antigen is present then it is also found on the surface of RBC.

– Single RBC is pale yellow in colour while group of RBC appear red in colour.

– In RBC. red coloured respiratory pigment **Haemogobin** is present.

– In each 26.5 crores molecules of Hb are present

– Molecular weigth of each molecule of haemoglobin 67,200.

– In composition of RBC 60% H_2O & 40% solid part is present. Only Hb. Constitutes 36% of total weight of RBC and 90% on of dry weight.

- **Haemoglobin**

  It is composed of two components

  1. Heam - 5% Lipid part
  2. Globin - 95% Protein part

(1) Heam (Iron and Porphyrin)

Iron Present in the form of Fe^{+2}

While in muscles myoglobin is present where iron is present in the form of Fe^{+3}

– Prophyrin is composed of **Acetic** acid and Glycene amino acid.

– Each molecule of Hb carries 4 molecules of O_2

– 1 gm Hb carries 1.34 ml O_2

– 100 ml blood contain 15 gm Hb

– 100 ml blood transport 20 ml O_2

(2) Globin: Each molecule of globin protein is composed of 4 polypeptide chains. Polypeptide chains are of 4 types.

(a) α polypeptide chain having 141 Amino Acids

(b) β polypeptide chain having 146 Amino Acids

(c) γ polypeptide chain having 146 Amino Acids

(d) δ polypeptide chain having 146 Amino Acids

On the basis of these polypeptide chains 3 type of Hb are formed in human

– Hb A (Adult Hb) – $2\alpha + 2\beta$

– Hb A_2 (Adult-2) – $2\alpha + 2\delta$

– HbF (Foetal Hb) – $2\alpha + 2\gamma$

(Oxygen binding capacity of foetal Hb is more than adult Hb)

- **Size of RBC**

  Human – 7.5 μ

  Rabbit – 6.9 μ

  Frog – 35 μ

– Largest RBC– Amphiuma 75-80 μ (Class Amphibia)

– Smallest RBC–Musk Deer 2.5μ. (Class Mammalia)

– Largest RBC among all mammals in Elephant 9-11 μ

– Change in the size of RBC is called as **Anisocytosis**

– Due to Vit. B_{12} deficiency RBC become larger in size called as **Macrocytes.** These are immature RBC which are destroyed in spleen. In these RBCs amount of haemoglobin is normal.

– Due to Fe deficiency RBC become smaller in size called as **Microcytes.** They are also destroyed in spleen. In these RBCs amount of haemoglobin is less.

- **Shape of RBC –**
  – Biconcave
  – Change in the shape of RBC is called as **Poikilcoytosis.**

– Uremia-RBC become irregular in shape.
– Sickle cell anaemia-RBC become sickle shaped.
– If RBC is kept in Hypertonic solution it will shrink (crenation).
– In Hypotonic solution it will burst.
– 0.8-1% NaCl solution is isotonic for RBC. (0.9% of NaCl)
– 80-100 mg% of glucose is also isotonic.

- **Life span of RBC**

Human	–	120 days
New Born Baby	–	100 days
Rabbit	–	80 days
Frog	–	100 days

Avg. life span of RBC in all mammals 120-127 days.

Radioactive chrominum method is used to estimate life span of RBC

- **RBC count**

Number of RBC in per cubic mm of blood is called RB count.

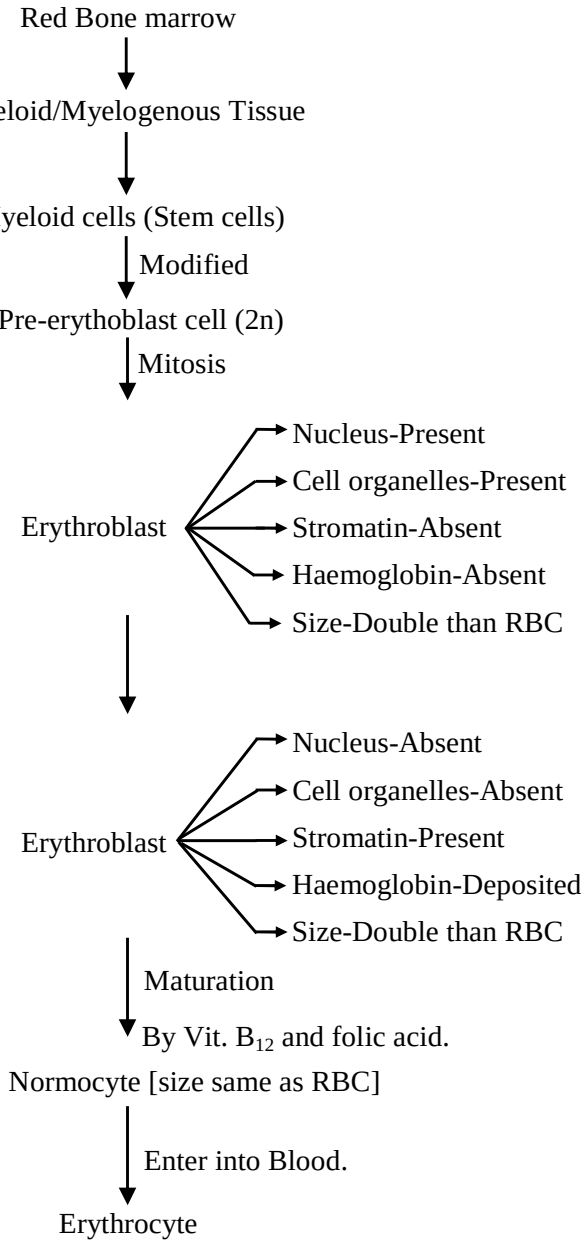
Human (Male)	5.5 million	15.5 ± 2.5 g/dl
Human (Female)	4.5 million	14.0 ± 2.5 g/dl
Newly born baby	6.8 million	16.5 ± 3.0 g/dl
Rabbit	7 million	
Frog	0.4 million	

– Increase in the RBC count condition is called **polycythemia.** This condition occurs at hill station.
– Decrease in RBC count condition is called **Anaemia.**

1. **Macrocytic Normochromic anaemia** – Due to Vit. B_{12} deficiency macroytes are formed which are destroyed in spleen. In Macrocytes % of Hb is normal.
2. **Microcytic/Hypochromic anaemia –** Due to Fe deficiency microcytes are formed.
3. **Normocytic/Normochromic Anaemia –** Excess blood loss.

- **Formation of RBC**

– Process of formation of RBC is called **Erythropoiesis.**
– Organs which produce RBC's called **Erythropoietic organs.**
– Hormone which stimulate Erthyropoiesis is called **Erythropoietin** synthesize by Kidney.
– 1^{st} RBC is produced by yolk sac.
– During embryonic life RBC are produced by Liver, Spleen, Placenta, Thymus gland.
– In adult stage RBC is produced by RBM which filled in Trabeculae of spongy bones.
– Kidney is an erthyropoietic organ in frog.

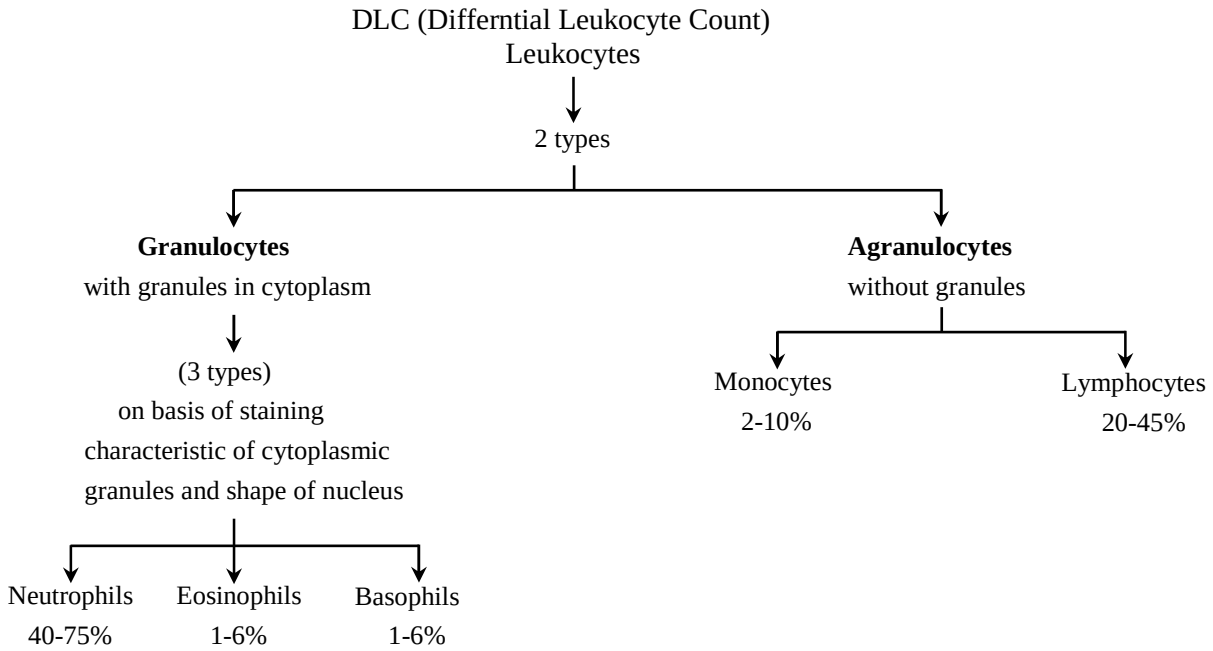


- 1% RBC are destroyed daily but in same number new RBC are entered in the blood.
- Destruction of RBC occur in spleen. So spleen is called **Grave yard** of RBC.
- Spleen stores excess blood corpuscles so it is called **Blood Bank of body.**
- In resting and slow flowing blood, the RBC form pile called **Roulaux** by adhering together due to surface tension. Fibrinogen favours rouleaux condtion.
- Minute bits of disintegrated red blood corpucles in known as **Haemoconia**
- Ghost of RBC is made up of its plasma membrance.

Table : Difference between different types of Leucocytes

Character	***Lymphocytes***	***Monocytes***	***Eosinophils***	***Basophils***	***Neutophils (Acidophils)***
Number/ percentage	20-25%	2-10%	2-3%	0.5-1%	60-65%

Granules in cytoplasm	Absent	Absent	Coarse	Coarse	Fine
Staining of cytoplasm	Basophilic	Basophilic	Eosinophilic	Basophilic	Neutrophilic
Nucleus	Rounded	**Bean-shaped**	Bilobed	S-shaped 3-lobed	Multilobed
Site of Formation	Lymph nodes, spleen, thymus, tonsils, Peyer's patches, Bone marrow	Bone marrow	Bone marrow	Bone marrow	Bone marrow
Life span	Few days or even years	10-20 hours in the blood tissue, months or even years	4-8 hours in blood and 4 to 5 days in tissue	4-8 hours in blood and 4 to 5 days in tissue	4-8 hours in blood and 4 to 5 days in tissue
Function	Antibody formation	Phagocytic	Important role in immunity anti-allergic	Secretion of heparin, histamine and serotonin	Phagocytic



- **LEUCOCYTES (WBC)**

– WBC (White Blood Corpuscles) are also called as **leucocytes** because they are colourless. **TLC** =Total leucocyte count. Number of WBC/mm^3 $\rightarrow$ 8000 – 11000/mm^3

Leucocytosis : - Increase in TLC. This condition occur in Bacterial & Viral infection.

Leucocytopenia :- Decrease in TLC. Normally TLC increases in Bacterial & Viral infection but in typhoid & AIDS, TLC decreases.

Leukemia :- Abnormal increase in TLC (more than 1 Lakh) it is called as blood cancer.

– **On the basis of nucleus & nature of cytoplasm, Leucocyte are of 2 types.**

- **Granulocytes**

– In their cytoplasm granules are present which can be stained by specific dye.
– Nucleus is multilobed and lobes are interconnected by protoplasmic strand.
– Due to presence of lobed nucleus they are called as polymorphonuclear WBC.
– Produced in Bone marrow
They are (i) Acidophils, (ii) Basophils & (iii) Neutrophils

- **Agranulocytes**

– Cytoplasm is clear & granular
– Nucleus do not divide in lobes so called as Mononuclear WBC.
– Produced in Bone marrow
They are of 2 types (i) Monocytes (ii) Lymphocytes

- **ACIDOPHILS/EOSINOPHILS**

– Amoeboid in shape.
– Size 10-14 μ
– Life span 4-8 hrs in blood
– In their cytoplasm acidiophilic granules are present which can be stained by acidic dye Eosin.
– Nucleus is bilobed
– They protect body against allergy & parastic infection.
– In allergy they synthesize **histamine.**
– In parasitic infection they act as lysosome. They attach with the surface or body wall of parasite and synthesize enzymes which dissolve body wall of parasite & destroy them.
– Increase in number of acidophils condition is eosinophilia which occurs in Taeniasis, Ascariasis, Hay fever (parasitic infection)

- **BASOPHILS**

– Minimum in number
– Amoeboidal in shape
– Size 8 -10 μ
– Smallest granulocytes
– Life span 4-8 hrs in blood
– In their cytoplasm basophilic granules are present which can be stained with basic dye methylene blue.
– Nucleus is divided in 2 or 3 lobes. 'S' shaped.
– Their main function is to secrete & transport Heparin, Histamine & Serotonin produced in liver.

- **NEUTROPHILS/HETEROPHILS**

– Maximum in number
– Amoeboid in shape
– Size 10-12 μ
– Life span – 4-8 hrs. in blood
– In their cytoplasm granules can be stained by any dye (acidic, neutral, basic).
– Nucleus is divided in 3-5 or more lobes. So maximum lobed nucleus is present in Neutrophils.
– Counting of lobes of Neutrophils is called **Arneth count.**
– They are active, motile WBC

– They can squeeze & comes out from the wall of blood capillaries in Tissue. This phenomenon is called **Diapedesis.**
– Phagocytic in nature
– Destroy Bacteria & Viruses by phagocytosis.
– Due to their smaller size & Phagocytic nature they are called **Microplice man.**
– Help in sex detection. In female neurophils barr body is attached with lobe of nucleus which is formed by the modification of x chromosomes.
– barr body is absent in male.

• **MONOCYTES**
– Size 12-20 μ
– Largest Blood Corpuscles.
– Life span-In blood 10-20 hours but in connective tissue it may be week/month.
– Nucleus kidney shaped/ bean shaped.
– Power of Diapedesis is present.
– Active motile WBC.
– Phagocytic nature.
– Destroy Bacteria & Viruses by phagocytosis so called **Macropoliceman.**
– Also called **scavenger** of blood because they engulf damaged or dead & minute bits of blood corpuscles.

• **LYMPHOCYTES**
– Amoeboid in shape.
– Size 6-16 μ (smallest WBC)
– Life span in blood less than 10 days but in connective tissue it may be month/year/whole life
– Large nucleus is present.
– Lymphocytes are of 2 types.

(a) **T-LYMPHOCYTES**
– Produced in bone marrow but mature in thymus gland. On the basis of function T-Lymphocyts are of 4 types :

1. T-Killer/Cytotoxic : - Direct kill Bacteria or Viruses
2. T-Helper : - Stimulate B-lymphocytes to produce antibody.
3. T-Suppressor : - Suppress T killer & protect immune system.
4. T-memory : - Stones profile of bacteria or virus or protein.

(b) **B-LYMPHOCYTES**
– Produced in bone marrow and mature in bone marrow. Its function is to produce, synthesize & transport antibodies

PLATELETS
– Also known as Thrombocytes
– Found only in mammals while in other vertebrates, Spindle corpuscles are present which perform same function.
– They are non nucleated and derived from **Megakaryocyte** cells of bone marrow.
– In shape platelets are disc like, oval shaped or biconvex.
– While spindle corpuscles are spindle in shape & round nucleus is present in the centre.

– In their cytoplasm basophilic granules are present which can be stained by methylene blue.
– Maximum part of cytoplasm is composed of contractile protein **Thrombosthenin.**
– Size 2-3 μ
– Life span – 2-4/5 days
– Count – 1.5-4.5 lakh/mm^3
– Decrease in number of Blood Platelets is called **Thrombocytopenia.**
– Critical count of Thromocytes is 40,000/mm^3. If number is less than critical count then red spot or rashes appears on the skin called **Purpura disease.**

Function :
– Repair endothelium of blood vascular system by the formation of platelet plug because they have tendency to attach on gelatinous or mucilaginous surface.
– Synthesize Thromoboplastin which help in blood clotting.
– Synthesize serotonin.

BLOOD CLOTTING

– Blood flows from cut or wound but after some times it stops automatically. It is called clotting of blood.
– Bleeding time 1-3 min.
Clotting time 2-8 min.
Some times clots are also formed in intact blood vessels which are of 2 types.

(a) Thrombus Clot
– Static clots which grow bigger & ultimately block the blood vessels.
– If this clot is formed in the coronary vessels then called as Coronary Thrombosis which can cause heart attack.
– If form in brain, then called as Cephalic Thrombus causes paralysis.

(b) Embolus clot
– Moving clots which flow with blood & ultimately dissolve in blood.
– More harmful due to their moving nature.

• **Machanism of blood clotting**
(Enzymes Cascade theory)
– Proposed by **Macfarlane & Co-workers.**
– According to this theory there are 3 steps in blood clotting.

(1) Releasing of Thromboplastin-
– Injured tissue synthesize exothrom hoplastin and platelets synthesize endothromboplastin.
– Both these thromboplstin react with plasma proteins in the presence of Ca^{++} ions to form **Prothrombinase enzymes.** (Thrombokinase)
– This enzymes inactivate Heparin. (Antineparin)

(2) Conversion of Prothrombin into Thrombin
– Prothrombinase enzymes convert inactive prothrombin into active Thrombin in the presence of Ca^{++} ion.

(3) Conversion of fibrinogen into fibrin
– Fibrinogen is soluble protein of plasma. Thrombin protein polymerise monomers of fibrinogen to form insoluble fibrous protein fibrin.

– Fibrin form network on cut in which blood corpuscles got trapped. This form clotting of blood.
– After clotting a pale yellow liquid oozes from clot called **Serum.** In which antibodies are found.

Blood	–	Corpuscles	= Plasma
Plasma	–	fibrinogen and large protein	= Serum

- **Clotting Factors :-**

– 13 factors help in blood clotting.
– These factors are mainly produced in liver.
– Vitamin K is required in the synthesis of these clotting factors.
– These factors are represented in Roman number.
– I – Fibrinogen
– II – Prothrombin
– III – Thromboplastin
– IV – Ca^{+2} (cofactor in each step of blood clotting)
– V – Proaccelerin
– VI – Accelerin (Rejected)
– VII – Proconvertein
– VII – AHG Anti Haemophelic Globin (Absent in Haemophilia-A)
– IX – Christmas factor
– X – Stuart factor
– XI – PTA (Plasma Thormboplastin Anticedent)
– XII – Hagman factor
– XIII – FSF Factors (Fibrin stabilizing factor) (Laki Lor and factor).
– Other natural anticoagulants are
Hirudin – found in leech.
Anophelin – found in female Anophelese.
Lampredin – found in Peteromyzon (Lamprey)
Cumerin – obtain from plants
Warfarin – obtain from plants
– To collect blood in bottle in blood bank artificial anticoagulants are used like
Sodium citrate
Sodium oxalate
EDTA (Ethylene diamine tetra acetic acid)
These chemicals act as Calcium binding units and remove Ca^{+2} ions from blood.

- **Blood Groups**

– Antigen of blood groups is present on the surface of RBC also called as **agglutinogen.**
– Antibody for blood group antigen is present in serum (Plasma) called **agglutinin.**
– Antigen & Antibody are special type of **glycoproteins.**
– Blood groups are of 4 type A, B, AB, O
– A, B, O discovered by **Landsteiner.**
– AB discovered by Decastello & Struli.

Blood groups	Antigen	Antibody	Receive	Donate
A	A	b	A , O	A , AB
B	B	a	B , O	B , AB
AB	A , B	-	A , B, AB, O	AB
O	-	ab	O	A , B , AB , O

- Blood group O is universal donar & Blood group is **AB** is universal acceptor.
- Blood groups are example of **multiple alleles.**
- For gene of blood group 3 alternatives are present.
- Gene A & B are dominant gene. They can give their expression in homozygous and hetrozgous condition so blood groups A & B are due to dominant gene A&B
- I^AI^O ┐
  A
- I^AI^A ┘
- I^BI^O ┐
  B
- I^BI^B ┘
- Gene O is recessive gene which gives its expression in homozygous condition. Blood Group O is due to recessivegene.
- I^0I^0 O
- Blood group AB is an example of co-dominance in which both dominant gene A&B are present.
- I^AI^B AB

RH FACTOR

- Discovered by **Landsteiner & Weiner** in Rhesus monkey.
- Rh antigen is due to dominant gene. So if one of the gamete possess gene of Rh factor, its off spring will be always Rh + Ve
- If antigen is present then Rh^+
- If antigen is absent then Rh^-

In India % ratio of Rh is

Rh^+ – 97%

Rh^- – 3%

In World

- Rh^+ – 80%
- Rh^- – 20%
- In Rh^+ antibody is absent for this antigen
- Rh antibody is also absent in Rh^-blood But

1. If Rh^+ blood is transfused to Rh^- then 1^{st} blood transfusion complete successfully but during Ist blood transfusion Rh antibodies are formed in receiver's blood so in next blood transfusion. agglutination of blood takes place.
2. If mother is Rh^- & father is Rh^+ then offspring is also Rh^+ In this case 1^{st} pregnancy is completely successful but during at the time 1^{st} delivery Rh antibody is formed in mother's blood due to damaged

blood vessel so in next pregnancy death of foetus will occur in the earilier stage due to agglutination of blood called **erythroblastosis foetalis.**

– To destroy Rh antibody medicines are used like **Rhogam, Rholin, Anti D.**

• **Lymph :** Blood, tissue fluid and lymph are almost contiguous parts of the body's "supply line".

– Infact the tissue fluid is a part of blood plasma that oozes out of arterial capillaries into intercellular substance and lymph is a part of tissue fluid.

– The blood plasma, tissue fluid and lymph have a basic similarity.

– **The lymph is like the blood but, having no RBCs**, it is colourless.

– It normally has more WBCs than the blood, and of these the lymphocytes are in large majority.

– It contains little of O_2 , but lot of CO_2 and metabolic wastes.

– It has the ability to coagulate like the blood. It coagulates outside the body.

– In mammals, lymph sinuses and lymph hearts are absent which are found in frog.

– The tissue of the mammals have lymph capillaries which join to form lymph vessels.

– In lymph vessel, the lymph flows from organs into the hearts.

– They are provided with semilunar valves to prevent reverse flow of the lymph.

– The lymph vessels are provided with lymph nodes which are found mainly in the head, neck, arm pits, near big blood vessels etc.

– **The lymph nodes form lymphocytes**, they clean the lymph by filtration and they form antibodies.

– Lymph nodes also from Payer's patches. The lymph vessels finally open into subclavian veins.

– The lymph capillaries in the villi of intestine are also called as lacteals.

– Cisterna chyle is also called as second heart which is situated just below the diaphragm in the abdominal cavity.

– **Functions of lymph :** The basic function of lymph is to bring back, into the vascular circulation, the cell debris, large colloid particles and the part of the blood plasma that had diffused out from arterial capillaries into the tissue fluid but has failed to return back into venous capillaries.

– The white corpuscles of the lymph are the same as those of the blood and have the same functions of defense and of assistance in tissue repair and healing. In intestinal wall, lymph capillaries, called lacteals, are specially meant for absorption of fats.

Comparison of blood and lymph

Blood		Lymph	
1.	Red corpuscles present.	**1.**	These are absent.
2.	White corpuscles fewer, neutrophils most numerous.	**2.**	White corpuscles more; lymphocytes most numerous.
3.	Soluble proteins more than insoluble proteins.	**3.**	Insoluble proteins more than soluble proteins.
4.	Amount of nutrients and O_2 comparatively more.	**4.**	Amount of nutrients and O_2 comparatively less.
5.	Amount of CO_2 and metabolic wastes normal.	**5.**	Amount of these much more.

- **Muscular Tissue**
  - **Origin**
  - It develop from the mesoderm of embryo.
  - **Special property**
  - **Contractibility** is the special property of muscular tissue. The cells of muscular tissue can shorten considerably and return to original relaxed state. The muscle cells contract in a definate direction.
  - **Functions of muscular tissue**
  - Muscles support the bone and other structure.
  - Muscles are responsible for heart beat production of sound, etc.
  - Muscles brings movements of the body parts and locomotion of individual.
  - Muscles are required for delivering a baby.

  ⇒ 40% to 50% of body weight is contributed by muscles.

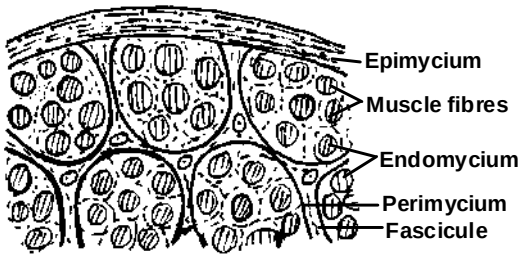


Fig. T.S. Muscle

  - **Types of muscles**

    Muscles are of three types :

    (1) Striated muscles **(2)** Unstriated muscles **(3)** Cardiac muscles

1. Striated Muscles

- **Structure**
- Striated muscle fibre is also called stripped. skeletal or voluntary muscle fibre.
- These muscle fibres occurs in bundles and are attached to the skeleton.
- Each muscle fibre is surrounded externally by a delicate membrane **sarcolemma**.
- In each fibre many nuclei appears at irregular interval, so each fibre is **syncytial**.
- The cytoplasm (Sarcoplasm) of each fibre possess large number of myofibrils which are tightly packed.
- Each myofibril possess dark and light bands alternating with each other.
- **Detailed structure of a myofibril**

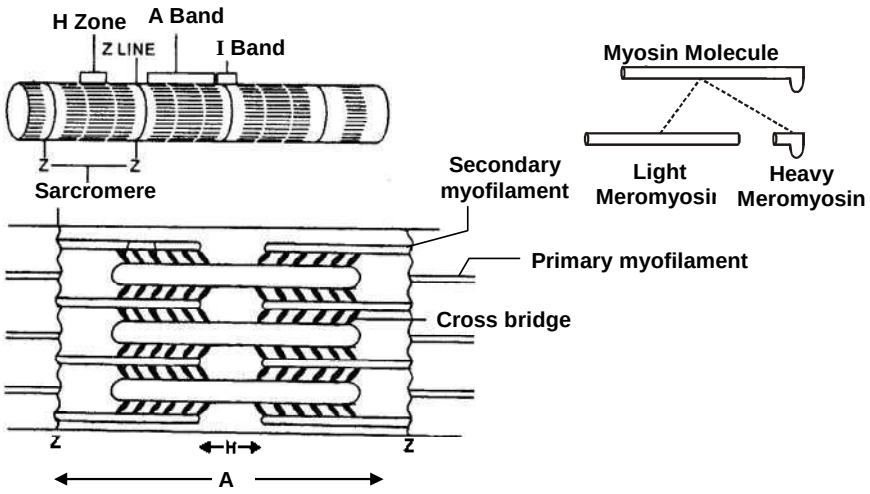


Fig. Structure of Vertebrate Striated Muscle at Magnification

- The dark band of myofibril is called **A-bands** (Anisotropic bands). Each A band possess a light zone called **H-zone or Henson's membrane** in the middle.

– The light band of myofibril is called **I-bands** (Isotropic bands). Each I-band possess a thin dark z-disc or krause's membrane in the middle.

⇒ Krause's membrane is also called **Dobie's line** or **Zwischencheibe line**.

The portion between two disc is called a **sarcomere. Sarcomere are the functional units of myofibrils**.

– Each sarcomere has two types of myofilaments; a coarse or primary and fine or secondary myofilaments arranged longitudinally. The primary myofilament is made of a protein called **myosin** whereas secondary myofilament is made up of 3 protein **actin** tropomyosin, troponin. Besides actin and myosin muscle fibre also contain **calcium ion, a phosphate** and adenosine triphosphate (ATP)

The primary filament remain confined to A bands only.

- **Location**

Striated muscles are found in the muscle of limbs, tongue, pharynx, beginning of oesophagus, etc.

- **Function**

These muscles are under control of will.

2. Unstriated muscle

- **Structure**

– Unstriated muscle fibre is also called smooth, involuntary, unstriped or visceral muscles.

– Each fibre is elongated or spindle shaped, having single oval nucleus surrounded by cytoplasm.

– Each muscle fibre possess longitudinally myofibrils arranged.

– The fibre is enclosed by plasma membrane and unlike striated muscle there is no sarcolemma.

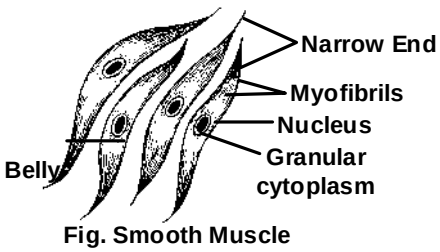


Fig. Smooth Muscle

– Several of muscles fibre are joined together in bundles by loose connective tissue.

- **Location**

Unstriated muscles are found in stomach, intestine, lungs, urinary bladder, urinogenital tract, iris of eye, dermis of skin, posterior part of oesophagus and arrector pilli muscles of hairs.

- **Function**

These muscle fibre helps in peristalsis. It causes slow and prolonged contraction which is involuntry i.e. not under control of will but are controlled by autonomic nervous system.

Single-unit smooth muscles	Multi-unit smooth muscles
(i) They have number of muscle fibres closely joined together.	(i) They have number of muscle fibres not so closely joined.
(ii) all the fibres contract together as a single unit, automatically and rhythmically. e.g. Walls of hollow visceral organs like stomach, intestine, urinary balder etc.	(ii) The individual fibres contract s separate units more of less as independent muscle e.g. hair roots, and on the walls of large blood vessels.

3. Cardiac muscles

- **Structure**

Cardiac muscle fibres shows character of both striped and unstriped muscles, fibres in some characteristic, but also have some peculiar characters of its own.

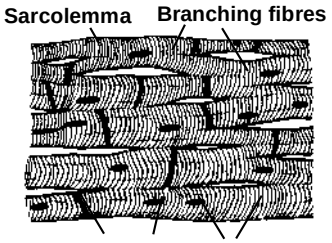


Fig. Cardiac muscle fibre

- **Similarities with striated muscle fibres :**
  Cylindrical, high vascularization, having more mitochondria and glycogen granules in the sarcoplasm; and having light and dark bands.
- **Similarities with smooth muscle fibres**
  Uninucleate; involuntary, covered by plasma membrane.
- **Unique character**

– Cardiac muscles fibre are joined with each other by flat dense zig-zag junctions, called **intercalated discs** or booster rings.
– Cardiac muscle fibre is supplied by both central nervous system and autonomic nervous system.
– These muscles never get fatigued, blood capillaries penetrate the cardiac muscles fibres. They have the property of contraction even when they are isolated from the body temporarily.
– Shows long refractory period.

Location :

These muscle fiber are found in the wall of heart and have very rich blood supply.

Differences between striated, non striated and cardiac muscles.

S.No.	Striped	Unstriped	Cardiac
1.	Occur in the body wall, limbs, tongue, pharynxand begining of oesophagus	Occur in the wall of hollow viscera, iris of the eye and dermis of the skin.	Occur in the walls of heart, pulmonary veins and superior venacava.
2.	Have numerous mitochondriaand glycogen granule	Have less numerous itocho-ndria and glycogen granules	Have numerous mitochondria and glycogen granules
3.	T-tubule system well developed	T-tubule system lacking	T-tubule system well developed
4.	No intercalated discs	No intercalated discs	Intercalated discs occur between the end of fibres.
5.	Voluntary	Involuntary	Involuntary
6.	Fibres unbranched	Fibres unbranched	Fibres join by short oblique bridges
7.	Blood supply is abundant, capillaries lie on the surface of fibres	Blood supply is scanty, capillaries lie on the surface of fibres	Blood supply is abundant, capillaries penetrate the fibres, Lymphatic capillaries also present
8.	Multinucleate, nuclei just near the sarcolemma	Uninucleate, nucleus at the centre	Mostly uninucleate, Nucleus at the centre.

9.	Myofibrils large and prominent, show distinct alternating light and dark cross bands, hence striped	Myofibrils indistinct and do not have light and dark bands, hence unstriped	My ofibrils distinct and with faint alternating light and dark bands
10.	Also called striated, skeletal and voluntary muscle fibres	Also called non-striated, smooth, visceral and involuntary muscle fibres	Also called heart muscle Fibres
11.	Contract quickly and power-fully, but cannot maintain contraction for a long time, hence soon get fatigued.	Contract slowly and mildly, but can remain contracted for a long time, are not fati-gued.	Contract quickly, Powerfully and rhythmically, non-fatigue. indefatigable
12.	Innervated by motor nerves from central nervous system (neurogenic)	Innervated by nerves from autonomic nervous system (neurogenic)	Innervated by nerves from central and autonomic nervous systems (neurogenic + Myogenic)

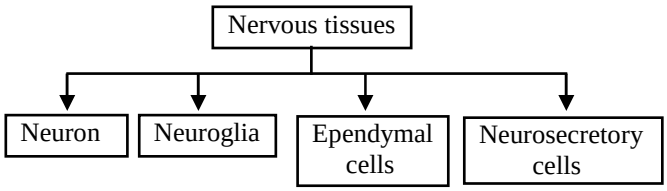
- **Nervous Tissue**
  - **Origin**

    Nervous tissues originates from ectoderm of embryo.
  - **Special properties**

– The special properties of the cells of nervous tissues are **excitability** and **conductivity**.

– The cells of nervous tissues are specialized for receiving stimuli and transmitting message.

These tissue forms nervous system of the body and include the following parts :



- **Composition**

Nervous tissue is formed of four types of cells –

(1) Neurons (2) Neuroglia (3) Neuro-secretory cells (4) Ependymal cells

1. Neurons

– A neuron is a nerve cell with all its branches, Neuron is formed from neuroblast.

– **It is structural and functional unit of nervous system.**

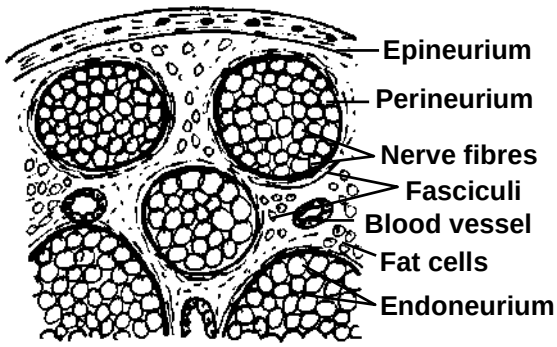
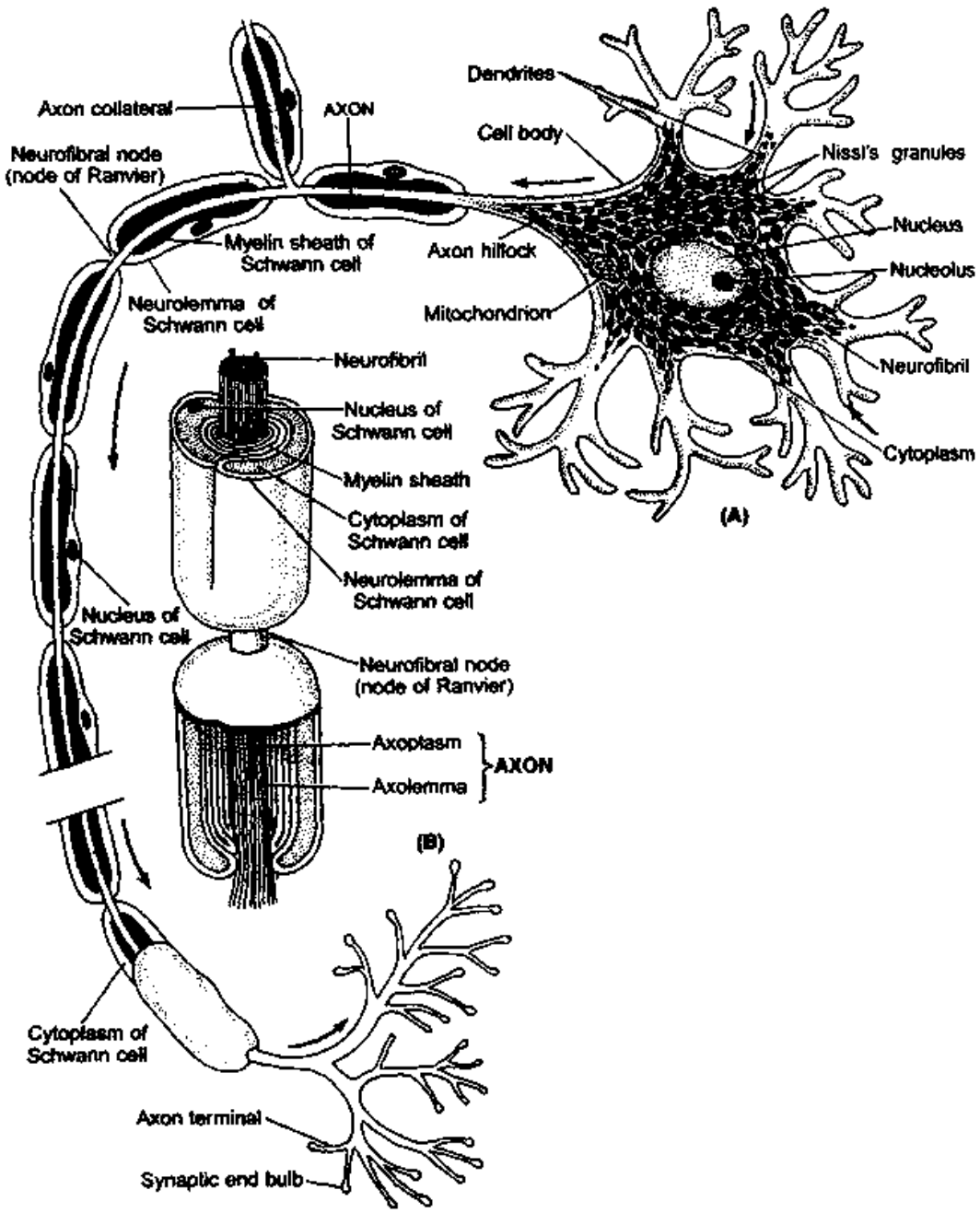


Fig. T.S. of

⇒ Neuron is the longest cell of the body.

Structure : Neurons is formed of two parts –

(A) Cyton (B) Nerve processes



(A) Basic Structure of a neuron (B) Section through a myelinated fibre

(A) Cyton

- Cyton is also called cell body or soma, its shape is variable.
- Its cytoplasm is granular called neuroplasm, within neuroplasm has a prominent spherical nucleus golgibodies, endoplasmic reticulum lysosome, fat globules, Nissl's granules and neurofibril is found.
- Nissl's granules are comparatively large and irregular masses of ribosomes and rough endoplasmic reticulum. **It is believed that nissil's granules synthesize protein in the cell**. Nissl's granules are made up of m-RNA, ER, Ribosomes and has affinity for basic dyes.

  A mature neuron cannot divide.

(B) Nerve processes

The nerve processess are also called neurites. Nerve processes can be divided into two parts-

(a) Dendrites (b) Axon

(a) Dendrites -

Dendrites may be one or several. It is branched structure.

(b) Axon -

– It is single, long and cylindrical process whose main function is to conduct the nerve impulses away from the cyton, so, axon is efferent in nature.

– It is the longest nerve process of a neuron.

Note :

– Giant squid (loligo) has axon of about 1500 μm in diameter.

– Neurons with very long axon is called golgi type I.

– Axon possess only neuro-fibrils. (Nissls Granule, Golgi body, Ribosome, fat globules are absent). The part of cyton from where the axon arises is called **axon hillock**. Some axon also give rise to side branches called **collateral fibres**.

– The plasmalemma of axon is called **axolemma** whereas cytoplasm is called **axoplasm**.

– The axon ends in a group of branched, the **terminal arborization**, ends of terminal arborization possess knob like structure called **synaptic knob** or **synaptic buttons**.

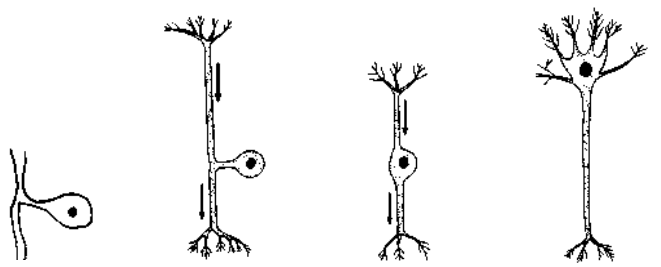
Synapse

– Synaptic knobs comes to lie very close to the dendrons of next neuron to form the synapses. There is a microscopic gap of about 200 Å called **synaptic cleft**.

– The nerve impulses are transmitted from axon to dendron with the help of chemical called **neurotransmitters** which is either acetylcholine or adrenalin (epinephrine) or Electrical symapse (with synaptic cleft of 2 nm)

⇒ Acetylcholine or adrenaline is produced by the secretory vesicles of the synaptic knobs.

- **Types of neurons**



Pseudopolar **Unipolar** **Bipolar** **Multipolar**

On the basis of number of dendron and axon neurons are of 3 types -

– **Unipolar neuron -** The neuron having a single process the axon are called unipolar neuron.
e.g.Unipolar nervous system occurs in embryo.

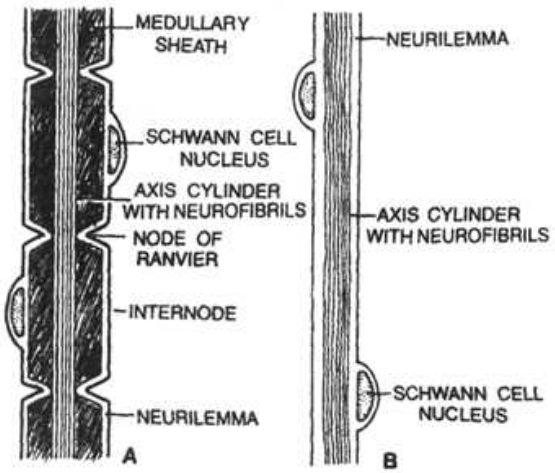
– **Bipolar neuron -** The neuron having one dendron and an axon at the opposite pole of the cell are known as **bipolar neuron**.
e.g. Bipolar neuron occur in retina of eye, Olfactory epithelium, Organ of Corti, Taste bonds.

– **Multipolar neuron :** The neuron which have many dendrons and one axon are termed as **multipolar neuron**.
  e.g. Multipolar neuron occur in nervous system of adults.

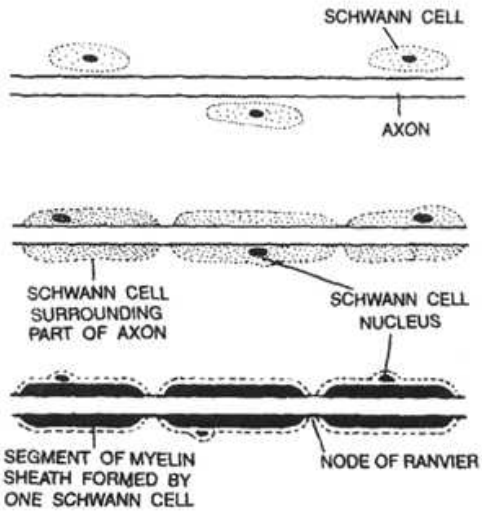
On the basis of functions neurons are of 3 types-

– **Sensory or afferent neuron -** They connect Sensory organs with central nervous system and brings sensory impulses into it.
– **Motor or efferent neuron -** They connect central nervous system with the effectors. (muscles and glands) and carry motor impulses to them.
– **Interneurons or adjustor neuron -** They are present in the central nervous system (Brain and spinal cord) and connect two or more neurons for distant transmission of impulses.

Nerve fibres



A - Medullated nerve fibre.
B - Non-medullated nerve



Stages in the formation of the myelin sheath by a Schwann cell

An axon of a neuron is covered with one or two sheaths.
On the basis of number of sheaths on nerve fibre, nerve fibres are of two types -
(a) Medullated or myelinated nerve fibre (b) Non medullary nerve fibre

(a) Medullated or myelinated nerve fibre

– In these nerve fibres around the nerve a sheath of fatty substance is formed which is termed as medullary sheath or myelin sheath.
– The medullary sheath is not continuous and point of absence of medullary sheath is called **nodes of Ranvier**. The part of medullated nerve fibre between two adjacent nodes is called an **internode**. Medullary sheath forms an insulating coat and prevents loss of energy during conduction of nerve impulse.
– The medullary sheath and node of ranvier are surrounded by a transparent cellular outer covering known as neurolemma of **Schwann cell**.
– Just beneath the neurolemma a thin layer of cytoplasm lies, which contains nuclei to form Schwann cells (Sheath cells) at intervals. These nuclei are termed nuclei of Schwann cell.
– Medullated nerve fibre are found in brain spinal cord, cranial and spinal nerves. In the central nervous system, medullated nerve fibres form white matter.

(b) Non-medullated (Non myelinated) nerve fibre

– In these nerve fibre no medullary sheath is found. The axon is surrounded by neurilemma and just below neurolemma a layer of cytoplasm containing nuclei at intervals is present. The node of Ranvier and internode are not present.
– The non medullated nerve fibres exists in autonomic nervous system.
– In central nervous system non medullated nerve fibre found in grey matter.

• **Functionally the nerve fibres are of two types :**

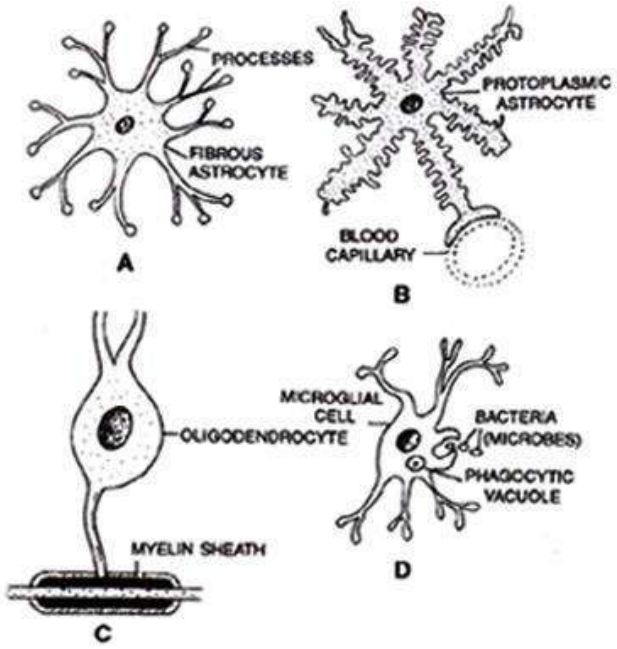
(a) Afferent or Sensory fibre - Afferent fibre carries the sensory impulse from the receptor organs to the central nervous system (brain and spinal cord).

(b) Efferent or motor fibre - Efferent fibre carries impulses from the central nervous system to the various effector organs (muscles and glands).

2. Neuroglia or Glial Cells

– These are non nervous cells which lie between the neurons of CNS, ganglia and retina of the eye.
– These are many times (10 times approx) more numerous than neurons.

• **Types of neuroglial cells**



Different kinds of neuroglial cells.
A. Fibrous astrocyte. B. Protoplasmic astrocyte C. Oligodendrocyte. D. Microglial cell.

Neuroglia cells are of following types

– **Microglia cell** - These are spindle shaped small cells.
– **Astrocytes** - These are highly branched.
– **Oligodendrocytes** - These have few branched processess which resemble dendrons of the neuron.

• **Functions**

– These act as packing cells between neurons.
– These provide nutrition to neurons
– These act as phagocyte and consume micro organism.

– These help in memory process
– These insulate the adjoining neurons.

3. Neuro-secretory cells

These are special type of neurons of the hypothalamus of brain. These are endocrine in function and release neurohormone (releasing factor) through portal system to anterior most lobe of pituitary gland where they regulate secretion of harmones TSH, GH, LH, ACTH, FSH and Prolactin.

4. Ependymal cells

These cells form an epithelium called **ependyma** that lines the ventricles of brain and the central canal of the spinal cord. The cells are generally ciliated.

MUSCLES

INTRODUCTION

Study of muscles known as Myology.

Myology also known as Sarcology.

- **Development of muscles : -**

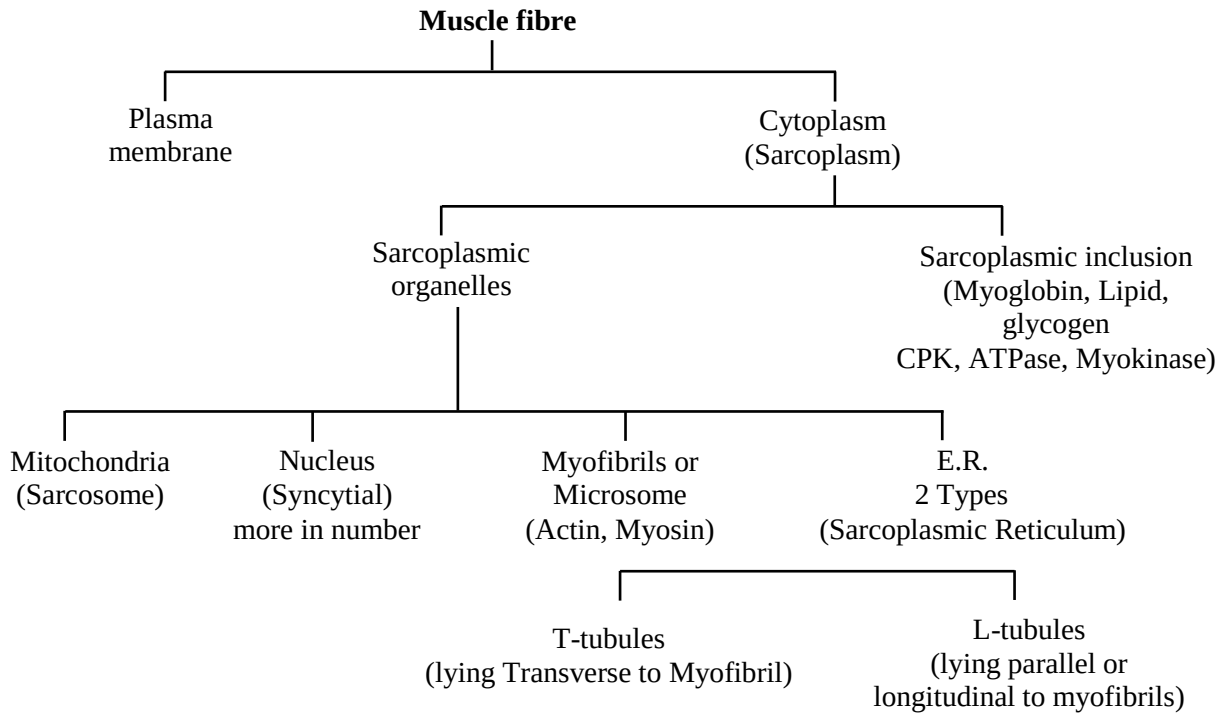
  Except muscles of Iris & cilliary body all muscles of body develop from **mesoderm.**

  - Muscle of Iris, cilleary body & myoepithelial cell of sweat gland develop form **Ectoderm.** Conductivity & contractility are the two main characteristics of muscles.
  - Three types of muscles are found in the body.

(i) Voluntary or skeletal muscles.

(ii) Involuntary or smooth muscles.

(iii) Cardiac muscles.



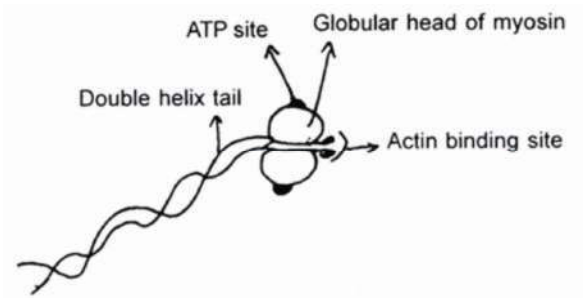
CHEMICAL COMPOSITION OF SKELETAL MUSCLES

- 75% water
- 25% solid
  - 20% Muscle proteins
    - Sarcoplasmic protein
      Globin, Globulin,
      Myoglobin
    - Contractile protein
      - Froce generating
        - Protein
          - Actin
            - G-Actin
            - F-Actin
          - Myosin
            - HMM
            - LMM
              - S_1 unit
              - S_2 unit
      - Regulating
        Protein
        - Tropomyosin
        - Troponin (T_p)
          - Sub unit
          - T_pC
          - T_pI
          - T_pT
      - Structure
        Protein
        - Z line Protein
          (Actinin)
  - 5% other substance
    - Nitrogenous
      Extractive
      Creatine & creatine
      phosphate
    - Nonnitrogenous
      extractive
      glycogen
      Inorganicion
      Eg. K^+, Na^+ , HCO_3^-

FORCE GENERATING PROTEIN

- **Actin –**

  The Actin or thin filament is a double helix made up of protein molecule called as. **G-Actin.** (Globular actin) Many G-actin combined to form a filament like structure, which is called as filamentous-actin. G-actin contain a active site where myosin head is attached.



- **Myosin –**

  Each myosin molecule consist of a tail & a head. Tail is made up of two chains interwined with each other like double helix. The myosin head has sites for attachments with (i) The actin filament (ii) ATP molecules.

  Each myosin (thick) filament is also a polymerised protein. Many monomeric proteins called Meromyosins constitute one thick filament. Each meromyosin has two important parts, a globular head with a short arm and a tail, the former being called the heavy meromyosin (HMM) and the latter, the light meromyosin (LMM)> The HMM component, i.e.: the head and short arm projects outwards at regular filament and is known as cross arm. The globular head is an active ATPase enzyme and has binding sites for ATP active sites for actin.

REGULATING PROTEIN

- **Tropomyosin –**

  It is one type of contractile protein. In the relaxed state of the muscle situated in **such a way**, that the active sites remain covered by the Tropomyosin & attached at the terminal end of actin.

- **Troponin –**

  It is one type of protein which attached with one of ends of the tropomyosin molecules.

  Troponin is made up of three subunit.

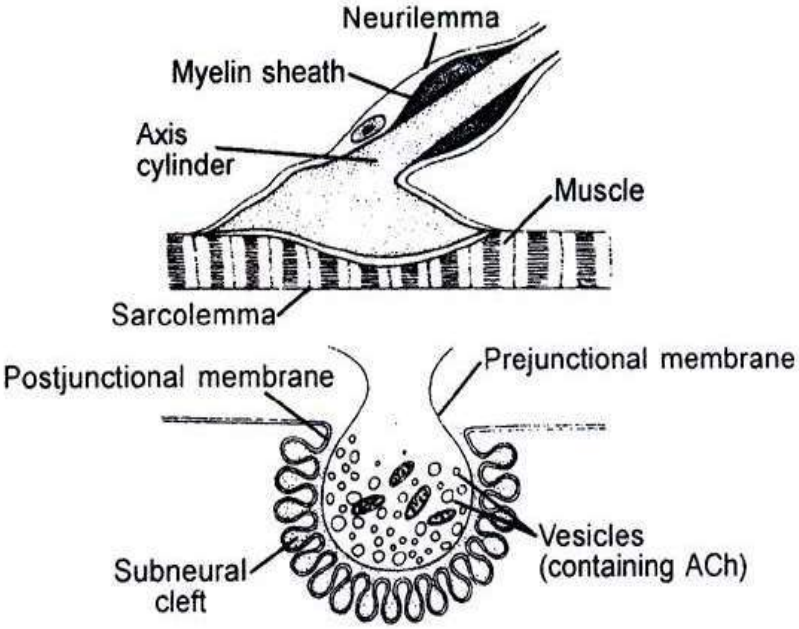
  (a) Troponin I (Inhibitory site) (b) Troponin T (Tropomyosin site) (c) Troponin C (Ca^{+2} binding site)

STRUCTURAL PROTEIN

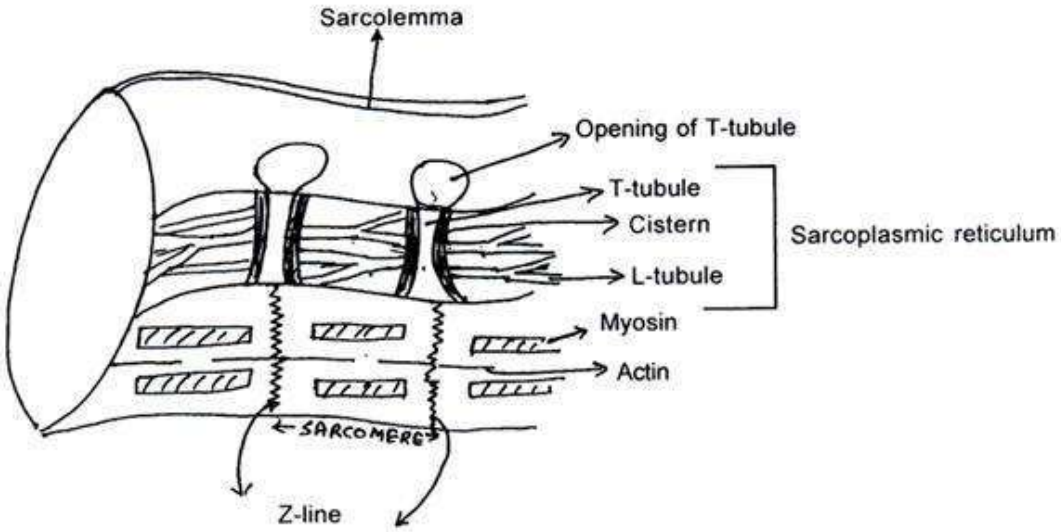
- **Actinin –**

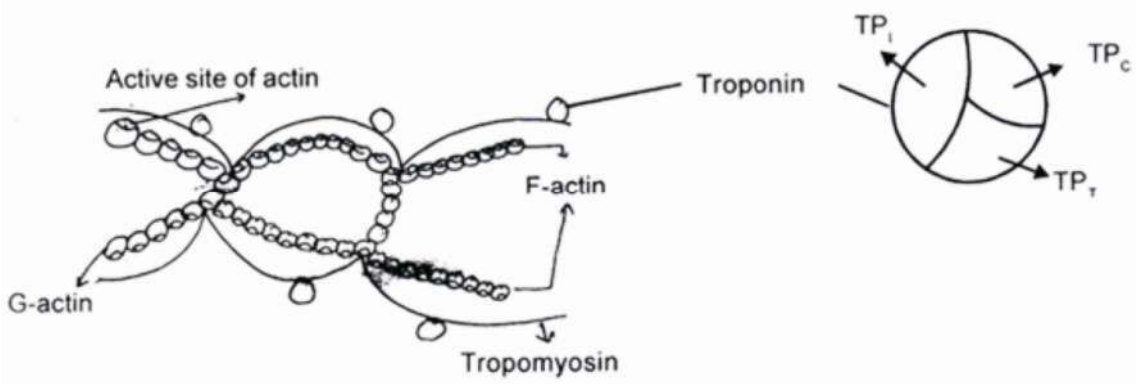
  It is one type of protein which found in Z-line.

PHYSIOLOGY OF MUSCLES CONTRACTION



Neuromuscular Junction





SLIDING FILAMENT THEORY

- This theory is given by A.F. HUXLEY, H.E. HUXLEY & HANSEN
- The junction of Nerve & muscle is called as neuromuscular junction.
- Terminal branches of Axon of motor nerve is embedded into sarcolemma.
- Its bulb like structure is called as **motor end plate.**
  Sarcolemma invaginate inside & form a fimbriated structure which is called **synaptic gutter or subneural cleft.** The cell membrane of the bulbous terminals is called as the **pre junctional membrane** where as the cell membrane of muscle fibre which invaginates called **post junctional membrane.**
  In motor end plate large number of vesicles & mitochondria are present. Each vesicle contains Ach in high concentration. In post junctional membrane, Ach receptor are presented.
  (Ach = Acetylcholine, it is a neurotransmitter chemical)

- **Neuromuscular Transmission –**
  - When motor nerve fibre stimulated it develops an **Action potential** (Resting potential 50 to 100 mV)
  - AP reaches in the neuromuscular junction & goes to bulbous expansion of the nerve terminal.
  - Than it increases permeability of Ca^{++} in the Pre junctional membrane & Ca^{++} enter from E.C.F. in to the cytosol of motor end plate by penetrating the prejunctional membrane.
  - Ca^{++} ions causes bursting of the vesicles & releases the Ach.
  - These Ach now cross the prejunctional membrane. via subneural cleft reach the post junctional membrane attach the **Ach receptor** also called as **End plate receptor.**
  - End plate receptor stimulate & develop end plate potential by opening of Na^{+}– K^{+} channels in post synaptic membrane.
  - When end plate potential sufficiently higher than A.P. develop on sarcolemma & myofibril.
  - Sarcolemma invaginates inside & form transverse & longuituidnal tubules which are also called as T-tubul and L-tubule
  - T-tubules are paralle = to Z-line wherease L-tubule is perpendicular to the Z-line.
  - T-Tubules communicates with ECF.
  - T & L system of tubules together called as **endoplasmic reticulum.**
  - L-Tubules dilated on both side of T-Tubules this dilated part called **cisterns.**
  - A.P. proceeds along the sarcolemma & A.P. contact with T-Tubules & further proceeds via T-tubules & enter with in muscle fibre & now this AP called as **T-tubule potential.**
  - T-tubule potential come in close contact of L-tubules at region of the **Triads** (T + L-tubules).
  - L-tubules in very rich source & store house of Ca^{++} ion in higher concentration release of Ca^{++} ion in large amount.
  - Released Ca^{++} ion combine with troponin C.

- In Relaxed state tropomyosin covers the active site of actin.
- But troponin-C combines with Ca^{++} ion some physiochemical changes occur in tropomyosin & Tropomyosin move away from active site of actin.
- Myosin have strong tendency to bind the actin molecule & Actomyosin complex
- Myosin head attach on active site of actin with the help of cross bridges.
- Now the myosin head twists in the groove of the active site of actin-F. This causes movement of actin toward H-zone.
- Contraction is caused by overlapping of actin filament over myosin – **sliding filament hypothesis.**
- All the cross bridges move simultaneously in one direction so the actin filaments move vigorously towards H-zone.
- When cross bridge disrupted than myosin molecule detached & reattach the new active site of actin.
- **After muscle contraction H-Zone disappears & length of sarcomere & I-band decreases by 20%. The length of A-band remains unchanged.**

  All process are reversible, at the time of relaxation Ca^{++} are goes into **L-tubules.**

- **Role of ATP –**

(i) The Rotational movement of myosin head with in the groove.

(ii) Deattachment of myosin head form the actin.

Depolarisation
↓
Sarcoplamic reticulum
↓
Ca^{2+} (Cistern)
↓
Myosin ATPase
↓
Cross-bridges
↓
Actin-Myosin Complex
↓
Muscle Contraction

- **Chemical reaction in Muscles :**

1. $ATP + H_2O \xrightarrow{\text{Creatine kinase}} ADP + P_1 + \text{Energy (For contractile muscle)}$
2. $\text{Creatine phosphate} + ADP \longrightarrow \text{Creatine} + ATP$ (Muscle contraction)
3. $\text{Gycogen} \xrightarrow{\text{Glyocysis}} \text{Lactic acid} + \text{Energy}$
4. 80% Lactic acid + Water $\xrightarrow{ATP}$ Glycogen (Liver cell)
5. 20% Lactic acid + Oxygen $\longrightarrow CO_2 + H_2O + ATP$ (Liver cell)
6. $\text{Creatine} + ATP \longrightarrow \text{Creatine phosphate} + ADP$ (Resting Muscle)

PROPERTIES OF MUSCLES

- **Terminology**

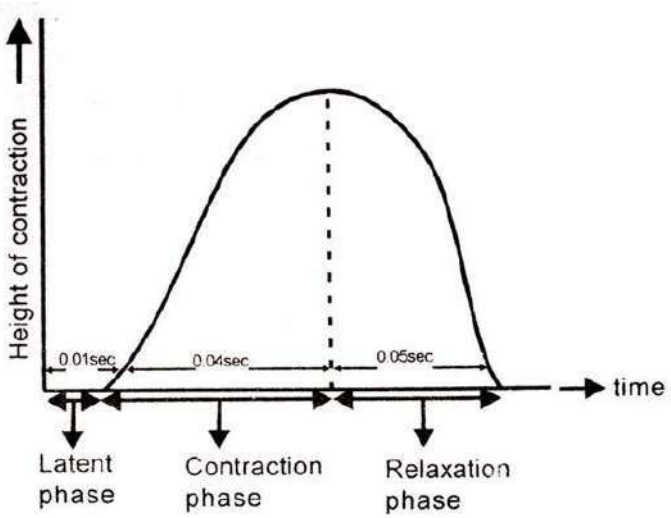
1. **Origin** – Fixed end of muscle (Proximal end)
   Insertion – Distal end of muscle which is attach to bone (Movable end)

2. **Excitability** – Muscles responds to stimuli which can be nervous, chemical, electrical & thermal mechanical.
   Conductivity – Stimulus acting in one region of muscle fibres propagated to all parts within no time.
   Contractility – On being stimulated the muscle fibres contract & shorten followed by Relaxation.
3. **Threshold stimulus** – Intensity of stimulus below the threshold value does not produces contraction in muscle fibres is called.
   Sub threshold Stimulus shambles stronger than threshold one is called suprathreshold stimulus.
4. **All or none law** – Response of muscle fibre is maximum whether the stimulus has threshold value or suprathreshold value. Response is absent when intensity is subthreshold. (Below threshold value)
5. **Muscle twitch** – It is single isolated contraction of Muscle fibres due to single stimulus. Muscle curve or kymograph indicates three phases.

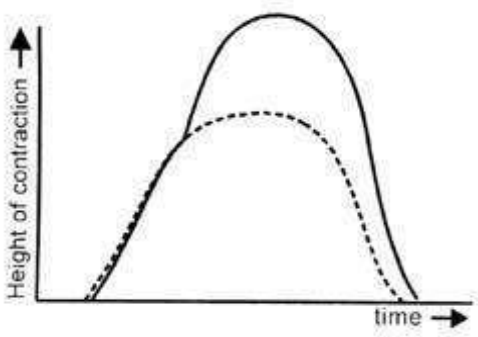
(a) Period of latent excitation (Latent period) Interval between the application of appropriate stimulus & initiation of contraction
It is 0.01 sec. in skeletal muscle. 3 sec. in smooth muscle.

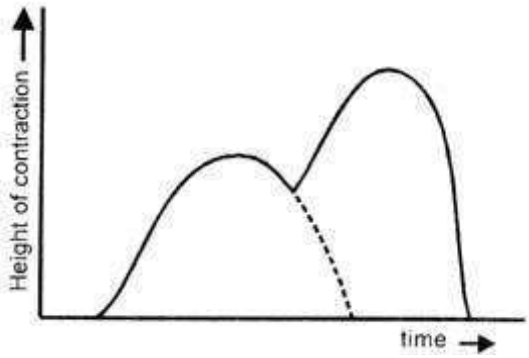
(b) Contraction phase – Duration for which muscle remain contracted state. It is 0.04 sec. in skeletal muscle. 20 sec. in smooth muscle.

(c) Relaxation phase – Interval for contracted muscle to regain its original/Relaxed state 0.05 sec. in skeletal muscle 23 sec. in smooth muscle.

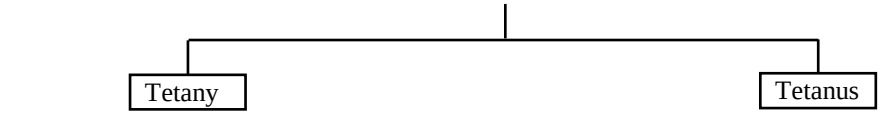


6. **Refractory Period** – It is period between two twitched during this muscle does not respond to second stimulus after single twitch.
   It is 0.002 – 0.005 second in skeletal muscles and 0.1 – 0.2 second in visceral muscles.
7. **Summation of stimuli** – Two subliminal stimuli Applied simultaneously get added up & Evoke the response
   Muscle response = (1^{st} stimulus +2^{nd} stimulus ≥ threshold value)
   Subliminal subliminal
   Howerver a muscles consist of large no. of muscle fibres with different threshold value so in intensity of stimulus increases contraction of muscle although individual fibres obey all/none law.
   Summation of IInd stimulus during contration phase





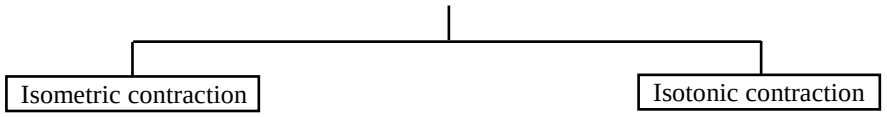
8. **Muscle tone** – In relaxed muscles, a few fibres always undergoing contraction alternately so maintain the health of muscles. It is known as Muscles tone
9. **Tetanic condition** – It is sustained muscles contraction due to rapid series of impulse, during this relaxation of muscles does not take place.



It is due to hypocalcaemia
It is hormonal deficiency disease

It is bacterial disease
(Clostridium tetani) **Lock jaw disease** during this abnormal muscles contraction of jaw muscle take place.

10. **Paralysis –** Supply of motor nerve impulse completely cut off. So function of muscle contraction is stoped.
11. **Shivering –** Involuntary contraction of muscles to make body warm.
12. **Muscle tension** – force produced during contraction of muscle is known as muscle tension.



Length same but tone changed
Eg. Pushing against an immovable object.

Length changed but tone same

- **Isometric –**

  Contraction occur when a muscle is stimulated adequately but is prevented to shorten.
  eg. applying too heavy load against the muscle so that the muscle but cannot lift the at all ext. work done is zero **Isotonic –**
  When muscles is stimulated adequately & is allowed to shorten, then the contraction is called Isotonic some external work is done. Technically called a load is lifted

13. **Antagonistic muscles**–
    They are pair of muscles which causes opposite movement at the same site when one muscle is contracting, the other is relaxes & viceversa.
    e.g. – Biceps (flexor) & Triceps of arms (extensor)
14. **Motor unit** – Groups of mucles fibres supplied by single motor neuron. It is a functional unit of muscles because all the muscle fibres of motor unit contract & relax simultaneously.
15. **Cori cyles** – Lactic acid accumulated in muscles during sustained contraction. formed lactic acid transported in blood as blood lactate to liver where is changes into liver glycogen which is changed in to glucose.

$$\text{Glycogen} \xrightarrow{\text{Muscle}} \text{Lactic acid} \xrightarrow{\text{Liver}} \text{Glycogen}$$

16. **Speed of –** Skeletal muscle = 0.1 sec. per contraction per cycle
    Cardiac muscle = 0.8 sec. per contraction per cycle
    Smooth muscle = 46 sec. per contraction per cycle
17.

Red muscle fibres	White muscle fibres
– Slow & Tonic muscles fibres	Fast & twitch muscle fibres
– Dark red b/o myoglobin +	Pale
– Mitochondria ++	Mitochondria+
– Slow sustained work from long period without getting fatigue	Perform fast, strenuous work for short duration & get fatigued quickly accumulation of lactic acids.
Sarcoplasmic reticulum – less	More
Eg : Extensor muscles of back, flight muscles	**Eg :** eyeball muscles

18. **Fatigue :** Marathian athelets develops red fibers in thigh muscles due repeated contraction
Due to sustained contraction initially muscle give beneficial effects of contraction (warm ups) but after it ATP is exhausted & muscle is as state of permanent contraction & no relaxation because no fresh ATP Available for detachment of actomysosin complex.
– B/o 1. Accumulation of lactic acids
2. Consumption of stores glycogen. ATP, CTP (Creatinine phosphate)
Infatigue–
(i) Increase latent period and phase of relaxation
(ii) decrease height of contraction
19. **Rigor Mortis**
After death fresh supply of ATP. become impossible so one the local store of ATP molecule are exhausted. Due to non availability of ATP/C.P. deattachment of myosin from actin cannot take place resulting in permanent state of contraction of muscle. This phenomenon is called rigor mortis. This condition helps fixation of the hour of death.
20. E.D.T.A (Ethylane diamine tetra acetic acid) injected inside muscle combined with Ca^{+} and stops contraction.
21. Muscle and nerve exitability is reduced by K^{+}.
22. During muscle contraction chemical energy changed into mechanical energy.
23. Over stretching of tendon is called sprain.

MUSCLE TYPES ON BASIS OF MOVEMENTS

1. **Flexor** = Fore arm move in upward direction. (Bend)
Bending of part over one another **Eg. biceps brachii**
Extensor – Fore arm move in downward direction. Straighting of bending part
Eg. Triceps
2. **Adductor -** Toward body axis. Towards the body
Lattissimus dorsi brings the arms towards body
Abductor-upper & lower limb move away from body axis. Away from the body (midline) **deltoids.**
3. **Pronator** – Palm state in down. Rotate downward eg **pronater teres**
Supinator – Palm state in upward Rotate upward eg **brachioradialis**
4. **Dilatation** – Diameter increases, widening of Iris (radial muscle of iris)
Constrictor – Diameter decreases, Closing an aperture–sphincter ani closes anus
5. **Depressor** – Lower Jaw move in downward direction. Lowering part depressor mandibularis
Elevator–Lower Jaw move in downward direction.Raising the part **eg. Massetar.**
6. **Median Rotation** – Upper & lower limb rotate in inward direction.
Lateral Rotation – Outward direction rotation
7. Inversion when sole of foot turn toward body axis.
Eversion - Away from body axis
Aryeiglotticus muscle is called Hilton muscle.
Gastrocenemius muscle present in shank.
Sartorius the **longest** muscle of body
Gluteus maximus (Buttock muscles) – Largest muscle of body
Stapedius – smallest muscle of body.
In Human beings 639 muscle are found 634 muscle are paired and 5 muscle are unpaired. 400 muscles are striated & most of muscles are found in back region & number of back muscles are 180. Jaw muscles are strongest. Longest smooth muscles is present in present in uterus of pregnant lady.

EXERCISE-1

EPITHELIAL TISSUE

Q.1 Pavement epithelium is the name of
(1) Cuboidal epithelium
(2) Squamous epithelium
(3) Columnar epithelium
(4) Ciliated epithelium

Q.2 Transitional epithelium occurs in
(1) blood vessels (2) Trachea
(3) Kidney (4) Ureter

Q.3 Pseudostratified columnar epithelium is found in
(1) Mouth
(2) Stomach/Oesophagus
(3) Kidney
(4) Trachea/Bronchiole

Q.4 Epithelium forming the inner layer of urinary bladder is
(1) Simple squamous (2) Transitional
(3) Simple columnar (4) Neurosensory

Q.5 Cells of squamous epithelium are
(1) Columnar
(2) Tall with elongated nuclei
(3) Flate plate-like (4) Cube-like

Q.6 Epithelial tissue with thin flat cells appearing like packed tiles occurs on
(1) Inner lining of cheek
(2) Inner lining of stomach
(3) Inner lining of fallopian tubes
(4) Outer surface of ovary

Q.7 Epithelial tissue is–
(1) Protective covering
(2) Reproductive structure
(3) Nerve cells (4) Corpuscles

Q.8 Epithelium of bronchioles is
(1) Simple cuboidal
(2) Pseudostratified columnar
(3) Simple squamous
(4) Pseudostratified sensory

Q.9 Podocytes are found in-
(1) Outer wall of Bowmann's capsule
(2) Inner wall of Bowmann's capsule
(3) Capillary (4) Henle's loop

Q.10 Ciliated cells are found in-
(1) Bronchus (2) Pancrease
(3) Liver (4) Uterus

Q.11 Which of the following is correct-
(1) Dermis of frog has melanophores
(2) Epidermis of frog contains only stratum corneum
(3) Hair is dermal in origin
(4) Sebaceous glands release watery fluid

Q.12 Desmosomes are associated with-
(1) Cell division (2) Cell excretion
(3) Cytolysis (4) Attachment

Q.13 Simple cuboidal epithelial is found in-
(1) Buccal cavity (2) Trachea
(3) Renal tubule (4) All

Q.14 Following is a character of simple epithelium-
(1) Cells are arranged irregularily
(2) Cells form a regular layer
(3) Cells divide constantly & help in the formation of organ
(4) None

Q.15 The mucous membrane of naso-pharynx is-
(1) Stratified (2) Ciliated
(3) Hair less (4) None

Q.16 Nuclei in the pseudostratified epithelium are arranged-
(1) At periphery
(2) In the centre of cells
(3) At different level
(4) Equally

Q.17 In which of the following organ lamina propria is developed maximum-
(1) Colon (2) Intestine
(3) Oesophagus (4) Stomach

Q.18 Schneiderian epithelium is-
(1) Ciliated (2) Hair less
(3) Stratified (4) None

Q.19 Term "epithelium" was coined by-
(1) Mayer (2) Ruysh
(3) Bichat (4) Robert

Q.20 The epithelium which has many layers of the cells-
(1) Simple (2) Stratified
(3) Squamous (4) All

Q.21 The epithelium of bronchioles is-
(1) Pseudostratified & columnar
(2) Squamous & sensory
(3) Pseudostratified & sensory
(4) Cuboidal & columnar

Q.22 Coiled glands is-
(1) Sweat gland (2) Sebaceous gland
(3) Mucous gland (4) None

Q.23 Cells secreting mucous are-
(1) Sweat (2) Goblet
(3) Paneth (4) Zymogen

Q.24 Pancrease is an example of-
(1) Compound tubular gland
(2) Compound alveolar gland
(3) Compound tubular-alveolar gland
(4) Simple alveolar gland

Q.25 Unicellular glands are-
(1) Parotid (2) Goblet
(3) Sweat (4) Sebaceous

Q.26 The peritoneal lining of the body cavity is-
(1) Cuboidal (2) Columnar
(3) Squamous (4) None

CONNECTIVE TISSUE

Q.27 Haversian canal includes-
(1) One arteriole & one venule
(2) Myelinated nerve fibres
(3) One lymphatic vessel & few bone cell
(4) One vein, one artery, lymph vessel, one nerve & few bone cells

Q.28 Latent period in skeletal muscle is-
(1) 0.1 second (2) 0.2 to 0.5 second
(3) 0.002 to 0.005 second
(4) 0.02 to 0.05 second

Q.29 The microtubules of the lacunae found in the bone maxtrix are called as-
(1) Semicircular canals (2) Canaliculi
(3) Bidder's canal (4) Capillaries

Q.30 An animal beings to run fast but get tired soon, because -
(1) Energy is exausted
(2) Succinic acid is formed in the muscles
(3) Lactic acid is formed in the muscles
(4) Muscles loses it's elasticity

Q.31 In a fatty person, the obesity is due to-
(1) Excess of blood
(2) More thicked bones
(3) More areolar tissues
(4) More adipose tissues

Q.32 Which tissue exhibit least changes after birth is-
(1) Connective (2) Epithelial
(3) Nervous (4) Muscle

Q.33 Intararticulated disc is found-
(1) In wall of liver (2) In wall of heart
(3) Pubic symphoises (4) Between vertebrae

Q.34 Mammalian liver can be identified by the presence of which of the following-
(1) Liver cells & venules
(2) Kupffer's cells & hepatic cords
(3) Leucocytes & bile canaliculi
(4) None

Q.35 Which forms most of the part of the body-
(1) Connective tissue (2) Epithelial tissue
(3) Muscular tissue (4) Nervous tissue

Q.36 Which is the strongest cartilage-
(1) Elastic (2) Fibrous
(3) Hyalin (4) None

Q.37 Chromatophores are found in-
(1) Areolar tissue (2) Muscle tissue
(3) Dermal connective tissue
(4) Epithelial tissue of epidermis

Q.38 Cartilage which is most common-
(1) Elastic (2) Fibrous
(3) Hyalin (4) None

Q.39 Whale blubber is madeup of-
(1) Skeletal tissue (2) Adipose tissue
(3) Muscular tissue (4) All

Q.40 The main inorganic substance of bone-
(1) $CaCO_3$ (2) $CaSO_4$
(3) $Ca_3(PO_4)_2$ (4) $CaCl_2$

CONNECTIVE SKELETON TISSUE

Q.41 Hardest tissue of the body is–
(1) Cartilage
(2) Fibrous connective tissue
(3) Bone (4) Areolar tissue

Q.42 Which of the following tissues has the minimum intercellular matrix
(1) Blood (2) Bone
(3) Cartilage (4) Areolar tissue

Q.43 Collagen fibres are–
(1) White (2) Yellow
(3) Green (4) Brown

Q.44 Ligament connects–
(1) Muscle to skin (2) Bone to bone
(3) Muscle to muscle (4) Muscle to bone

Q.45 Bone marrow is composed of–
(1) Areolar tissue and blood vessels
(2) Adipose tissue and fibroblasts
(3) Adipose tissue, areolar tissue and blood
(4) Adipose and areolar tissue

Q.46 Major inorganic component of vertebrate bone is
(1) Calcium carbonate
(2) Calcium phosphate
(3) Sodium hydroxide
(4) Potassium hydroxide

Q.47 Haversian canals found in bones contain
(1) Artery and vein
(2) Osteoblasts in areolar tissue
(3) Nerve and lymph vessel
(4) All the above

Q.48 Membrane surrounding a bone is–
(1) Endosteum (2) Periosteum
(3) Perichondrium (4) Pericardium

Q.49 Membrane lining the bone marrow cavity is–
(1) Endosteum (2) Periosteum
(3) Perichondrium (4) Pericardium

Q.50 Haversian canals are found in–
(1) Ear
(2) Mammalian bone
(3) Fish and amphibian bone
(4) Simple sponges

Q.51 Hardest substance of the body is–
(1) Bone (2) Enamel
(3) Cartilage (4) Tendon

Q.52 Cells occurring in the bones are–
(1) Osteoblasts (2) Osteocytes
(3) Chondroblasts (4) Chondrocytes

Q.53 Haversian canals found in–
(1) Humerus (2) Pubis
(3) Scapula (4) Clavicle

Q.54 Besides calcium phosphate the bones contain–
(1) Calcium chloride
(2) Magnesium carbonate
(3) Sodium chloride
(4) Potassium/Magnesium phosphate

CONNECTIVE VASCULAR TISSUE

Q.55 Mineral found in red pigment of vertebrate blood is
(1) Magnesium (2) Iron
(3) Calcium (4) Copper

Q.56 Red blood cells are produced in
(1) Bone marrow (2) Spleen
(3) Liver (4) Thymus

Q.57 B- and T-cells required for immune system are produced in
(1) Bone marrow (2) Liver
(3) Spleen (4) Lymph nodes

Q.58 In normal healthy female, the number of RBC/mm^3 of blood is
(1) 6.5 – 7.0 million (2) 5.5 – 6.0 million
(3) 4.5 – 5.0 million (4) 3.5 – 4.0 million

Q.59 Vitamin K is required for–
(1) Formation of thromboplastin
(2) Conversion of fibrinogen to fibrin
(3) Conversion of prothrombin to thrombin
(4) Synthesis of prothrombin

Q.60 Main haemopoietic tissue of human embryo is–
(1) Liver (2) Spleen
(3) Bone (4) Kidney

Q.61 Cells of squamous epithelium are
(1) Columnar
(2) Tall with elongated nuclei
(3) Flate plate-like
(4) Cube-like

Q.62 Red blood cell count is carried out by–
(1) Haemocytometer (2) Haemoglobinometer
(3) Sphygmomanometer
(4) Electrocardiogram

Q.63 In Camel, erythrocytes are–
(1) Circular, biconcave, non-nucleated
(2) Oval and nucleated
(3) Circular, biconcave and nucleated
(4) Oval and non-nucleated

Q.64 Blood clotting requires
(1) Na^+ and K^+
(2) Na^+ and prothrombin
(3) Na^+ and thromboplastin
(4) Ca^{2+} and thromboplastin

Q.65 Mammalian erythrocytes are–
(1) Circular (2) Biconcave
(3) Nonnucleated (4) All the above

Q.66 Epithelium of bronchioles is
(1) Simple cuboidal
(2) Pseudostratified columnar
(3) Simple squamous
(4) Pseudostratified sensory

Q.67 Thromboplastin required for blood clotting is produced by
(1) Platelets (2) Erythrocytes
(3) Monocytes (4) Lymphocytes

Q.68 Maximum number of WBC is that of
(1) Basophils (2) Neutrophils
(3) Monocytes (4) Eosinophils

Q.69 Proteolytic enzyme required for lysis of fibrinogen during fibrinolysis is
(1) Plasmin (2) Fibrin
(3) Platelet factor (4) Thrombin

Q.70 Which of the following are involved in body defence–
(1) Neutrophils (2) Lymphocytes
(3) Macrophages (4) All the above

Q.71 Largest corpuscles in human blood are–
(1) Erythrocytes (2) Monocytes
(3) Lymphocytes (4) Basophils

Q.72 Heparin is formed by–
(1) Liver cells (2) Plasma cells
(3) Blood cells (4) Spleen cells

Q.73 Following is not a granulocyte-
(1) Basophils (2) Monocytes
(3) Acidophils (4) Neutrophils

Q.74 Change in the caliber of blood vessels is-
(1) Vasomotion (2) Bradycardia
(3) Trachycardia (4) Circulation failure

Q.75 Fibrin is formed by-
(1) Liver (2) Thrombin
(3) Thrombokinase (4) Proteolysis

Q.76 White ghosts are formed by-
(1) Choanocytes (2) Thrombocytes
(3) Lymphocytes (4) Erythrocytes

Q.77 Correct for WBC -
(1) Non-nucleated (2) Formed in thymus
(3) Deficiency causes cancer
(4) Can pass out of the blood capallaries

Q.78 Reticulocytes are-
(1) Blood platelets (2) Immature RBC
(3) Lymphocytes (4) WBC

MUSCULAR TISSUE

Q.79 Certain fibres are long more than a feet. These are–
(1) Muscle Fibres (2) Nerve fibres
(3) Fibroblasts (4) All the above

Q.80 In mammals yellow fibres are found in–
(1) Ear pinna (2) Tip of nose
(3) Epiglottis (4) All of these

Q.81 Characteristics of smooth muscle fibres are–
(1) Spindle-shaped, unbranched, unstriated, uninucleate and involuntary
(2) Spindle shaped, unbranched, unstriped, mutlinucleate and involuntrary
(3) Cylindrical, unbranched, unstriped, multinucleate and involuntary
(4) Cylindrical, unbranched, striated, multinucleate and voluntary

Q.82 Which one possesses striated muscles–
(1) Gall blader (2) Leg muscles
(3) Bronchial wall (4) Lungs

Q.83 Heart muscles are–
(1) Voluntary and unstriated
(2) Voluntary and striated
(3) Involuntary and striated
(4) Involuntary and unstriated

Q.84 Which one contains voluntary muscles–
(1) Heart (2) Hind limb
(3) Liver (4) Lung

Q.85 Cardiac muscles are–
(1) Striated, syncytial and voluntary
(2) Striated, syncytial and involuntary
(3) Smooth, spindle-shaped and involuntary
(4) Striated, crossoconnected and involuntary

Q.86 Muscles involved in movement of arm are–
(1) Striated (2) Unstriated
(3) Cardiac (4) Smooth

Q.87 Striated muscles found in–
(1) Trachea (2) Lungs
(3) Gall bladder (4) Limbs

Q.88 Ligaments made up of –
(1) Yellow elastin fibre (2) White collagen fibre
(3) White elastin fibres (4) None of above

Q.89 Bundles of striated muscle fibres are enclosed in
(1) Periosteum (2) Epimysium
(3) Perimysium (4) Endomysium

Q.90 Unstriated, unstriped or smooth muscle fibres occur in–
(1) Iris (2) Eye muscles
(3) Tongue (4) Thigh

Q.91 What is not true of smooth muscle fibres–
(1) Spindle shaped (2) Under ANS
(3) Syncytial (4) Structurally simple

Q.92 Cross-bridges occur in–
(1) Mid brain of Rabbit (2) Mid brain of Frog
(3) Cranial nerves (4) Cardiac fibres

Q.93 Multi-unit smooth muscles are found in the wall of–
(1) Large blood vessels (2) Intestine
(3) Stomach (4) Urinary bladder

Q.94 Large irregular ovoid cells found in areolar tissue are
(1) Fibroblasts (2) Macrophages
(3) Mast cells (4) Chromatophores

Q.95 Smooth muscles occure in–
(1) Vein (2) Artery
(3) Uterus (4) All the above

Q.96 Muscles develop from–
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) All the above

Q.97 Muscular tissue is differentiated into–
(1) Striped and cardiac
(2) Unstriped, striated and cardiac
(3) Cardiac and unstriped
(4) Striped and unstriped

Q.98 Striped muscles are–
(1) Syncytial (2) Multinucleate
(3) Binucleate (4) Annucleate

Q.99 Voluntary muscles are controlled by-
(1) Cerebral hemisphere
(2) Medulla
(3) Cerebellum (4) Cerebrum

Q.100 Which has both voluntary & involuntary muscles-
(1) Blood vessels (2) Gland ducts
(3) Urethra (4) None

Q.101 Fatigued muscle contains-
(1) ADP (2) Lactic acid
(3) Keto acid (4) None

Q.102 In striated muscle, Krau's membrane separate many-
(1) Sarcomeres (2) Micromeres
(3) Chromosomes (4) All

Q.103 The stored food material found in the muscles of animals-
(1) Phosphogens (2) Proteins
(3) Lipids (4) Glycogen

Q.104 Intercostal muscle are attached to-
(1) Diaphragm (2) Ribs
(3) Fingers (4) None

NERVOUS TISSUE

Q.105 Nissal granules found in cyton of a neuron and having affinity for basic dyes are composed of
(1) DNA (2) RNA
(3) Proteins (4) Amino acids

Q.106 Area of coming together of two neuron ends or between a dendron and axon ends is
(1) Junction (2) Synapsis
(3) Synapse (4) Synapticula

Q.107 The efferent part of a neuron is–
(1) Dendron (2) Dendrite
(3) Axon (4) Cyton

Q.108 Area of synapse contains–
(1) Inhibitory chemicals
(2) Excitatory chemicals
(3) Both (4) None

Q.109 Most of the human neurons are–
(1) Multipolar (2) Bipolar
(3) Unipolar (4) Pseudo-unipolar

Q.110 Units of nervous system are–
(1) Cytons (2) Axons
(3) Neurons (4) Dendrites

Q.111 Schwann cells is associated with-
(1) Epithelial tissue (2) Muscle tissue
(3) Connective tissue (4) Nervous tissue

Q.112 Nerve cells differs from muscle cell in having-
(1) Sarcomere (2) Sarcolemma
(3) Z-line (4) Dendrites

Q.113 Nerve cells divide by-
(1) Amitosis (2) Meiosis
(3) Mitosis (4) They don't divide

Q.114 Which damaged cells can not be repaired-
(1) Dermal cells (2) Bone cells
(3) Brain cells (4) All

Q.115 Which contains non-myelinated nerve fibres-
(1) Optic nerves (2) Cranial nerves
(3) Spinal nerves (4) Autonomous nerves

Q.116 Nissl's granules are found in -
(1) Nerve cells (2) Mas cells
(3) Bone cells (4) All

Q.117 Node of Ranvier is found in-
(1) Right auricle (2) Muscle bundle
(3) Dendrite (4) Axon

Q.118 Cell which are more than one feet in length-
(1) Nerve cells (2) Muscle cells
(3) Bone cells (4) Not possible

Q.119 The junction of neurons is-
(1) Synapse (2) Synapsis
(3) Junction (4) All

GRANDULAR TISSUE

Q.120 When the glandular cells breakdown completely, the gland is known as
(1) Holocrine gland (2) Apocrine gland
(3) Merocrine gland (4) None of the above

ANSWER KEY

EXERCISE - 1

Q.1	2	Q.2	4	Q.3	4	Q.4	2	Q.5	3	Q.6	1	Q.7	1
Q.8	2	Q.9	2	Q.10	1	Q.11	1	Q.12	4	Q.13	3	Q.14	2
Q.15	1	Q.16	3	Q.17	2	Q.18	1	Q.19	2	Q.20	2	Q.21	1
Q.22	1	Q.23	2	Q.24	3	Q.25	2	Q.26	3	Q.27	4	Q.28	3
Q.29	2	Q.30	3	Q.31	4	Q.32	3	Q.33	4	Q.34	2	Q.35	1
Q.36	2	Q.37	3	Q.38	2	Q.39	2	Q.40	3	Q.41	3	Q.42	2
Q.43	1	Q.44	2	Q.45	3	Q.46	2	Q.47	4	Q.48	2	Q.49	1
Q.50	2	Q.51	2	Q.52	2	Q.53	1	Q.54	4	Q.55	2	Q.56	1
Q.57	4	Q.58	3	Q.59	4	Q.60	1	Q.61	3	Q.62	1	Q.63	2
Q.64	4	Q.65	4	Q.66	2	Q.67	1	Q.68	2	Q.69	4	Q.70	4
Q.71	2	Q.72	1	Q.73	2	Q.74	1	Q.75	4	Q.76	4	Q.77	4
Q.78	2	Q.79	2	Q.80	4	Q.81	1	Q.82	2	Q.83	3	Q.84	2
Q.85	4	Q.86	1	Q.87	4	Q.88	1	Q.89	2	Q.90	1	Q.91	3
Q.92	4	Q.93	1	Q.94	1	Q.95	4	Q.96	2	Q.97	2	Q.98	2
Q.99	3	Q.100	3	Q.101	2	Q.102	1	Q.103	4	Q.104	2	Q.105	2
Q.106	3	Q.107	3	Q.108	1	Q.109	1	Q.110	3	Q.111	4	Q.112	4
Q.113	4	Q.114	3	Q.115	4	Q.116	1	Q.117	4	Q.118	1	Q.119	1
Q.120	1												

EXERCISE-2

EPITHELIAL TISSUE

Q.1 Compound tissue is defined as–
(1) Similar types of cells held together by connective tissue
(2) Different types of cells which are different in structure and function
(3) Different types of cells performing one function
(4) Similar cells at different regions performing many functions.

Q.2 Epithelial cells get nutrient material from–
(1) Neighbouring cells (2) Blood vessels
(3) Lymph vessels (4) Underlying tissue.

Q.3 Microvilli of epithelial cells–
(1) Increase surface area
(2) Protect the cells
(3) Engulaf the foreign matter
(4) Give movements to the cells

Q.4 Squamous epithelium is also called–
(1) Germinal epithelium
(2) Columnar epithelium
(3) Pavement epithelium
(4) Sensory epithelium

Q.5 Epidermis of skin of vertebrates comprises
(1) Simple epithelium
(2) Stratified epithelium
(3) Transitional epithelium
(4) Columnar epithelium

Q.6 Ciliated epithelial cells are present in–
(1) Buccal cavity of Frog
(2) Stomach of Frog
(3) Pancreatic duct of Pancreas
(4) None of these

Q.7 Tesselated epithelium is found in–
(1) Lining of intestine
(2) Lining of blood vessel
(3) Seminiferous tubule
(4) Uriniferous tubules

Q.8 Germinal epithelial cells are present in–
(1) Seminiferous tubules
(2) Uriniferous tubules
(3) Lining of stomach
(4) Inner lining of trachea

Q.9 Transitional epithelium is found in–
(1) Larynx
(2) Vein
(3) Kidney
(4) Ureter and renal pelvis

Q.10 Outer layer of skin that frog casts off is composed of–
(1) Simple squamous epithelium
(2) Tesselated epithelium
(3) Ciliated epithelium
(4) Cuboidal epithelium

Q.11 Urinary bladder is lined with–
(1) Simple epithelium
(2) Stratified epithelium
(3) Transitional epithelium
(4) Pseudostratified epithelium

Q.12 Presence of extracellular basement membrane is the peculiarity of
(1) Epithelial tissue
(2) Connective tissue
(3) Nervous tissue
(4) Muscular tissue

Q.13 Which of the following in mammalian tissues is associated with filtration and diffusion
(1) Simple columnar (2) Simple squamous
(3) Stratified squamous (4) Stratifed columnar

Q.14 Ciliated epithelium lines–
(1) Stomach (2) Trachea
(3) Duodenum (4) Ileum

Q.15 Ciliated epithelium occurs in–
(1) Ureter and Trachea (2) Trachea and Lungs
(3) Trachea and Liver (4) Trachea and Uterus

Q.16 Germinal epithelium of ovary is formed of
(1) Columnar epithelium
(2) Squamous epithelium
(3) Cuboidal epithelium
(4) Stratified epithelium

Q.17 The epithelium found in the lining layer of stomach and intestine is
(1) Columnar (2) Squamous
(3) Stratified (4) Pseudostratified

Q.18 Epithelium present in cornea, oesophagus, urethra and vagina is
(1) Glandular (2) Ciliated
(3) Stratified columnar (4) Stratified squamous

Q.19 Ciliated epithelium occurs in Frog in–
(1) Buccal cavity and oviduct
(2) Stomach and urinary bladder
(3) Blood vessels and lymph vessels
(4) Kidney and stomach

Q.20 Cells of peritoneum comprise–
(1) Ciliated epithelium
(2) Columnar epithelium
(3) Glandular epithelium
(4) Squamous epithelium

CONNECTIVE TISSUE

Q.21 Human mammary glands belong to one of the following types of glands
(1) Simple alveolar
(2) Coiled tubular
(3) Compound tubulo-alveolar
(4) Simple tubular

Q.22 Areolar tissue connects–
(1) The skin with muscles
(2) Muscles to muscles
(3) Bone to bone (4) Bone to muscles

Q.23 Matrix of the connective tissue is secreted by–
(1) Fibrocytes (2) Histiocytes
(3) Mast cells (4) Plasma cells

Q.24 Dermis of the skin is formed of–
(1) Adipose connective tissue
(2) Epithelial tissue
(3) Muscular tissue
(4) Areolar connective tissue

Q.25 Tendon is made up of–
(1) Yellow fibrous connective tissue
(2) Adipose tissue
(3) Modified white fibrous tissue
(4) Areolar tissue

Q.26 Which of the following cell contains fat droplets–
(1) Macrophages (2) Plasma cells
(3) Adipoe cells (4) Leucocytes

Q.27 Tendons and ligaments belong to–
(1) Muscular tissue
(2) Epithelial tissue
(3) Fibrous connective tissue
(4) Areolar connective tissue

Q.28 Fibres present in connective tissue are–
(1) Reticular (2) Elastic
(3) Collagen (4) All the above

Q.29 Histamine secreting cells are found in
(1) Connective tissues (2) Lungs
(3) Muscular tissue (4) Nervous tissue

Q.30 Histiocyte is a connective tissue cell which takes part in
(1) Fibre production (2) Matrix production
(3) Phagocytosis (4) Secretion

Q.31 Mast cells occur in–
(1) Areolar tissue (2) Adipose tissue
(3) White fibrous tissue (4) Yellow fibrous tissue

Q.32 A tissue in which matrix is the source of structural and functional performance is
(1) Muscular (2) Epithelial
(3) Connective (4) Nervous

Q.33 In Camel, the hump is mainly made of tissue
(1) Areolar (2) Adipose
(3) Muscular (4) Skeleton

Q.34 The cartilage found in larynx, trachea & bronchi is-
(1) Hyalin (2) Elastic
(3) Fibrous (4) Calcified

CONNECTIVE SKELETON TISSUE

Q.35 Yellow fibres are made up of–
(1) Ossein (2) Elastin
(3) Chondrin (4) Collagen

Q.36 Perichondrium covers the–
(1) Bone (2) Cartilage
(3) Decalcified bone (4) Dried bone

Q.37 The process of bone formation is called–
(1) Ossification (2) Calcification
(3) Calcination (4) None of these

Q.38 Matrix of cartilage is secreted by–
(1) Chondrocytes (2) Chondroblasts
(3) Osteocytes (4) Histiocytes

Q.39 The main difference between bone and cartilage is of
(1) Mineral salts (2) Blood vessels
(3) Lymph vessels (4) Haversian canals

Q.40 60% inorganic components are present in–
(1) Cartilage (2) Bone
(3) Connective tissue (4) None of these

Q.41 Matrix of bone is arranged–
(1) In concentric layers
(2) Not in concentric layers
(3) Matrix forms the ground substance
(4) None of these

Q.42 Volkmann's canal connects–
(1) Osteocyte with matrix
(2) Different bones
(3) Haversian canal with matrix
(4) Haversian canal with other Haversian canals.

Q.43 Ossification of connective tissue results in
(1) Cartilage (2) Seasmoid
(3) Membrane bone (4) None of the above

Q.44 Bone has longitudinal canals, called–
(1) Central canals (2) Haversian canals
(3) Volkmann's canals (4) None of the above

Q.45 Hyoid apparatus is composed of–
(1) Hyaline cartilage (2) Fibrous cartilage
(3) Calcified cartilage (4) Elastic cartilage

Q.46 Calcified cartilage is found in–
(1) Head of femur (2) Pectoral girdle
(3) Ribs and sternum (4) Both 1 and 2

Q.47 Supportive connective tissue means
(1) Tendon (2) Cartilage and bone
(3) Ligament (4) Blood and lymph

Q.48 Yellow fibres are present in–
(1) Bundles
(2) Singly and branched
(3) Singly and unbranched
(4) None of these

Q.49 In hyaline cartilage, matrix is–
(1) Granular (2) Transparent
(3) Agranular (4) Semitransparent

Q.50 Sprain is due to pulling of–
(1) Muscles (2) Ligaments
(3) Tendons (4) Nerves

CONNECTIVE VASCULAR TISSUE

Q.51 RBC that lack nuclei when they are mature are of
(1) Frog (2) Lizard
(3) Man (3) Birds

Q.52 Blood clot is mainly due to–
(1) Plasma and RBC
(2) Plasma and thrombocytes
(3) Heparin and corpuscles
(4) Fibrin and corpuscles

Q.53 Which of the following is not a phagocytic cell–
(1) Neutrophils (2) Monocytes
(3) Lymphocytes (4) Eosinophils

Q.54 Blood cells are formed in bone marrow. The process is known as
(1) Haemolysis (2) Erythroblastosis
(3) Haemopoiesis (4) None of these

Q.55 Blood platelets are not present in the blood of–
(1) Fishes (2) Amphibians
(3) Reptiles (4) All the above

Q.56 Agranulocytes normally develop in–
(1) Bone marrow
(2) Liver
(3) Lymph glands and spleen
(4) None of these

Q.57 Granulocytes are produced in–
(1) Liver (2) Bone marrow
(3) Spleen (4) None of these

Q.58 Formation of platelets is known as–
(1) Haemopoiesis (2) Thrombopoiesis
(3) Haemolysis (4) None of these

Q.59 Percentage of protein is more in–
(1) Lymph (2) Blood
(3) Plasma (4) W.B.C.

Q.60 Which of the following acts as middle man–
(1) W.B.C. (2) Plasma
(3) Blood (4) Lymph

Q.61 Blood is a–
(1) Epithelial tissue (2) Muscular tissue
(3) Connective tissue (4) Supportive tissue

Q.62 In man, the number of R.B.C. per cubic mm of blood is
(1) 1 to 3 millions
(2) 5 to 5.4 millions
(3) Less than one million but more than 50 thousand
(4) Less than 50 thousand

Q.63 Life span of a W.B.C. in man is–
(1) 100 days (2) 50 days
(3) 7 days (4) None of the above

Q.64 The diameter of RBC is–
(1) 10-12 μm (2) 2-3 μm
(3) 7-8 μm (4) None of the above

Q.65 Formation of antibodies is the function of–
(1) Monocytes (2) Neutrophils
(3) Basophils (4) Lymphocytes

Q.66 Life span of mammalian R.B.C. is–
(1) 100-128 days (2) 100 days
(3) Less than 100 days
(4) None of the above

Q.67 The main difference in the blood and lymph is–
(1) Absence of RBC
(2) Absence of WBC
(3) Number of WBC is less in blood
(4) None of these

Q.68 Which blood corpuscle is largest in diameter-
(1) Erythrocyte (2) Monocyte
(3) Neutrophil (4) Lymphocyte

Q.69 Which of the W.B.C. has many lobed nucleus–
(1) Monocytes (2) Lymphoytes
(3) Neutrophils (4) Basophils

Q.70 Number of R.B.C. is more in persons living at hills because
(1) There is less oxygen
(2) Air is more purified
(3) Heat is required to warm the body
(4) None of these

Q.71 Name any mammal where R.B.C. are nucleated–
(1) Elephant (2) Rabbit
(3) Monkey (4) None

Q.72 Name the cells which help in clotting of blood in mammals
(1) Platelets (2) Thrombocytes
(3) Lymphocytes (4) Monocytes

Q.73 Plasma has water to the extent of–
(1) 80% (2) 60%
(3) 70% (4) 90%

Q.74 Blood platelets are–
(1) Nucleated cells
(2) Nonnucleated cells
(3) Nonnucleated cells fragments
(4) Nucleated cell fragments

Q.75 Instead of platelets, the non-mammals possess clotting factor in
(1) Nucleated cells called thrombocytes
(2) RBC
(3) WBC
(4) Plasma

Q.76 As compared to blood, lymph contains–
(1) More protein, same number of leucocytes mainly lymphocytes and few erythrocytes
(2) Less protein, more leucocyts chiefly granuclocytes and a few erythrocytes
(3) Less protein, large number of leucocytes mainly lymphocytes and a few granulocytes, no erythrocytes
(4) Less protein, same number of leucocytes mainly lymphocytes and a few erythrocytes

MUSCULAR TISSUE

Q.77 Muscle fibres having rounded ends are
(1) Unstriped muscles (2) Smooth muscles
(3) Striped muscles (4) All the above

Q.78 Inter-calated discs are present in–
(1) Cardiac muscles (2) Striped muscles
(3) Unstriated muscles (4) Ligament

Q.79 The cytoplasm of muscle fibre is known as–
(1) Neuroplasm (2) Protoplasm
(3) Germ plasm (4) Sarcoplasm

Q.80 "All or Non" rule can't be implicate on
(1) Non straited muscles
(2) Cardiac Muscles
(3) Straited muscles
(4) All the above

Q.81 Each myofibril has a diameter of–
(1) 1 to 2 μm (2) 0.1 to 0.2 μm
(3) .001 to .002 μm (4) None of the above

Q.82 Myofibrils show dark and light bands in–
(1) Cardiac muscles (2) Unstriped muscles
(3) Striped muscles (4) Both 1 and 3

Q.83 Myosin filaments are localized in–
(1) Z-Band (2) H-Band
(3) A-Band (4) None of the above

Q.84 Uninucleate muscles are–
(1) Smooth muscles (2) Cardiac muscles
(3) Involuntary muscles (4) All the above

Q.85 Multinucleate muscle cells are–
(1) Striped muscles (2) Smooth muscles
(3) Skeletal muscles (4) All the above

Q.86 Which of the muscles are attached to bones–
(1) Smooth muscles (2) Straited muscles
(3) Cardiac muscles (4) All the above

Q.87 Chemical ions responsible for muscle contraction are–
(1) Ca^{++} and K^{+} (2) Na^{+} and K^{+}
(3) Na^{+} and Ca^{++} (4) Ca^{++} and Mg^{++} ions

Q.88 Rhythmical contraction is noticed in–
(1) Cardiac muscles (2) Striped muscles
(3) Unstriped muscles (4) In all the muscles

Q.89 Muscles get fatigued due to accumulation of–
(1) Adenosine triphosphate
(2) CO_2
(3) Lactic acid
(4) Phosphate molecules

Q.90 Mitochondria are more in–
(1) Striated mucles (2) Cardiac muscles
(3) Smooth muscles (4) All the above

Q.91 Striped muscle fibres are held together by–
(1) Areolar connective tissue
(2) Adipose tissue
(3) White fibrous tissue
(4) Yellow fibrous tissue

Q.92 Cross connections are the characteristic feature of–
(1) Cardiac muscles (2) Striated muscles
(3) Smooth muscles (4) None of the above

Q.93 Power of regeneration is poor in–
(1) Nerve cell (2) Bone cell
(3) Chondroblasts (4) Striated muscles

Q.94 Basic unit of muscle contraction is–
(1) Actin (2) Myosin
(3) Sarcomere (4) Tropomyosin

Q.95 Schwann cells are present around–
(1) Medullated nerve fibre
(2) Non-medullated nerve fibre
(3) Medullated and non-medullated nerve fibres
(4) None of these

Q.96 Transmitter substance released at the synapse is–
(1) Secretin (2) Cholecystokinin
(3) Cholesterol (4) Acetylcholin

Q.97 The Muscles resistant to fatigue is–
(1) Striped (2) Unstriped
(3) Cardiac (4) Eye muscles

NERVOUS TISSUE

Q.98 Neurilemma is outer covering of
(1) Blood capillaries (2) Muscle fibre
(3) Intestine (4) Nerve fibre

Q.99 Unipolar nerve cell means–
(1) Nerve cell with one dendron
(2) Nerve cell with many dendrons
(3) Nerve cell without dendron
(4) None of the above

Q.100 Multipolar neuron means–
(1) With one dendron and one axon
(2) With many dendrons and one axon
(3) With one dendron and no axons
(4) With many dendrons and no axons

Q.101 Nissel's granules are absent in
(1) Dendrons and dendrites
(2) Cyton
(3) Axon
(4) Dendrons and cyton

Q.102 Neuro-fibrils are present in–
(1) Cyton (2) Muscles
(3) Bones (4) Connective tissue

Q.103 Plasmalemma of axon is called–
(1) Axolemma (2) Neurilemma
(3) Sarcolemma (4) None of these

Q.104 Collateral fibres are given out along its way is–
(1) Muscle fibre (2) Axon
(3) Dendron (4) Dendrites

Q.105 Myelin sheath is pressent around the–
(1) Non-medullated nerve fibre
(2) Medullated nerve fibre
(3) Medullated and non-medullated nerve fibres
(4) Muscle fibres

Q.106 Which of the following posesses nodes of Ranvier–
(1) Medullated nerve fibre
(2) Non-medullated nerve fibre
(3) Muscle fibre
(4) Medullated and non-medullated nerve fibres

Q.107 The packing cells around nerve cells in brain are called
(1) Histiocytes (2) Mast cells
(3) Matrix (4) Neuroglia cells

Q.108 Bipolar nerve cells are present in–
(1) Skin tactile corpuscles
(2) Spinal cord
(3) Retina of eye
(4) All the above

Q.109 Multipolar nerve cells are present in–
(1) Cochlea
(2) Dorsal root ganglia of spinal cord
(3) Retina of eye
(4) Brain

Q.110 Which is correct–
(1) A medullated nerve fibre appears grey
(2) A nonmedullated nerve fibre appears white
(3) Neurilemma is composed of Schwann cells
(4) Neurilemma is composed of neuroglia cells

Q.111 Tissue connecting bones is–
(1) Tendon (2) Ligament
(3) Areolar tissue (4) Adipose tissue

MUSCLES

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(1) Unstriped muscles (2) Smooth muscles
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(3) Cardiac (4) Eye muscles

Q.133 Certain fibres are long more than a feet. These are -
(1) Muscle Fibres (2) Nerve fibres
(3) Fibroblasts (4) All the above

Q.134 In mammals yellow fibres are found in-
(1) Ear pinna (2) Tip of nose
(3) Epiglottis (4) All of these

Q.135 Characteristics of smooth muscle fibres are-
(1) Spindle-shaped, unbranched, unstriated, uninucleate and involuntary
(2) Spindle shaped, unbranched, unstriped, mutlinucleate and involuntrary
(3) Cylindrical, unbranched, unstriped, multinucleate and involuntary
(4) Cylindrical, unbranched, striated, multinucleate and voluntary

Q.136 Which one possesses striated muscles-
(1) Gall blader (2) Leg muscles
(3) Bronchial wall (4) Lungs

Q.137 Heart muscles are-
(1) Voluntary and unstriated
(2) Voluntary and striated
(3) Involuntary and striated
(4) Involuntary and unstriated

Q.138 Which one contains voluntary muscles-
(1) Heart (2) Hind limb
(3) Liver (4) Lung

Q.139 Cardiac muscles are-
(1) Striated, syncytial and voluntary
(2) Striated, syncytial and involuntary
(3) Smooth, spindle-shaped and involuntary
(4) Striated, crossoconnected and involuntary

Q.140 Muscles involved in movement of arm are-
(1) Striated (2) Unstriated
(3) Cardiac (4) Smooth

Q.141 Striated muscles found in-
(1) Trachea (2) Lungs
(3) Gall bladder (4) Limbs

Q.142 Ligaments made up of -
(1) Yellow elastin fibre
(2) White collagen fibre
(3) White elastin fibres
(4) None of above

Q.143 Bundles of striated muscle fibres are enclosed in
(1) Periosteum (2) Epimysium
(3) Perimysium (4) Endomysium

Q.144 Unstriated, unstriped or smooth muscle fibres occur in-
(1) Iris (2) Eye muscles
(3) Tongue (4) Thigh

Q.145 What is not true of smooth muscle fibres-
(1) Spindle shaped (2) Under ANS
(3) Syncytial (4) Structurally simple

Q.146 Cross-bridges occur in-
(1) Mid brain of Rabbit (2) Mid brain of Frog
(3) Cranial nerves (4) Cardiac fibres

Q.147 Multi-unit smooth muscles are found in the wall of-
(1) Large blood vessels (2) Intestine
(3) Stomach (4) Urinary bladder

Q.148 Large irregular ovoid cells found in areolar tissue are
(1) Fibroblasts (2) Macrophages
(3) Mast cells (4) Chromatophores

Q.149 Smooth muscles occure in-
(1) Vein (2) Artery
(3) Uterus (4) All the above

Q.150 Muscles develop from-
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) All the above

Q.151 Muscular tissue is differentiated into-
(1) Striped and cardiac
(2) Unstriped, striated and cardiac
(3) Cardiac and unstriped
(4) Striped and unstriped

Q.152 Striped muscles are-
(1) Syncytial (2) Multinucleate
(3) Binucleate (4) Annucleate

Q.153 Voluntary muscles are controlled by-
(1) Cerebral hemisphere
(2) Medulla
(3) Cerebellum
(4) Cerebrum

Q.154 Which has both voluntary & involuntary muscles-
(1) Blood vessels (2) Gland ducts
(3) Urethra (4) None

Q.155 Fatigued muscle contains-
(1) ADP (2) Lactic acid
(3) Keto acid (4) None

Q.156 In striated muscle, Krau's membrane separate many-
(1) Sarcomeres (2) Micromeres
(3) Chromosomes (4) All

Q.157 The stored food material found in the muscles of animals-
(1) Phosphogens (2) Proteins
(3) Lipids (4) Glycogen

Q.158 Intercostal muscle are attached to-
(1) Diaphragm (2) Ribs
(3) Fingers (4) None

ANSWER KEY

EXERCISE - 2

Q.1	3	Q.2	4	Q.3	1	Q.4	3	Q.5	2	Q.6	1	Q.7	2
Q.8	1	Q.9	4	Q.10	1	Q.11	3	Q.12	1	Q.13	2	Q.14	2
Q.15	1	Q.16	3	Q.17	1	Q.18	4	Q.19	1	Q.20	4	Q.21	4
Q.22	1	Q.23	3	Q.24	1	Q.25	3	Q.26	3	Q.27	3	Q.28	4
Q.29	1	Q.30	3	Q.31	1	Q.32	3	Q.33	2	Q.34	1	Q.35	2
Q.36	2	Q.37	1	Q.38	2	Q.39	4	Q.40	2	Q.41	1	Q.42	4
Q.43	3	Q.44	2	Q.45	1	Q.46	4	Q.47	2	Q.48	2	Q.49	3
Q.50	2	Q.51	3	Q.52	4	Q.53	3	Q.54	3	Q.55	4	Q.56	3
Q.57	2	Q.58	2	Q.59	2	Q.60	4	Q.61	3	Q.62	2	Q.63	3
Q.64	3	Q.65	4	Q.66	1	Q.67	1	Q.68	2	Q.69	3	Q.70	1
Q.71	4	Q.72	1	Q.73	4	Q.74	3	Q.75	1	Q.76	3	Q.77	1
Q.78	1	Q.79	4	Q.80	4	Q.81	3	Q.82	4	Q.83	3	Q.84	4
Q.85	3	Q.86	2	Q.87	4	Q.88	1	Q.89	3	Q.90	2	Q.91	1
Q.92	1	Q.93	1	Q.94	3	Q.95	3	Q.96	4	Q.97	3	Q.98	4
Q.99	3	Q.100	2	Q.101	3	Q.102	1	Q.103	1	Q.104	2	Q.105	2
Q.106	1	Q.107	4	Q.108	3	Q.109	2	Q.110	3	Q.111	2	Q.112	1
Q.113	1	Q.114	4	Q.115	4	Q.116	3	Q.117	4	Q.118	3	Q.119	4
Q.120	3	Q.121	2	Q.122	4	Q.123	1	Q.124	3	Q.125	2	Q.126	1
Q.127	1	Q.128	1	Q.129	3	Q.130	3	Q.131	4	Q.132	3	Q.133	2
Q.134	4	Q.135	1	Q.136	2	Q.137	3	Q.138	2	Q.139	4	Q.140	1
Q.141	4	Q.142	1	Q.143	2	Q.144	1	Q.145	3	Q.146	4	Q.147	1
Q.148	1	Q.149	4	Q.150	2	Q.151	2	Q.152	2	Q.153	3	Q.154	3
Q.155	2	Q.156	1	Q.157	4	Q.158	2						

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Compound squamous epithelium occurs in - **[BHU-1995]**

(1) Stomach (2) Pharynx

(3) Intestine (4) Trachea

Q.2 Epithelial tissue is **[MP-PMT-1995]**

(1) Protective covering

(2) Reproductive structure

(3) Nerve cells (4) Corpuscles

Q.3 Epithelium of bronchioles is **[MP-PMT-1996]**

(1) Simple cuboidal

(2) Pseudostratified columnar

(3) Simple squamous

(4) Pseudostratified sensory

Q.4 Stratified and nonkeratinised squamous epithelium occurs in **[MP-PMT-1996]**

(1) Epidermis of skin

(2) Vagina and cervix

(3) Buccal cavity (4) Both 2 and 3

Q.5 Basement membrane is formed of **[AIPMT-1996]**

(1) Epidermal cells

(2) Endodermal cells

(3) Both 1 and 2

(4) None of the above but present below epithelial cells

Q.6 Inner lining of gut, stomach and liver is made of **[AFMC-1997]**

(1) Simple squamous epithelium

(2) Simple columnar epithelium

(3) Simple cuboidal epithelium

(4) All the above

Q.7 Gastric glands are **[RPMT-1998]**

(1) Simple tubular

(2) Simple coiled tubular

(3) Branched tubular

(4) Compound tubular

Q.8 Regeneration after injury is absent in **[RPMT-1998]**

(1) Nervous tissue (2) Skin epidermis

(3) Tendon (4) Smooth muscles

Q.9 Brush border epithelium occurs in **[CPMT-1999]**

(1) Trachea (2) Stomach

(3) Small intestine (4) Fallopian tube

Q.10 Adjacent epithelial cells are held together by means of **[AFMC-1999]**

(1) Liposomes (2) Glyoxisomes

(3) Desmosomes (4) Microsomes

Q.11 Vertebrate salivary glands and exocrine part of pancreas are **[BHU-1991]**

(1) Apocrine (2) Holocrine

(3) Epicrine (4) Merocrine

Q.12 Simple epithelium is made of **[AIPMT-2000]**

(1) Noncellular layer of hyaluronic acid

(2) Actively dividing cells

(3) Loosely arranged cells

(4) Compactly packed single layer of cells.

Q.13 Goblet cells are **[JKCMEE2000]**

(1) Unicellular glands

(2) Multicellular glands

(3) Loosely arranged cells

(4) Dead keratinised cells

Q.14 Sebaceous glands are **[CPMT-2000]**

(1) Apocrine (2) Holocrine

(3) Mesocrine (4) Eccrine

Q.15 Squamous epithelium occurs in inner lining of **[Kerala-2000]**

(1) Kidney (2) Pancreatic duct

(3) Lung alveoli (4) Liver

Q.16 Branched tubular gland is **[CPMT-2001]**

(1) Salivary (2) Gastric

(3) Sebaceous (4) Sweat

Q.17 Characteristic of epithelial tissues is **[Karnataka-2001]**

(1) Never produce glands

(2) Cells can undergo rapid divisions

(3) Abundant vascularisation

(4) Large intercellular spaces

Q.18 Blood platelets are found only in the blood of **[UTTARANCHAL PMT-2004]**

(1) Birds (2) Reptiles

(3) Mammals (4) Amphibians

Q.19 Ligament connects **[UTTARANCHAL PMT-2004]**

(1) Bone to bone (2) Bone to muscle

(3) Muscle to muscle (4) Both 'b' and 'c'

Q.20 Mammary glands are modified **[UTTARANCHAL PMT-2004]**

(1) Sweat gland (2) Sebaceous gland

(3) Lacrymal gland (4) Endocrine gland

Q.21 The term haematocrit means **[UTTARANCHAL PMT-2006]**

(1) The percentage of blood having is red blood cells

(2) The ratio of blood volume to extracellular space

(3) The percentage of new blood cells formed every 120 days

(4) The percentage of blood that is white blood cells

Q.22 What is the main difference in human and frog RBC **[UTTARANCHAL PMT-2006]**

(1) Human RBC are non-nucleated

(2) Haemoglobin is found only in human RBC

(3) Human RBC have nucleus

(4) Human RBC are multinucleated

Q.23 Prothrombin is found in **[UTTARANCHAL PMT-2006]**

(1) Intestine and helps in cellulose digestion

(2) Liver and helps in production of bile

(3) Blood and gives red colour

(4) Blood and helps in blood clotting

Q.24 Which type of WBCs are most aboundant in blood of rabbit and other vertibrates **[UTTARANCHAL PMT-2006]**

(1) Acidophils (2) Basophils

(3) Lymphocytes (4) Neutrophils

Q.25 Blood clotting in a test tube can be prevented by adding a little of **[UTTARANCHAL PMT-2006]**

(1) Sodium oxalate (2) Sodium chloride

(3) Sodium hydroxide

(4) Ammonium chloride

Q.26 Oval, biconvex and nucleated RBCs are found in **[UTTARANCHAL PMT-2006]**

(1) Camel (2) Rabit

(3) Man (4) Rat

Q.27 Which of the following is an anticoagulant and checks blood coagulation in blood vessels **[UTTARANCHAL PMT-2006]**

(1) Prothrombin (2) Globulin

(3) Thromboplastin (4) Heparin

Q.28 In normal healthy female, the number of RBC/mm^3 of blood is **[UTTARANCHAL PMT-2006]**

(1) 6.5–7.0 million (2) 5.5 – 6.0 million

(3) 4.5 – 5.0 million (4) 3.5 – 4.0 million

Q.29 The tissue which forms the basic structure of lymphoid organs, spleen etc, is **[UTTARANCHAL PMT-2006]**

(1) Lymphoid tissue (2) Cartilage tissue

(3) Elastic tissue (4) Areolar tissue

Q.30 Which of the following should be avoided in Biological marriage **[UTTARANCHAL PMT-2006]**

(1) A^+ boy and A^+ girl (2) A^+ boy and A^- girl

(3) O^+ boy and O^+ girl (4) O^- boy and O^- girl

Q.31 After examining the blood group of husband and wife, the doctor advised them not to have more than one child. The blood groups of the couple are likely to be **[UTTARANCHAL PMT-2006]**

(1) Male Rh^- and male Rh^+

(2) Female Rh^- and male Rh^+

(3) Male Rh^+ and female Rh^+

(4) Male Rh^- and female Rh^-

Q.32 Blood colloidal osmotic pressure is maintained by **[WEST BENGAL JEE-2007]**

(1) Albumin (2) Globulin

(3) Fibrinogen (4) Thrombin

Q.33 Haversian canal is situated in **[WEST BENGAL JEE-2007]**

(1) Glandular connective tissue
(2) Skeletal connective tissue
(3) Fibrous connective tissue
(4) Nervous tissue

Q.34 Histamine is secreted by **[WEST BENGAL JEE-2007]**

(1) Neutrophils (2) Basophils
(3) Leucocytes (4) Monocytes

Q.35 Which one of the following is agranulocyte **[JHARKHAND-2006]**

(1) Neutrophil (2) Eosinophil
(3) Basophil (4) Monocyte

Q.36 Stratified squammous epithelium is found in **[JHARKHAND-2006]**

(1) Pharynx (2) Trachea
(3) Ileum (4) Bownan's capsule

Q.37 During the process of blood coagulation vitamin K helps in the **[JHARKHAND-2004]**

(1) Formation of thromboplastin
(2) Formation of prothrombin
(3) Conversion of prothrombin to thrombin
(4) Conversion of fibrinogen to fibrin

Q.38 In mature RBC, nucleus is present in **[JHARKHAND-2004]**

(1) Frog
(2) Rabbit
(3) Both 'a' and 'b'
(4) Neither in frog nor in rabbit

Q.39 ABO blood group system is given by **[BIHAR-2005]**

(1) Landsteiner (2) Wallace
(3) De vries (4) Lamarck

Q.40 Which of the following, does not help in clotting of blood **[BIHAR-2004]**

(1) Heparin (2) Prothrombin
(3) Ca^{2+} (4) Exposure to O_2

Q.41 Collagen fibres are secreted by **[BIHAR-2005]**

(1) Mast cells (2) Macrophage
(3) Histiocytes (4) Fibroblasts

Q.42 Haversian canal is found in the bone of **[BIHAR-2003]**

(1) Mammals (2) Reptiles
(3) Aves (4) Pices

Q.43 Haematocrit value gives **[BIHAR-2001]**

(1) Amount of RBC in blood
(2) Number of WBC in blood
(3) Amount of plasma in blood
(4) Haemoglobin concentration in blood

Q.44 Tendons and ligaments are specialized types of **[UP-CPMT-2003]**

(1) Nervous tissue
(2) Epithelial tissue
(3) Muscular tissue
(4) Fibrous connective tissue

Q.45 Which one of the follwoing is transparent tissue **[UP-CPMT-2001]**

(1) Tendon (2) Ligament
(3) Fibrous cartilage (4) Hyaline cartilage

Q.46 Ciliated epithelium is present in **[UP-CPMT-2002]**

(1) Trachea (2) Ureter
(3) Intestine (4) Nasal chamber

Q.47 Difference between bone and cartilage is **[UP-CPMT-2002]**

(1) Haversian canal (2) Blood vessel
(3) Lymph vessel (4) None of these

Q.48 Minimum regeneration power is present in **[UP-CPMT-2002]**

(1) Nervous tissue (2) Connective tissue
(3) Epithelial tissue (4) None of these

Q.49 Which one of the following couple were suggested by Doctors to not have more than one child **[UP-CPMT-2002]**

(1) Rh^+ male and Rh^- female
(2) Rh^- male and Rh^+ female
(3) Rh^+ male and Rh^+ female
(4) Rh^- male and Rh^- female

Q.50 The pH of blood is **[UP-CPMT-2003]**

(1) Between 7– 8 (2) Between 2 – 4
(3) Between 12 – 14 (4) Between 2 – 5

Q.51 Histamine is secreted by **[UP-CPMT-2003]**

(1) Goblet cell (2) Nerve cell

(3) Kupffer cell (4) Mast cell

Q.52 Universal blood recipient is **[MP-PMT-2003,06]**

(1) Blood group –O (2) Blood group–AB

(3) Blood group–A (4) Blood group–B

Q.53 Life span of RBC is **[UP-CPMT-2003]**

(1) 50 days (2) 70 days

(3) 120 days (4) 220 days

Q.37 During blood clotting which of the following is used **[UPCPMT-2003]**

(1) Co (2) Ca^{++}

(3) Na^{+} (4) Cl^{-}

Q.54 Haemoglobin contains **[UPCPMT-2003]**

(1) Fe^{++} (2) Mg^{++}

(3) Na^{++} (4) Ca^{++}

Q.55 Which of the following does not play a role in blood coagulation **[UPCPMT-2004]**

(1) Vitamin K (2) Vitamin D

(3) Calcium ions (4) Fibrinogen

Q.56 Which of the following cells of connective tissue secrete antibodies **[UPCPMT-2005]**

(1) Mast cells (2) Reticular cells

(3) Adipose cells (4) Plasma cells

Q.57 The cavities of brain are lined by **[UP-CPMT-2006]**

(1) Cuboidal cells (2) Polygonal cells

(3) Ependymal cells

(4) Simple squamous cells

Q.58 Ligament is mainly made up of **[MP-PMT-2007]**

(1) Reticulin (2) Elastin

(3) Myosin (4) Collagen

Q.59 Which is a sesamoid bone **[MP-PMT-2007]**

(1) Patella (2) Femur

(3) Ulna (4) Pterygoid

Q.60 Mammary glands are modified - **[MP-PMT-2004]**

(1) Sweat glands (2) Sebaceous glands

(3) Cutaneous glands (4) Scent glands

Q.61 Anaemia disease is caused by **[MP-PMT-2006]**

(1) Deficiency of Fe (2) Deficiency of Na

(3) Deficiency of Ca (4) Deficiency of Mg

Q.62 The main function of ligament is **[MP-PMT-2001, 06]**

(1) Joining of two bones

(2) Joining of muscles

(3) Joining of muscle to bone

(4) Joining of muscle to nerves

Q.63 The following are needed for blood clotting **[MP-PMT-2001]**

(1) Ca^{++} and Vitamin E

(2) Ca^{++} and Vitamin K

(3) Ca^{++} and Vitamin A

(4) K^{+} and Vitamin K

Q.64 The type of epithelium found in conjunctiva of eye is **[MPPMT-2001]**

(1) Stratified cuboidal

(2) Stratified columnar

(3) Stratified squamons

(4) Transitional epithelium

Q.65 Haversian canals are found in the **[MPPMT-2001]**

(1) Bones of birds (2) Bones of mammals

(3) Bones of frog (4) Cartilage

Q.66 It is not found in the Red Blood corpuscles of human being **[MPPMT-2001]**

(1) Haemoglobin (2) Plasmalemma

(3) Nucleus (4) Cytoplasm

Q.67 Lifr-span of human R.B.C. is **[MPPMT-2001]**

(1) 120 days (2) 90 days

(3) 2–3days (4) 20 days

Q.68 Volkmann's canals are found in **[MPPMT-2001]**

(1) Bones of birds

(2) Bones of amphilbians

(3) Bones of mammals

(4) Cartilage of mammals

Q.69 An example of merocrine gland is **[MP-PMT-2001]**

(1) Sebaceous gland (2) Pineal gland

(3) Salivary gland (4) Mammary gland

Q.70 Bones formed by ossification of a tendon is called **[MPPMT-2002]**
(1) Membrane bone (2) Sesamoid bone
(3) Dermal bone (4) Cartilage

Q.71 Epithelial tissues arise from **[MP-PMT-2002]**
(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) All the aboves

Q.72 The percentage of Hb in RBC is **[MP-PMT-2003]**
(1) 48 % (2) 34 %
(3) 10% (4) 20%

Q.73 White adipose tissue contains **[MPPMT-2003]**
(1) Multilocular fat cells
(2) Bilocular fat cells
(3) Unilocular fat cells (4) Alocular fat cells

Q.74 In human fibrous cartilage is found abundantly **[MP-PMT-2003]**
(1) Hyaline cartilage of joints
(2) Nostrils
(3) Intervertebral discs
(4) External ear

Q.75 Which of the following is enucleate **[MP-PMT-2003]**
(1) Squamous epithelial cell
(2) Mature human erythrocyte
(3) Mature human leucocyte
(4) Mature frog erythrocyte

Q.76 Which one of the following anticogulant is added in blood during storage **[MP-PMT-2003]**
(1) Sodium carbonate (2) Sodium oxalate
(3) Sodium chloride (4) Sodium hydroxide

Q.77 Blood clotting requires
(1) Na^+ and K^+
(2) Na^+ and prothrombin
(3) Na+ and thromboplastin
(4) Ca^{2+} and thromboplastin

Q.78 Mammalian pinna is supported by **[MP-PMT1995]**
(1) Hyaline cartilage (2) Calcified cartilage
(3) Elastic cartilage
(4) White fibrous connective tissue

Q.79 Bone marrow takes part in **[MP-PMT-1995]**
(1) Controlling blood pressure
(2) As haemopoietic tissue
(3) Assisting kidneys
(4) Assisting liver

Q.80 Agranulocytes are **[BHU-2000, Har. PMT-2000]**
(1) Eosinophils and neutrophils
(2) Monocytes and lymphocytes
(3) Eosinophils and lymphocytes
(4) Lymphocytes and basophils

Q.81 Platelets are a source of **[MP-PMT-1996]**
(1) Fibrinogen (2) Calcium
(3) Thromboplastin (4) Heamoglobin

Q.82 Which is unrelated to blood plasma is **[BHU1996]**
(1) Fibrinogen (2) Fibrin
(3) Bilirubin (4) Calcium

Q.83 Major component of blood plasma is **[AFMC-1996]**
(1) Water
(2) Inorganic Substances
(3) Organic substances
(4) Blood cells

Q.84 Connective tissue belongs to **[MP-PMT-1996]**
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) Any of the above

Q.85 Which one is unrelated **[MP-PMT-1996]**
(1) Keratin (2) Elastin
(3) Dextrin (4) Collagen

Q.86 Thromboplastin required for blood clotting is produced by
(1) Platelets (2) Erythrocytes
(3) Monocytes (4) Lymphocytes

Q.87 Maximum number of white blood corpuscles is that of **[DPMT-1996]**
(1) Basophils (2) Neutrophils
(3) Monocytes (4) Eosinophils

Q.88 Protein present in cartilage is **[MIPMT-1997,2000]**
(1) Cartilagin (2) Chondrin
(3) Ossein (4) Oesein

Q.89 Life span of human white blood corpuscles is **[AIPMT1997, JIPMER-2000]**

(1) 24 hours (2) Less than 10 days
(3) 120 days (4) 100 hours

Q.90 Which of the following is not a granulocyte **[AIPMT-1997]**

(1) Lymphocyte (2) Basophil
(3) Neutrophil (4) Eosinophil

Q.91 Which of the following are involved in body defence **[CET Chd. 1997]**

(1) Neutrophils (2) Lymphocytes
(3) Macrophages (4) All the above

Q.92 Ends of two long bones are connected' by **[MP-PMT-1997, CPMT-2000]**

(1) Cartilage (2) Muscles
(3) Ligaments (4) Tendons

Q.93 Largest corpuscles in human blood are **[MP-PMT-1997]**

(1) Erythrocyrtes (2) Monocytes
(3) Lymphocytes (4) Basophils

Q.94 Heparin is formed by **[BHU-1997]**

(1) Liver cells (2) Plasma cells
(3) Blood cells (4) Spleen cells

Q.95 Prothrombin, albumin and fibrinogen are synthesised by **[AFMC-1997]**

(1) Pancreas (2) Bone marrow
(3) Spleen (4) Liver

Q.96 Regeneration of cartilage can occur from its **[CPMT-1997]**

(1) Matrix (2) Plasma
(3) Perichondrium
(4) A piece without perichondrium

Q.97 Mast cells occur in **[MP-PMT-1997]**

(1) Connective tissue (2) Epithelial tissue
(3) Skeletal tissue (4) Nervous tissue

Q.98 Ground susbtance of connective tissue is formed of **[MP-PMT-1997]**

(1) Phospholipids (2) Lipids
(3) Monosaccharides
(4) Mucopolysaccharides

Q.99 Matrix of hyaline cartilage contains **[CPMT-1998]**

(1) Collagen (2) Chondrin
(3) Ossein (4) All the above

Q.100 Ends of long bones are covered by **[MP-PMT-1998]**

(1) Blood cells (2) Ligaments
(3) Muscles (4) Cartilage

Q.101 Erythrocytes of adult mammals are formed in **[AFMC-1998]**

(1) Spleen (2) Liver
(3) Bone marrow (4) Kidney

Q.102 Histamine is secreted by **[AIPMT-1998, CPMT-1998]**

(1) Mast cells (2) Histiocytes
(3) Lymphocytes (4) Fibroblasts

Q.103 Blood leucocytes are **[Pb.PMT-1998]**

(1) Epithelial (2) Endothelial
(3) Glandular (4) Connective

Q.104 Which one is a factor for maturation of erythrocytes **[AIPMT-1998]**

(1) Vitamin B_{12} (2) Vitamin A
(3) Vitamin D (4) Vitamin C

Q.105 Antibodies are **[MP PMT-1998]**

(1) Albumins (2) Gamma-globulins
(3) Sucrose (4) Vitamin C

Q.106 In which state iron is present in haemoglobin

(1) Unionic (2) Fe^{2+}
(3) Fe^{3+} (4) None of these

Q.107 White fibrous tissue is **[CPMT-1999]**

(1) Nervous (2) Muscular
(3) Ligaments (4) Tendons

Q.108 Loose conective tissue is **[CPMT-1999]**

(1) Areolar (2) Adipose
(3) Blood (4) Cartilage

Q.109 Ligament is **[AIPMT-1999]**

(1) Modified white fibrous tissue
(2) Inelastic white fibrous tissue
(3) Modified elastic connective tissue
(4) None of these

Q.110 Percentage of haemoglobin in RBCs is **[DPMT- 1999]**

(1) 10% (2) 20%
(3) 34% (4) 48%

Q.111 Immature RBCs of mammals have **[BHU-1999]**

(1) No nucleus
(2) Single beaded nucleus
(3) Many nuclei
(4) Single nucleus

Q.112 Megakaryocytes **[MP-PMT-2000]**

(1) Produce leucocytes
(2) Forms blood platelets
(3) Are carriers of oxygen
(4) Are carriers of oxygen

Q.113 During blood clotting, fibrin is produced by **[MP-PMT-2000]**

(1) Thrombokinase (2) Prothrombin
(3) Liver (4) Proteolysis

Q.114 Cartilage present in trachea, larynx and bronchi is **[AFMC-2000]**

(1) Fibrous (2) Elastic
(3) Hyaline (4) Calcified

Q.115 Number of erythrocytes per mm^3 of human blood is **[AFMC- 2000]**

(1) 4 million (2) 5 million
(3) 6 million (4) 0.5 million

Q.116 Number of WBCs per mm^3 of human blood is **[Pb. PMT-2000]**

(1) 8000 (2) 7000
(3) 6500 (4) 6000

Q.117 RBCs are nucleated in **[MP PMT1991, Pb PMT-2000]**

(1) Man (2) Rabbit
(3) Rat (4) frog

Q.118 Cartilage is **[Har. PMT-2000]**

(1) Nonvascular (2) Poorly vascular
(3) Highly vascular
(4) Irregularly vascular

Q.119 An anticoagulant is **[BV-2000]**

(1) Heparin (2) Hirudin
(3) EDTA (4) All the above

Q.120 Collagen and elastin are formed by **[Kerala- 2000]**

(1) Macrophages (2) Fibroblasts
(3) Mast cells (4) Chondrocytes

Q.121 The rarest leucocyte of human blood is – **[Kerala-2000]**

(1) Basophil (2) Monocyte
(3) Neutrophil (4) Eosinophil

Q.122 Blood plasma has a pH of **[Kerala 2000]**

(1) 7.4 (2) 7.8
(3) 6.9 (4) 6.3

Q.123 In Camel, the RBCs are **[Manipal-2001]**

(1) Oval and nucleated
(2) Circular, biconcave and nucleated
(3) Circular, biconcave and nonnucleated
(4) Oval and nonnucleated

Q.124 Bilirubin and biliverdin are derived from **[Manipal-2001]**

(1) Globulin (2) Heam
(3) Iron (4) Fat

Q.125 Protein required for coagulation of blood is **[Manipal-2001]**

(1) Haemoglobin (2) Globulin
(3) Fibrinogen (4) Albumin

Q.126 Globulin is **[BHU-2001]**

(1) Plasma protein
(2) Antigen
(3) Serum
(4) Found in lymphatic tissue

Q.127 Which is not a component of areolar tissue **[Karnataka-2001]**

(1) Macrophage (2) Plasma cell
(3) Schwann cell (4) Adipose cell

Q.128 Structure absent from fresh frozen blood plasma is **[BV-2001]**

(1) Immunoglobulin (2) Plasma
(3) Albumin (4) Platelets

Q.129 To prevent clotting, donor's blood is treated with **[Wardha-2001]**

(1) Sodium glycochotate
(2) Sodium citrate
(3) Heparin
(4) Sodium taurocholate

Q.130 Bones are mainly formed of **[AFMC-20001]**

(1) Calcuim and Magnesium
(2) Calcium and phosphorus
(3) Calcium and Sulphur
(4) Calcium and Iron

Q.131 Nasal septum gets damaged. Its recovery requires cartilage called – **[AIPMT-2001]**
(1) Fibrous cartilage (2) Elastic cartilage
(3) Hyaline cartilage (4) Calcified cartilage

Q.132 Which cartilage is present at the end of long bones – **[CPMT-2002]**
(1) Calcified cartilage (2) Hyaline cartilage
(3) Elastic cartilage (4) Fibrous cartilage

Q.133 Continuous bleeding from an injured part of body is due to deficiency of - **[CPMT-2002]**
(1) Vitamin–A (2) Vitamin–B
(3) Vitamin–K (4) Vitamin–E

Q.134 What will happen if ligaments are cut or broken – **[CPMT-2002]**
(1) Bones will move freely at joints
(2) No movement at joint
(3) Bone will become unfix
(4) Bone will become fixed

Q.135 Abnormal increase in number of RBC in blood is called – **[RPMT-2003]**
(1) Anaemia (2) Polycythemia
(3) Leukemia (4) Sarcoma

Q.136 Which one of the following contains the largest quantity of extracellular material – **[AIPMT-2003]**
(1) Striated muscle
(2) Areolar tissue
(3) Stratified epithelium
(4) Myelinated nerve fibres

Q.137 Liquid which remain after clotting of blood is called as – **[RPMT-2005]**
(1) Serum (2) Plasma
(3) Lymph (4) Blood

Q.138 Four healthy people in their twenties got involved in injuries resulting in damage and death of a few cells of the following. Which of the cells are least likely to be replaced by new cells – **[AIPMT-2005]**
(1) Osteocytes
(2) Liver cells
(3) Neurons
(4) Malpighian layer of the skin

Q.139 Which of the following substances, if introduced into the blood stream, would cause coagulation of blood at the site of its introduction – **[AIPMT-2005]**
(1) Thromboplastin (2) Fibrinogen
(3) Heparin (4) Prothrombin

Q.140 Examination of blood of a person suspected of having anemia, shows large, immature, nucleated erythrocytes without haemoglobin. Supplementing his diet with which of the following is likely to alleviate his symptoms? **[AIPMT-2006]**
(1) Thiamine
(2) Folic acid and cobalamine
(3) Riboflavin (4) Iron compounds

Q.141 Areolar connective tissue joins – **[AIPMT-2006]**
(1) Fat body with muscles
(2) Integument with muscles
(3) Bones with muscles
(4) Bones with bones

Q.142 Mast cell secrete – **[AIPMT-2006]**
(1) Hippurin (2) Myoglobin
(3) Histamine (4) Hemoglobin

Q.143 Which one of the following mammalian cells is not capable of metabolising glucose to carbon - dioxide areobically ? **[AIPMT-2007]**
(1) Red blood cells (2) White blood cells
(3) Unstriated muscle cells
(4) White blood cells

Q.144 In which one of the following preparations are you likely to come across cell junctions most frequently ? **[AIPMT-2007]**
(1) Hyaline cartilage (2) Ciliated epithelium
(3) Thrombocytes (4) Tendon

Q.145 Drop of each of the following is placed separately on four slides. Which of them will not coagulate ? **[AIPMT-2007]**
(1) Whole blood from pulmonary vein
(2) Blood plasma
(3) Blood serum
(4) Sample from the thoracic duct of lymphatic system

Q.146 Which one is the most abundant protein in the animal world ? **[AIPMT Pre 2012]**

(1) Haemoglobin (2) Collagen

(3) Insulin (4) Trypsin

Q.147 Compared to those of humans, the erythrocytes in frog are : **[AIPMT Pre 2012]**

(1) nucleated and with haemoglobin.

(2) very much smaller and fewer.

(3) nucleated and without haemoglobin.

(4) without nucleus but with haemoglobin.

Q.148 Select the correct statement regarding the specific disorder of muscular or skeletal system : **[AIPMT Pre 2012]**

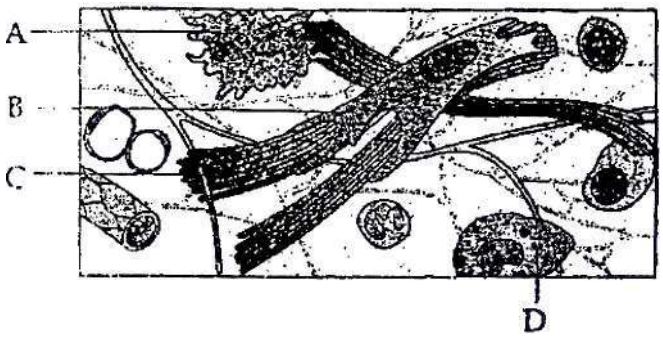
(1) *Oseoporosis* - decrease in bone mass and higher chances of fractures with advancing age.

(2) *Myasthenia gravis* - Auto immune disorder which inhibits sliding of myosin filaments

(3) *Gout* - inflammation of joints due to extra deposition of calcium.

(4) *Muscular dystrophy*-age related shortening of muscles.

Q.149 Given below is the diagrammatic sketch of a certain type of connective tissue. Identify the parts labelled A, B, C and D and select the right option about them.



Options : **[AIPMT Mains 2012]**

	Part–A	**Part–B**	**Part–C**	**Part–D**
(1)	Macrophase	Fibroblast	Collagen fibres	Mast cell
(2)	Mast cell	Macrophase	Fibroblast	Collagen fibres
(3)	Macrophase	Collagen fibres	Fibroblast	Mast cell
(4)	Mast cell	Collagen fibres	Fibroblast	Mcrophase

Q.150 Which one of the following pairs of chemical substances, is correctly categorised ?

[AIPMT Mains 2012]

(1)	Calcitonin and thymosin	Thyroid hormones
(2)	Pepsin and prolactin	Two digestive enzymes secreted in stomach
(3)	Troponin and myosin	Complex proteins in striated muscels
(4)	Secretin and rhodopsin	Polypeptide hormones

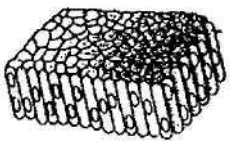
Q.151 The supportive skeletal structures in the human external ears and in the nose tip are examples of : **[AIPMT Mains 2012]**

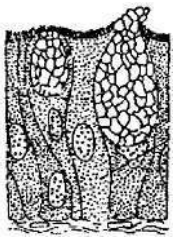
(1) ligament (2) areolar tissue

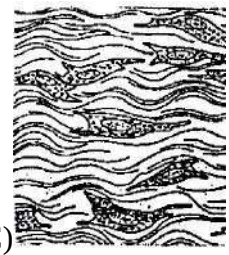
(3) bone (4) cartilage

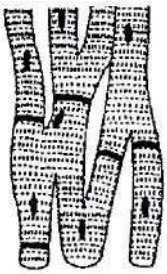
Q.152 The four sketches (A, B, C and D) given below, represent four different types of animal tissues. Which one of these is correctly identified in the options given, along with its correct location and function?

[AIPMT Mains 2012]

(A) 

(**B**) 

(C) 

(D) 

		Tissue	Location	Function
(1)	(B)	Glandular epithelium	Intestine	Secretion
(2)	(C)	Collagen fibres	Cartilage	Attack skeletal muscles to bones
(3)	(D)	Smooth muscle tissue	Heart	Heart contraction
(4)	(A)	Columnar epithelium	Nephron	Secretion and absorption

ANSWER KEY

EXERCISE – 3

Q.1	2	Q.2	1	Q.3	3	Q.4	4	Q.5	4	Q.6	2	Q.7	3
Q.8	1	Q.9	3	Q.10	3	Q.11	4	Q.12	4	Q.13	1	Q.14	2
Q.15	3	Q.16	2	Q.17	2	Q.18	3	Q.19	1	Q.20	1	Q.21	1
Q.22	1	Q.23	4	Q.24	4	Q.25	1	Q.26	1	Q.27	4	Q.28	3
Q.29	1	Q.30	2	Q.31	2	Q.32	1	Q.33	2	Q.34	2	Q.35	4
Q.36	1	Q.37	2	Q.38	1	Q.39	1	Q.40	1	Q.41	4	Q.42	1
Q.43	1	Q.44	4	Q.45	4	Q.46	1	Q.47	1	Q.48	1	Q.49	1
Q.50	1	Q.51	4	Q.52	2	Q.53	3	Q.54	2	Q.55	1	Q.56	2
Q.57	4	Q.58	3	Q.59	2	Q.60	1	Q.61	1	Q.62	1	Q.63	1
Q.64	2	Q.65	1	Q.66	2	Q.67	3	Q.68	1	Q.69	3	Q.70	3
Q.71	2	Q.72	4	Q.73	2	Q.74	3	Q.75	3	Q.76	2	Q.77	2
Q.78	4	Q.79	3	Q.80	2	Q.81	2	Q.82	3	Q.83	3	Q.84	1
Q.85	2	Q.86	3	Q.87	1	Q.88	2	Q.89	2	Q.90	2	Q.91	1
Q.92	4	Q.93	3	Q.94	2	Q.95	1	Q.96	4	Q.97	3	Q.98	1
Q.99	4	Q.100	2	Q.101	4	Q.102	3	Q.103	1	Q.104	4	Q.105	1
Q.106	2	Q.107	2	Q.108	4	Q.109	1	Q.110	3	Q.111	3	Q.112	1
Q.113	2	Q.114	2	Q.115	3	Q.116	2	Q.117	1	Q.118	4	Q.119	1
Q.120	4	Q.121	2	Q.122	1	Q.123	1	Q.124	1	Q.125	1	Q.126	3
Q.127	1	Q.128	3	Q.129	4	Q.130	2	Q.131	2	Q.132	3	Q.133	2
Q.134	3	Q.135	3	Q.136	2	Q.137	2	Q.138	1	Q.139	3	Q.140	1
Q.141	2	Q.142	2	Q.143	3	Q.144	1	Q.145	2	Q.146	3	Q.147	2
Q.148	1	Q.149	1	Q.150	3	Q.151	3	Q.152	4	Q.153	1		

Instruction for following questions :

Each of the questions given below consists of Assertion and Reason. Use the following Key to choose the appropriate answer.

(A) If both Assertion and Reason are correct, and Reason is the correct explanation of Assertion.

(B) If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

(C) If Assertion is correct but Reason is incorrect.

(D) If Assertion is false but Reason is correct.

Q.1 **A :** Lymphocyte cells of connective tissue proper are called as cart wheel cells.
R : Lymphocytes cell is largest cell of connective tissue proper.

Q.2 **A :** Lymphocytes are the largest corpuscles.
R : Nucleus of lymphocyte is large and kidney shape.

Q.3 **A :** Ureter and Urinary bladder are lined with Transitional Epithelium.
R : Transitional Epithelium rest directly on Connective tissue.

Q.4 **A :** Cardiac muscle have striations and fibre is nucleated and involunlary.
R : Intercalated disc form three dimensional network of cardiac muscle fibre.

Q.5 **A :** Perikaryon contains neurofibrils.
R : Neurofibril in soma are responsible for afferent & efferent conduction.

Q.6 **A :** Multipolar neurons have several efferent process.
R : Axons are the afferent processes of a neuron.

Q.7 **A :** Calcified cartilage is formed by the calcification of hyaline cartilage.
R : Calcified cartilage is the strongest cartilage.

Q.8 **A :** Blood circulation is absent in Epithelium Tissue.
R : Blood vessels are unable to pierce Basement membrane.

Q.9 **A :** Mesenchymal cells are undifferentiated cells of Connective Tissue.
R : Their function is formation of other cells of Connective Tissue Proper.

Q.10 **A :** Reticular fibres connective Tissue is called as embryonic tissue.
R : Reticular fibrous connective tissue is mainly found in embryonic stage.

Q.11 **A :** New Born baby is resistant for cold.
R : The immune system of new born baby is very well developed.

Q.12 **A :** Simple columnar epithelium is also called as Germinal epithelium.
R : Columnar cells of gonads forms gametes.

Q.13 **A :** Epithelia are highly regenerative.
R : When epthelia get damaged, they regenerate more rapidly than other Tissue.

Q.14 **A :** Platelets play an important role in blood clotting.
R : In the blood oozing from an injury the platelets disintegrate and release thromboplasm that initiates clotting.

Q.15 **A :** Blood group 'O' is a universal donar blood.
R : Antiboidies of blood group are absent in blood group 'O'.

Q.16 **A :** Bone and cartilage are rigid connective tissue.
R : Blood is a connective tissue with matrix.

Q.17 **A :** Where a man usually travel in aeroplane RBC count increase in his body.
R : At high attitude production of vit. increase and percentage of haemoglobin is increase.

Q.18 **A :** Glands originate from all germinal layers.
R : All glands are composed of epithelial tissue.

Q.19 **A :** Brown fat produce more energy.
R : Brown fat composed of monolocular adipocyte.

Q.20 **A :** Simple cuboidal epithelium is called as germinal epithelium.
R : Cuboidal cells of gonads forms gametes.

Q.21 **A :** Mucoid connective tissue is called embryonic tissue .
R : Mucoid connective tissue is mainly form in embryonic stage.

Q.22 **A :** During embryonic development mother gives to child IgG.
R : IgG is able to cross placenta.

Q.23 **A :** Platelets repair damage endothelium of blood vessels
R : Platelets secrete serotonin which is a constrictor.

Q.24 **A :** Rh factor is considered in blood transfusion.
R : Rh antigen may leads agglutination of blood.

Q.25 **A :** Heparin is a anticoagulant found in mammals.
R : Heparin prevent conversion of Prothrombin to Thrombin.

Q.26 **A :** Epithelium cells get their nutrients from Adjacent cells.
R : In epithelium tissue large intercellular spaces are present.

Q.27 **A :** Urinary Bladder is lined by transitional epithelium.
R : Transitional epithelium keeps the size of the bladder constant at all times.

Q.28 **A :** Patella bone of knee is a sesamoid bone.
R : Skull bones and clavical bone are membranous bones.

Q.29 **A :** Epiphysis of long bone is haemopoietic.
R : In epiphysis yellow bone marrow is present which produce blood corpuscles.

Q.30 **A :** A woman of blood group AB when married to an 'O' group man will never get an AB group child.
R : Gene of blood group 'O' is dominent over the gene of blood group A, B or AB.

Q.31 **A :** Perichondrium is a white fibrous connective tissue.
R : Perichondrium is a connective tissue.

Q.32 **A :** Fibrous cartilage posses thick dense bundle of collagen fibre in matrix,
R : Fibrous cartilage is the hardest cartilage.

Q.33 **A :** All diploic bones of body are haemopoietic.
R : Red bone marrow is present in the diploic bone.

Q.34 **A :** Most bones body are cartilaginous.
R : Connective tissue originated first during embryonic development.

Q.35 **A :** Squamous epithelium helps in glomerular filtration.
R : It forms inner lining of Bowman's capsule.

Q.36 **A :** Deficiency of vitamin B_{12} and folic acid can cause anaemia.
R : Vitamin B_{12} and folic acid are essential for maturation of RBC.

Q.37 **A :** Prothrombinase enzyme act as antiheparin.
R : Heparin prevent coagulation of blood in Blood vessels.

Q.38 **A :** Lower most layer of stratified tissue is known as Germinative layer.
R : Lower most layer of stratified tissue is mostly cuboidal in shape and rest directly on connective tissue.

Q.39 **A :** Cells of epithelium tissue rest on a thin basement membrane.
R : Basement membrane has both fibrous and basal lamina part secreted by connective tissue and epithelial tissue respectively.

Q.40 **A :** Origin wise hair are epithelial tissue which are of ectodermal origin.
R : Epithelial tissue can be formed from mesoderm and endoderm also.

Q.41 **A :** Most of the human haemoglobin in our body has $2\alpha 2\beta$ polypeptide chains.

R : Haemoglobin is a conjugate protein and has 4 polypeptide chain in its one globin molecules.

Q.42 **A :** During contraction both half I-bands and A-band disappears.

R : Sarcolemma is a real contractile unit found between two Z-lines.

Q.43 **A :** Mammary glands are apocrine glands.

R : The product of secretion is shed with the whole cell leading to its destruction

Q.44 **A :** Human bone has haversian canals.

R : Haversion canals are interconnected by Volkmann's canal.

Q.45 **A :** In non-keratinished stratified squamous epithelium stratum corneum is absent.

R : Such epithelium occus over surface which are not exposed to drying but are subject to abrasions.

Q.46 **A :** Plasma cells give cart wheel appearance to the nucleus.

R : Nucleus contains peripheral clumps of heterochromatin.

Q.47 **A :** Yellow bone marrow is reserve erythropoietic tissue.

R : After severe bleeding yellow marrow may convert to red marrow.

Q.48 **A :** muscle cells are also called myofibrils

R : muscle cells are very thin and short.

Q.49 **A :** deficiency of proteins lead to poor healing of wounds.

R : plasma proteins immunoglobulins play a major role in the healing of wounds.

Q.50 **A :** smooth muscle fibres do not appear to be striated

R : this is due to regular alternate arrangement of thick and thin filaments in smooth muscle fibre.

Q.51 **A :** non-straited muscles are said to be voluntary in nature.

R : non-straited muscle can be moved according to will.

Q.52 **A :** cardiac muscle have striations and fibre is nucleated and involunlary.

R : intercalated disc form three dimensional network of cardiac muscle fibre.

Q.53 **A :** during contraction both half i-bands and a-band disappears.

R : sarcolemma is a real contractile unit found between two z-lines.

ANSWER KEY

EXERCISE – 4

Q.1	4	Q.2	4	Q.3	2	Q.4	3	Q.5	1	Q.6	4	Q.7	3
Q.8	3	Q.9	1	Q.10	4	Q.11	3	Q.12	4	Q.13	1	Q.14	1
Q.15	3	Q.16	2	Q.17	4	Q.18	1	Q.19	3	Q.20	1	Q.21	1
Q.22	1	Q.23	2	Q.24	1	Q.25	1	Q.26	4	Q.27	2	Q.28	2
Q.29	3	Q.30	3	Q.31	1	Q.32	3	Q.33	1	Q.34	3	Q.35	1
Q.36	1	Q.37	2	Q.38	3	Q.39	2	Q.40	2	Q.41	2	Q.42	4
Q.43	3	Q.44	2	Q.45	1	Q.46	1	Q.47	1	Q.48	4	Q.49	3
Q.50	2	Q.51	4	Q.52	3	Q.53	4						

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

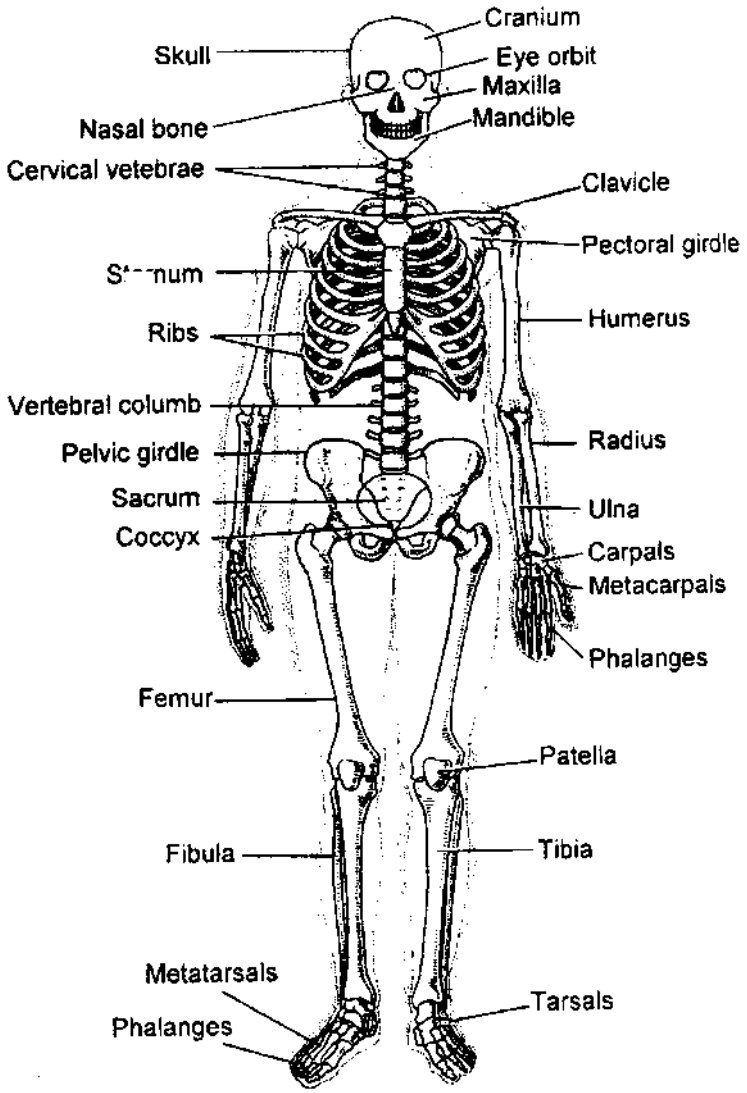
<u>Advantages</u>

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

SKELETAL SYSTEM

DEFINITION AND INTRODUCTION

- The hard protective or supportive part of the animal constitute **skeletal system**.
- Study of skeleton is called **Osteology or Skeletology**.
- Design of the skeleton depends on the animals mode of life.
- Skeleton of different design are needed for the aquatic or terrestrial animals.



Endoskeleton Framework of man

TYPES OF SKELETON

On the basis of location skeleton is of two types-

(1) Exoskeleton

(2) Endoskeleton

1. Exoskeleton

- It is formed by secretion of the skin from epidermis.
- It is always non living.
- It is found in invertebrate as well as vertebrate.
- It is composed of a non-living protein material called **keratin** or **horn**.

Epidermal exoskeleton

- Scales of reptiles are epidermal exoskeleton.
  Exception - Crocodile and Tortoise. (mesodermal in origin)
- Beak, claws, horn hoof, feathers, hairs and nail are epidermal exoskeleton.

Dermal exoskeleton

- Scales of fishes, crocodile and tortoise are dermal exoskeleton.

2. Endoskeleton

- The endoskeleton includes hard parts present inside the body. The bone and cartilage are example of endoskeleton.
- It is always living.
- Some invertebrate like, corals, cuttle fish and Echinodermata also possess endoskeleton.

TOTAL NUMBER OF BONES

In adult total number of bones are	-	206
Axial skeleton	-	80
Appendicular skeleton	-	126
		206

In neonates total number of bones are - 306

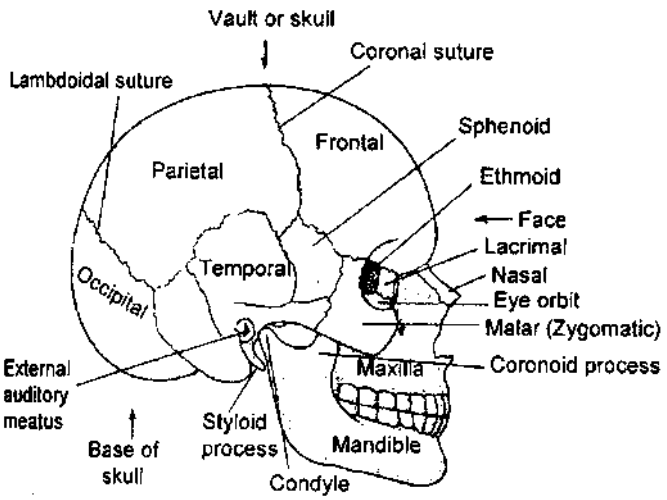
On the basis of the position of skeletal structure in the body Skeleton system is divided into 2 parts-

AXIAL SKELETON

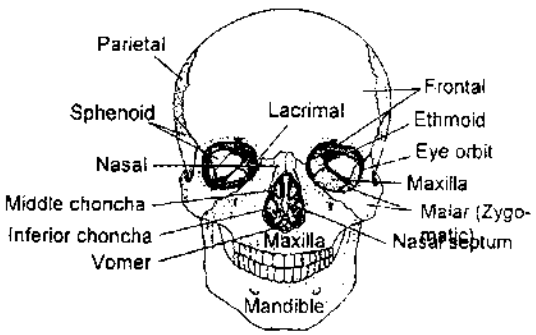
It is present on the median **longitudinal axis of the body**. It consists of -

- Skull
- Ribs
- Sternum
- Vertebral column

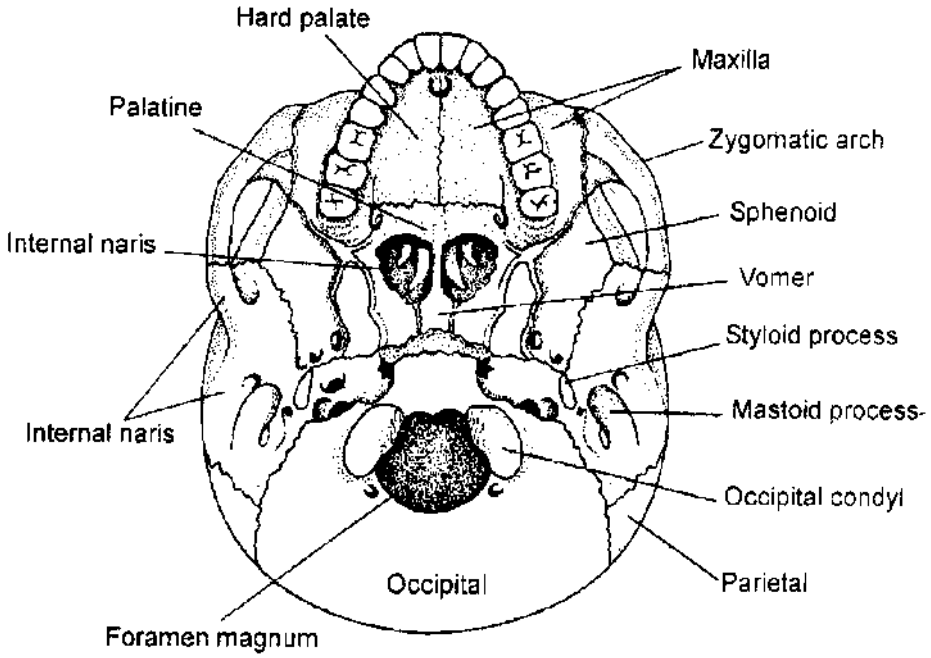
SKULL



HUMAN SKULL VIEWED FROM RIGHT SIDE



HUMAN SKULL VIEWED FROM IN FRONT



HUMAN SKULL VIEWED FROM BELOW

- Skull with two occipital condyles is called dicondylic. Human skull is **dicondylic**.
- Skull is formed of 29 bones.
- In rabbit 53 bones are found in skull.
- Skull is composed of **4 portions**.
  (A) Cranium
  (B) Face
  (C) Hyoid
  (D) Sensory capsule

A. Cranium

- It is also called brain box.
- It is large and hollow round part of skull which encloses and protects the brain in the **cranial cavity**.
- It has large opening **foramen magnum** at the posterior end , through which brain is continuous with spinal cord.
- Cranium is composed of 8 bones, which are as follows :

Frontal	-	1
Parietals	-	2
Temporal	-	2
Occipital	-	1
Sphenoid	-	1
Ethmoid	-	1
		8 bones

- These bones are joined by immovable fibrous joints called **Sutures**.

Coronal Suture lies between frontal and parietal.

Lambdoidal suture lies between parietal and occipital bones.

Sella Turcica - depression in sphenoid bone of skull that lodges pituitary body.

largest foramen - foramen magnun which is present below brain box, through it the spinal chord comes out.

B. Face

Face is composed of 14 bones which are as follows -

Maxillae	-	2
Palatine	-	2
Nasals	-	2
Lacrymals	-	2
Inferior turbinal	-	2
Zygomatic/malar bones	-	2
Vomer	-	1
Maldible	-	1
		14 bones

Note :

Mandible is movable to allow mastication and speech.(Only Movable bone apart from ear ossicles.) In its posterior part a pair of condyle are present which fit in the cavity of temporal bone, so the lower jaw attaches with the cranium. This type of suspension is called craniostylic.

C. Hyoid bone

- It is also called **tongue bone**.
- It is situated in the wall of the upper part of the throat, just above the larynx.

D. Sensory capsule

Ear is surrounded by bony auditory capsules, middle ear has 3 movable ear ossicles

(i) Maleus (Modification of articular bone)

(ii) Incus (Modification of Quadrate bone)

(iii) Stapes (smallest bone of body) modification of Hyomandibular bone.

RIBS

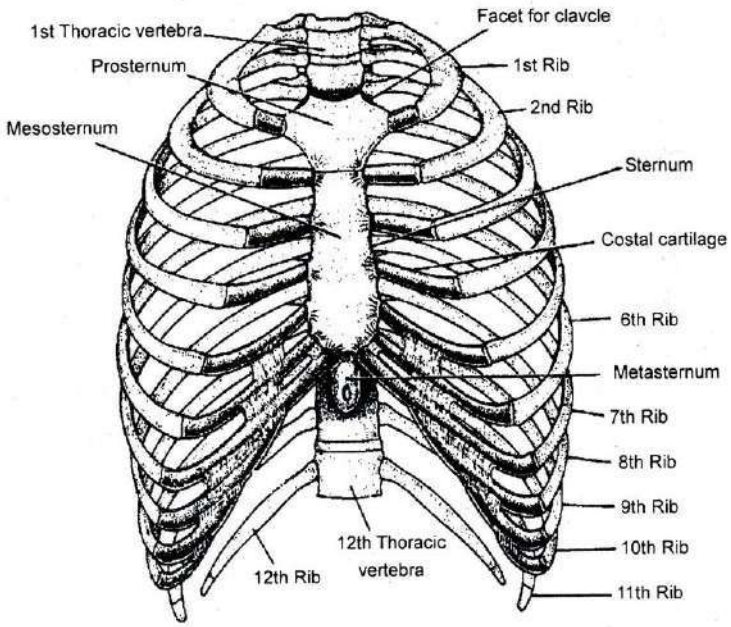
- There are 12 ribs on each side of thoracic cage
- First 7 which are connected throuhg cartilage to the sternum are called **True Ribs.** (Vertebrosternal ribs)
- Remaining 5 are **False Ribs,** out of these cartilage of the 8th, 9th & 10th ribs are joined to the next higher cartilage, 8th, 9th, 10th are called Vertebrochondral ribs. The anterior ends of 11th & 12th ribs are free & are called **floating ribs**.
- **Head -** Has two parts. Lower part articulates with numerically corresponding vertebrae
- While the upper part articulates with higher vertebrae.

Costal Cartilages

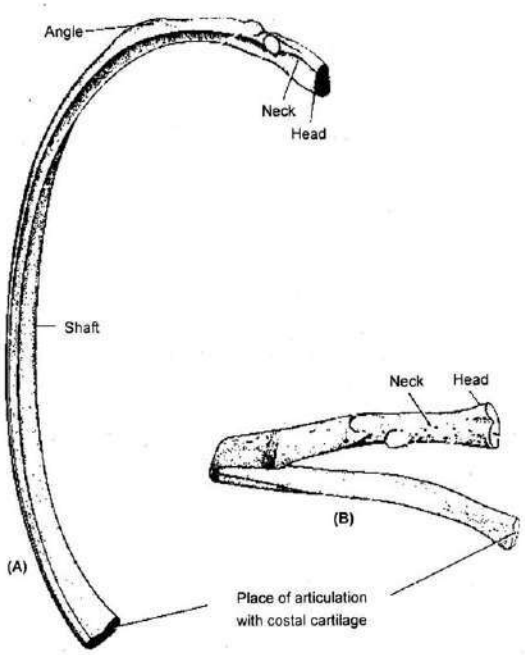
- Unossified anterior parts of ribs made of hyaline cartilage. These contribute to the elasticity of thoracic wall.

- Medial ends of CC of first seven ribs are directly attached to sternum.
- 8th, 9th & 10th CC articulate with one another. The cartilage of 11^{th} & 12^{th} ribs are small. Theri ventral end are free and lie in the muscle of abdominal wall.

Note : Like human in rabbit also 12 pairs of ribs are found.



Bones of thorax (front view)



A typical rib of left side
A - inferior aspect ; B – Posterior aspect

STERNUM

- It is also called **breast bone**.
- It is 15 cm long in man.
- In embryo sternum is made up of a series of bone called **sternebra**. In rabbit there is 7 sternebra while in human there is 3 sternebra.
- It is composed of 3 parts -

Manubrium	- Upper part
Body	- Middle part (It is largest part)
Cartilaginous Xiphoid (Xiphisternum)	- Lower part

Note : Sternum is absent in fishes.

VERTEBRAL COLUMN

General facts

- Presence of vertebral column is characteristic feature of vertebrates.
- It is also called **spinal column** or **backbone**.
- The component of vertebral column are called vertebrae. Vertebrae of man is acoelus (centrum is flat with cavity)
- In between vertebrae pads are found which are composed of fibrocartilage, called **intervertebral pads**.

These pads or disc acts as shock absorber.

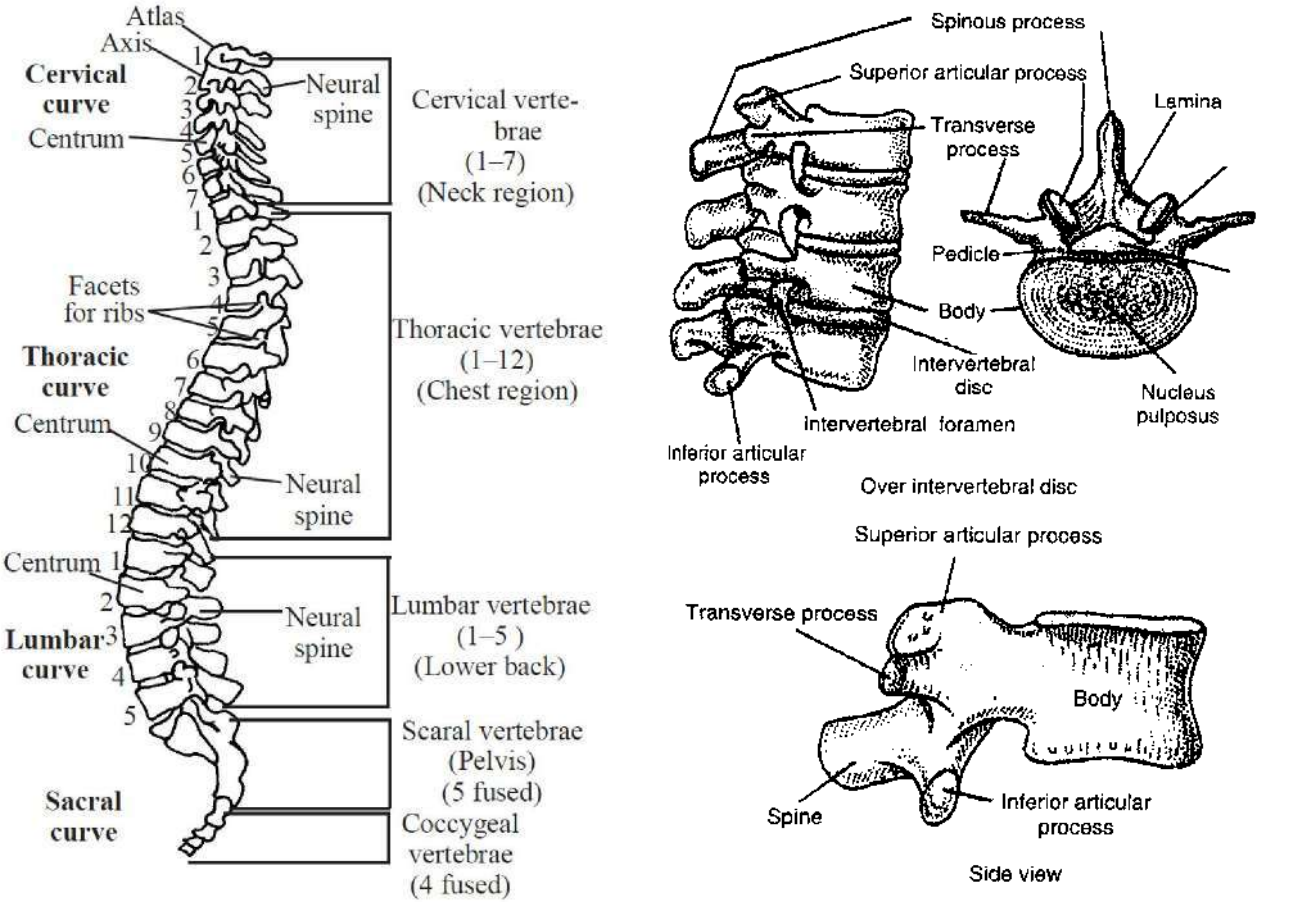


Fig.: Human vertebra with intervertebral foramina

- **Vertebral formula of man**

  The vertebral formula is $C_7T_{12}L_5S_{(5)}Co_{(4)}$ = 33 vertebrae.

- **Vertebral formula of rabbit**

  The vertebral formula is $C_7T_{12}L_7S_4Co_{16}$ = 46 vertebrae.

- **Basic structure of vertebrae**

(i) A vertebrae is typically a bony ring.

(ii) The two main portion of vertebrae is disc like **centrum or body** and **neural arch**.

(iii) Within neural arch a hole is found is called **vertebral foramen**. The vertebral formen of all the vertebrae when intact form a **vertebral canal**, that encloses the spinal cord.

Note :

Centrum of man is flat with no cavity, such centrum is called **Acoelus** or **Amphiplatyn**.

- **Functions of vertebral column**

(i) It encloses and protects the spinal cord.

(ii) It carries the weight of the body.

(iii) It helps in upright posture and locomotion.

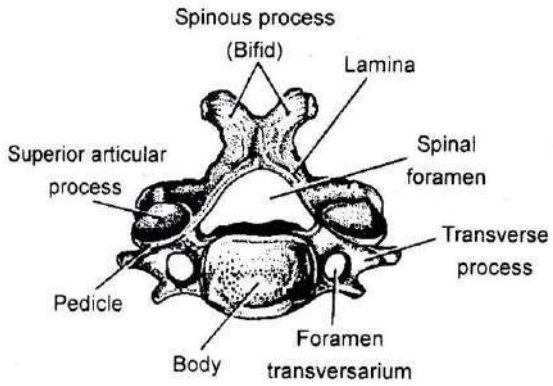
(iv) It helps in free movement of the head.

Groups of vertebrae

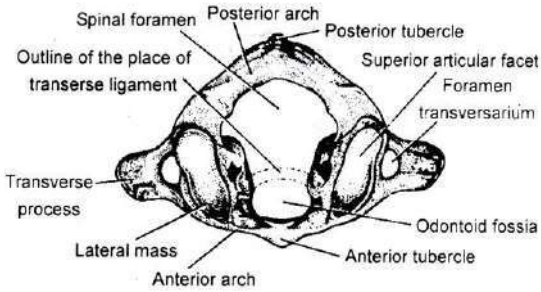
The vertebrae of vertebral column can be put in 5 groups, according to their location, which are as follows-

1. Cervical vertebrae

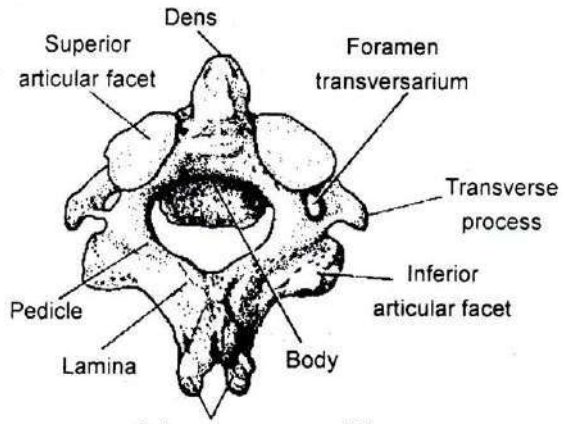
- Cervical vertebrae are present in neck.
- They are 7 in number. In most mammal number of cervical vertebrae is 7



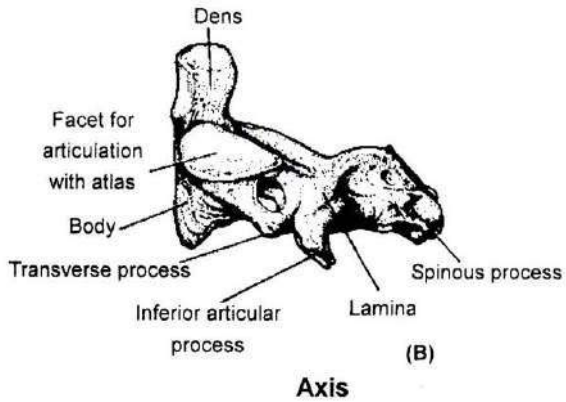
A typical cervical vertebra (superior aspect)



ATLAS



Axis



Axis

- All cervial vertebrae have apertures in their transverse process (**Foramina transversalis** which form vertebraterial canal on either side for vertebral artery to pass through to supply brain & posterior spinal cord).
- **C_1 & C_2** = Atypical, **C_3 to C_7 =** typical
- **Atlas : -** Transverse process are wing like, centrum is absent, Ring like.
- Neural arch of this vertebrae is divisible in 2 parts with a ligament. In the upper part of the ligament, Spinal cord is present. In lower part odontoid fossa is present in which odontoid process of axis is fitted to make pivot joint. (Also called as median atlanto axial joint)
- On each surface of atlas a pair of articular process are present. The upper pair articulates with condyle of skull to form Rt & Lt Atlantooccipital joints.
- Lower pair articulates with superior Articular process of axis to make Rt & Lt **Lateral atlanto axial joints.**
- Axis : C_2 - Centrum is present. At anterior surface of centrum a long odontoid process is present which fits into odonotoid fossa of atlas vertebrae.
- Only C_7 has demifacets where upper part of head of 1st Rib articulates.

Note : Cervical vertebrae are 7 in all mammals is despite of long or small neck.

2. Thoracic vertebrae

- Thoracic vertebrae are present in chest.
- They are 12 in number.
- Presence of costal demifacets helps in their identification

3. Lumbar vertebrae

- Lumbar vertebrae are present in the abdomen.
- They are 5 in number.
- Lumbar vertebrae are largest and heaviest.

4. Sacral vertebrae

- They are 5 in number.
- The 5 sacral vertebra fuse to form single bone.

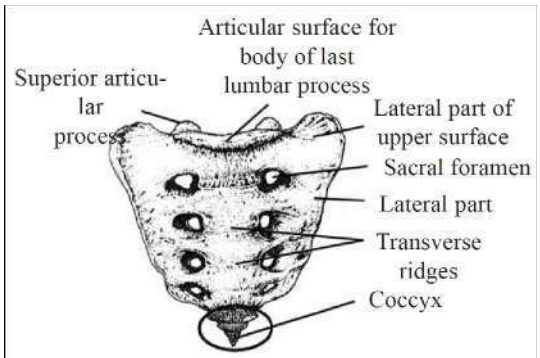
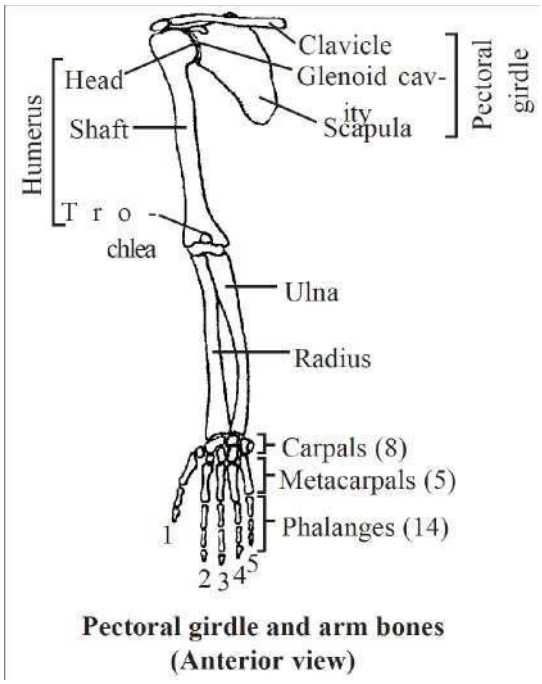


Fig.: Sacrum of man

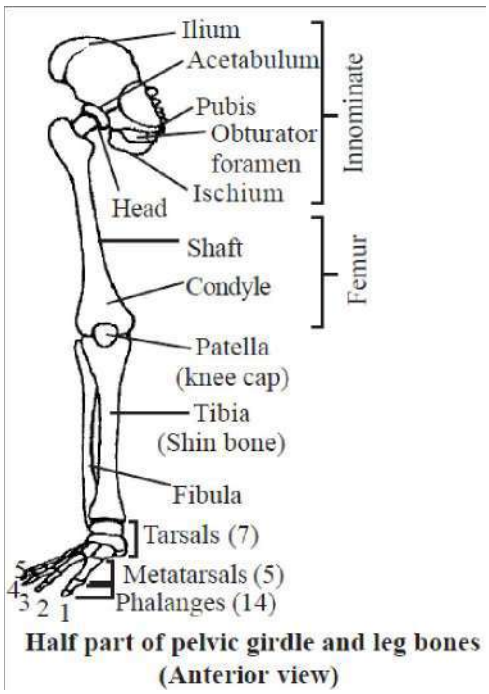
5. Coccygeal vertebrae

- These are 4 in number.
- The 4 vertebrae fuse to form curved and triangular bone, called the **coccyx** or **tail bone**.

APPENDICULAR SKELETON



Pectoral girdle and arm bones (Anterior view)



Half part of pelvic girdle and leg bones (Anterior view)

It is situated at lateral sides which extends outward from the principle axis. It is of composed of -

– Girdle bones
– Limb bones

- **Girdle bones**

These are of 2 types-

(A) Pectoral girdle (B) Pelvic girdle

(A) Pectoral girdle

Pectoral girdle is formed of two bones **clavicle** and **scapula**.

Clavical is also called collar bone.

Scapula is also called shoulder bone or shoulder blade. It is flat and triangular structure present at the back of shoulder.

At the junction of clavical and scapula a depression is found in the scapula called **glenoid cavity**.

In a glenoid cavity head of humerus fits to form shoulder joint.

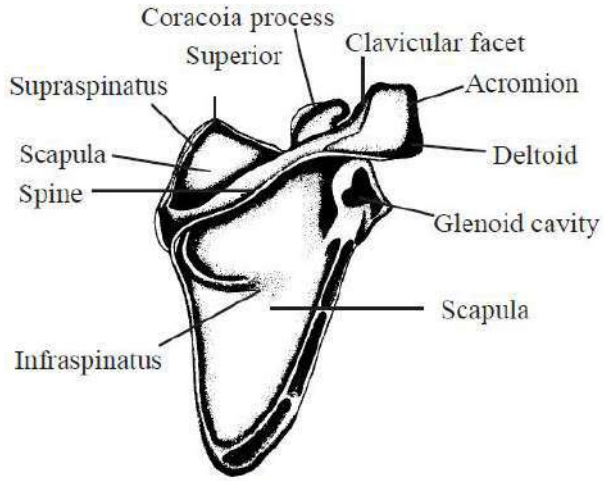


Fig. Scapula-Pectoral Girdle

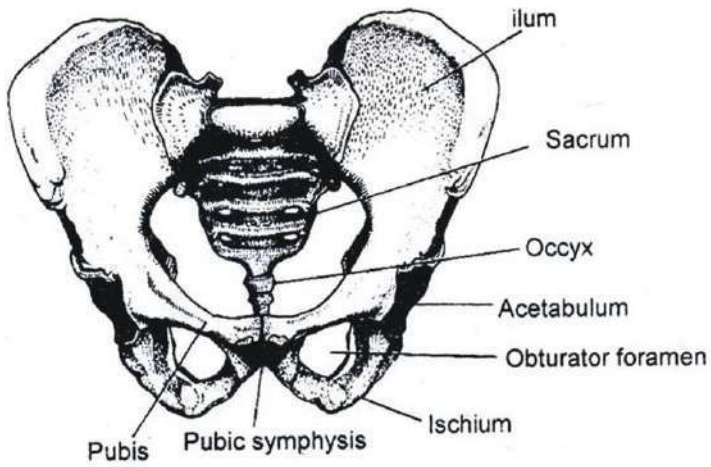
(B) Pelvic girdle

- It is also called hip girdle.
- It is composed of 3 bones, which are as follows-

Ilium	-	Upper side
Pubis	-	Inner side
Ischium	-	Below the pubis

- At the junction of these 3 bones, a depression is found. Which is called **acetabulum**.

  Femur fits in acetabulum to form hip joint.
- The pelvic girdle of female are broader than male.



Human pelvis from anterior aspect

- **Limb Bones**
  - **Bones of fore limb**

In each fore limb total 30 bones are found-

Upper arm	-	Humerus	-	1
Fore arm	-	Radius (outer) ulna (inner)	-	2
Wrist	-	Carpals	-	8
Palm	-	Metacarpals	-	5
Fingers	-	Phalanges	-	14
				30

Phalangeal formula for human hand is 2,3,3,3,3.

The Humerus

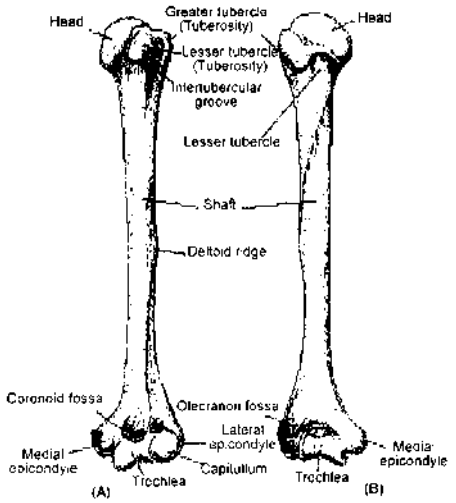
- Head : It articulates with the glenoid cavity of scapula to form shoulder joint.
- Deltoid ridge : Elevated rough part on the shaft here deltoid muscle is attached.
- Lower end : Articulated laterally with radius & medialy with ulna
- Coronoid fossa : depression just above the anterior aspect of trochlea. It accomodated the Coronoid process of ulna when elbow is flexed.
- Olecranon fossa : It accomodatee the olecranon process of ulna when Elbow is extended.

The Radius & Ulna

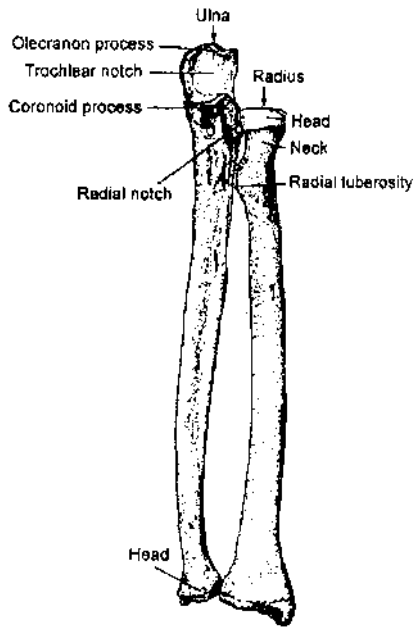
- **Radius :** Its head is disc shaped, covered with hyaline cartilage. it's superior concave surface articulates with the capitulum of humerus at the elbow joint.
- Circumference of head is also articular, it fits into socket formed by the radial notch of the ulna to form radioulanar joint.
- Olecranon process : Projects upwards from shaft of ulna. It is responsible for making elbow joint hinge.

Carpal Bones

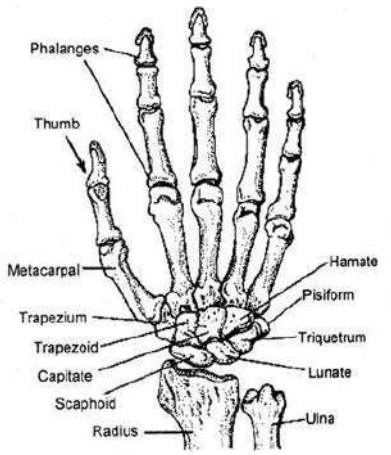
- Proximal Row : From lateral to medial - Scaphoid, lunate, triquetrum, pisciform
- Distal Row : Trapezium, trapezoid, capitate, Hammate.
- **Metacarpal bones :** 5 bones, numbered lateral to medial.
- **Phalanges :** There are 14 phalanges in each hand. 3 for each finger & for the thumb.



Left humerus from anterior (A) and posterior (B) aspects



Bones of left forearm (anterior aspect)



Bones of right hand and wrist

Bones of hind limb

In each hind limb total 30 bones are found.

Thigh	-	Femur	-	1
Shank	-	Tibia (inner)	-	2
		Fibula (outer)		
Ankle	-	Tarsals	-	7
In step	-	Metatarsal	-	5
Toes	-	Phalanges	-	14
Knee joint	-	Patella (Knee cap)	-	1
				30

Femur

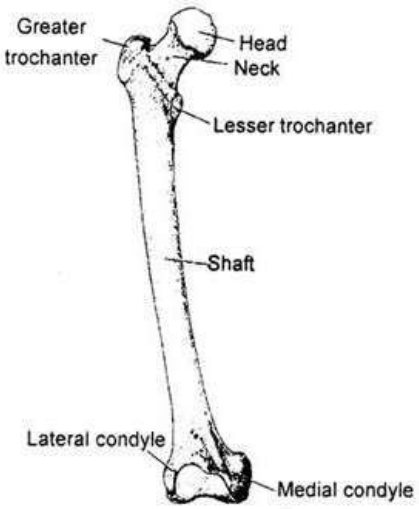
- Strongest heaviest and largest bone
- Articulates with acetabulum to form the hip joint.
- Lower end of femur is widely expanded to form two large condyles, one medial & one lateral.
- **Greater and lesser trochanter** are rough projections to provide attachement to muscles.

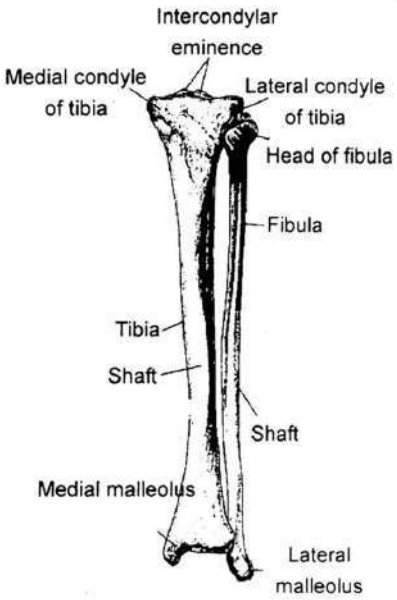
Tibia

- Medial & larger bone of the leg.
- **Upper end :** Expanded from side to side fo from two large condyles.
- **Medial condyle :** Its superior surface articulates with medial condyle of femur.
- **Lateral condyle :** Superior surface of condyle articulates with lateral condyle of femur.

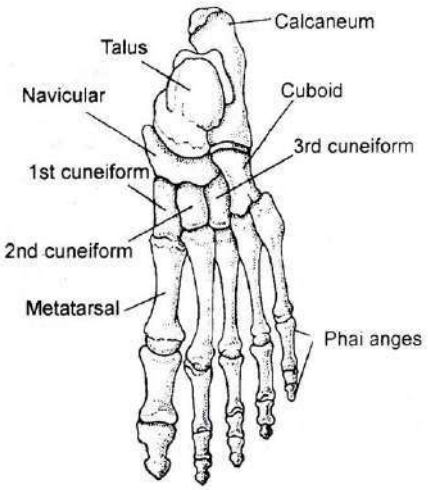
Fibula

- Lateral & smaller bone of the leg.
- Its upper end articulates with the lateral condyle of tibia.





Left tibia and fibula (anterior aspect)



Bones of left foot (Upper aspect)

Tarsus

- Tarsus is made of seven tarsal bones arranged in two rows.
- **Proximal row :** Talus above, Navicular in between and Calcaneum below. Tarsal bones are larger & stronger than carpal bones becuase they have to support & distribute body weight.

  Talus is second largest tarsal bone, lies between tibia above & calcaneum below.

  Calcaneum : Largest tarsal bone, forms the prominence of heal.
- **Distal row :** Four tarsal bones lying side by side (three cuneiform and one cuboid)

Meta tarsus

- Made of 5 meta tarsal bones which are **numbered medial to lateral.**

Phalanges

- 14 Phalanges, 2 for great tow & 3 each for each othe four toes.
- As compared to Phalanges of hand these are small in size.
- Phalangeal formula for human foot is 2, 3, 3, 3, 3.

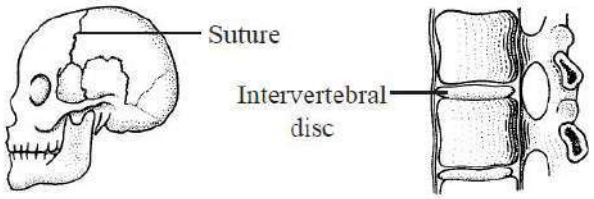
JOINTS

Study of joints is called **Arthrology**.

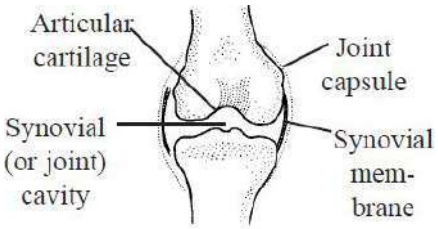
Types of joints

Joints are mainly of 3 types-

1. Immovable or fibrous joints / Synarthroses
2. Slightly movable or cartilaginous joints / Amphiarthroses.
3. Freely movable or synovial joints/Diarthroses



Synarthroses Amphiarthroses



Diarthroses

- **Structural Classification :**

(A) Fibrous joints (Immovable) : Also called as Synarthrosis.

(i) Sutures : Eg. Skull

(ii) Syndesmosis : Bones are connected by interosseus ligament e.g. inferior tibio fibular joints.

(iii) Gomphosis : (Peg & Socket) – e.g. tooth in its socket

(B) Cartilagenous joints (Slightly movable) : also called as amphiarthrosis

(i) **Primary :** hyaline cartilage joints (synchondrosis). After certain age the cartilage is replaced by bone e.g. jointbetween Epiphysis & Shaft.

(ii) **Secondary :** (Symphysis) fibro cartilagenous joints. Articular surface are covered by a thin layer of hyaline cartilage & united by a disc of fibro cartilage. there joint are persistant throughout life. e.g. Symphysis pubis, intervertebral joint.

(C) Freely movable or Synovial joint : also called as **diarthrosis**.

- The ends of both the bones are covered by **hyaline cartilage or articular cartilages**.
- The cartilage provides smooth and elastic surface and reduce friction and acts as shock absorber.
- In between two bones a space is found called **synovial space or cavity**. This space provides free movement to the bone.
- The synovial cavity is lined by a synovial membrane. Synovial membrane contains secretory cells. Synovial membrane secrete or fluid called **synovial fluid.**

  Synovial fluid lubricates and nourish the joints.

- **Type of Synovial joints : (Most mobile) :**

(a) **Plain synovial or gliding joint :** Permit slight gliding movement e.g., joint between articular processes of vetebrae and joints between Carpals.

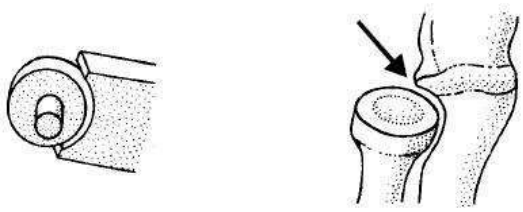
(b) **Hinge joint :** Movements are permitted in one plane around transverse axis e.g. elbow, ankle, intephalangeal joint.

Hinge joints

(c) **Pivot joint :** Articular surfaces comprise of

- a central bony pivot

- surrounded by osteoligamentous ring movement are permitted in one plane around vertical axis. e.g. radioulnar joint, median atlanto axial joint.

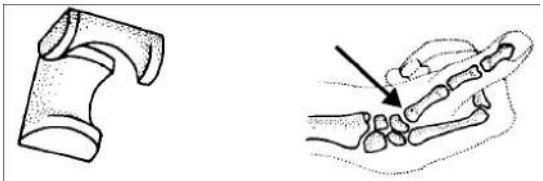


Pivot or rotating joints

(d) **Condylar joint :** Articular surface include two distinct condyles and movement are permitted in both transverse & vertical axis. Rt & left jaw joint.

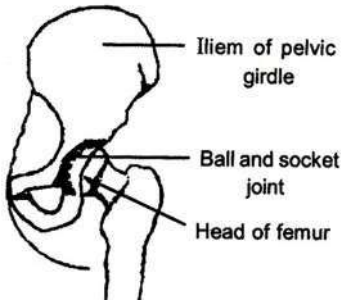
(e) **Ellipsoid joint :** e.g. wrist, Metacarpophalengeal joint. movement are permitted in both axis, but articular surfaces are not in form of condyles.

(f) **Saddle joint :** Articulating surface are reciprocally concavo convex. these are improperly developed ball & socket joints e.g. first carpometacarpal joint and calcaneocuboid joint.



Saddle joints (Biaxial joints)

(g) **Ball & socket joint :** Here one articular surface is like a ball and other of the shape of socket and movements are possible around infinte axises. e.g. shoulder & Hip joint.



ROLE OF MUSCLES AND BONES IN MOVEMENT

(i) Movement of an organ occurs due to the pulling of the bones caused by force generated due to contraction in muscles. Movements take place along the joints which act as fulcrum of the lever.

(ii) Three types of lever functioning can be observed in movements of human joints .

(A) Class I lever : Here Fulcrum is between effort & resistance.

Example : Joint between the first vetebra (ATLAS) and occipital bone of skull.

Fulcrum : is the joint

Effort : is contraction of back muscles.

Resistance : Weight of the facial bone of skull.

(B) Class II lever : Here resistance is between effort Y fulcrum.

Example : Human body restingh on toe.

Fulcrum : Is the toe

Effort : Is contraction of calf muscle.

Resistance : Is body Weight.

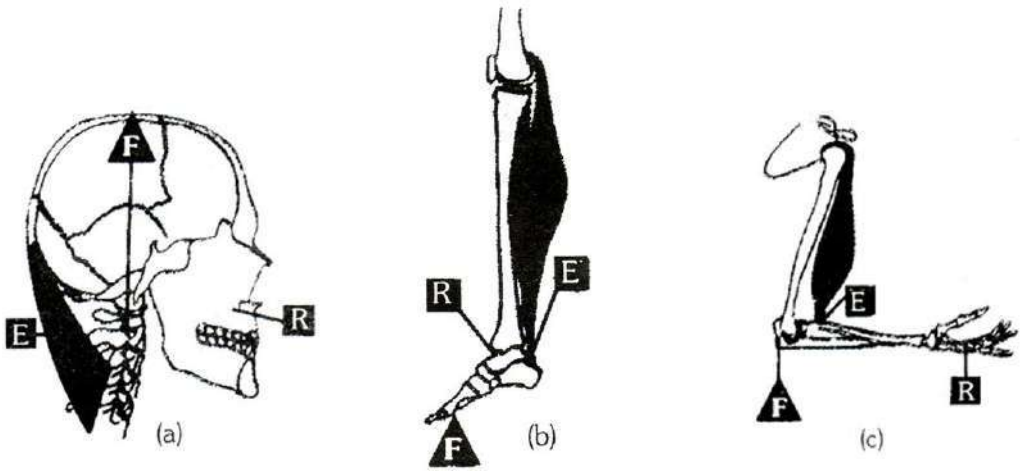
(C) Class III lever : Here effort is between resistance and fulcrum.

Example : Flexing movement of the elbow of forearm.

Fulcrum : Is the elbow joint.

Effort : Is contraction in Bicep muscle.

Resistance : Weight of distal part of hand.



SKELETAL DISORDER

(i) **Dislocation :** It is displacement of bone from their normal position at joint.

(ii) **Slipped disc :** It is displacement of intervertebral fibrocartilage disc or vertebrae from their normal position.

(iii) **Sprain :** It is stretching or tearing of tendons or ligaments.

(iv) **Osteitis or Osteomyelitis :** It is inflammation of bone.

(v) **Spondylitis :** It is inflammation of one or more vertebrae.

(vi) **Osteoporosis :** It is excessive loss of calcium and phosphorus from the bone.

(vii) **Rickets :** In this disease bones of leg get curved bowlegs, It is due to deficiency of **vitamin D**.

CHARACTERISTICS OF FEMALE'S SKELETON

(i) Skull - Female skull is lighter in comparison to male.

(ii) Shoulders - Female shoulder's are narrower.

(iii) Sacrum - Female sacrum is shorter and wider.

(iv) Pelvis - Female pelvis is lighter and broader.

(v) Pelvic cavity - The female cavity is wider in diameter to accommodate the growing foetus during pregnancy and to facitilate the child birth.

(vi) Coccyx : Female coccyx is more movable than male coccyx.

TYPES OF BONES (ON BASIS OF SHAPE AND SIZE)

(i) Long bones

e.g. Humerus, Radius, Ulna, Tibia fibula, Femur.

(ii) Short bones

e.g. Carpals and tarsals.

(iii) Flat bones

e.g. Skull bone, sternum and ribs.

(iv) Irregular bones

e.g. Ear ossicles and vertebrae.

(v) Sesamoid bones

e.g. Patella (knee cap)., pisciform

SPECIAL POINTS

(i) The bones of a children have large amount of organic matter, so, their bones are very flexible and less likely to break. (hence they may undergo green stick fracture)

(ii) In frog tibiofibula is the longest bone.

(iii) Bones formed by ossification in cartilages is called **replacing bone** e.g. Humerus, femur. (cartilagenous bones)

(iv) Bones formed by ossification in the dermis and sink to get attached over the cartilages. e.g. Frontals and parietals is called **investing bone** of the skull.(Dermal bones or membranous bones)

(v) Bones formed by ossification in the tendons at the joint is called **sesamoid bones** e.g. **Patella**.

(vi) Skull of reptiles and birds possess one occipital condyles so the skull is called **monocondylic,** skull of amphibians and mammals possess two occipital condyles, so the skull is called **dicondylic**.

(vii) Os penis : A bone supporting the penis of bats is called os penis.

(viii) Os cordis : A bone supporting the heart of cattle is called oscordis.

(ix) The end of two bones are connected by ligaments. While a muscle atlaches with bone through tendon.

(x) **Procoelous** - Centrum concave anteriorly but convex posteriorly 2^{nd} to 7^{th} vertebrae of frog. All reptilian vertebrae are procoelous.

Amphicoelous - Centrum concave on both sides. 8^{th} vertebrae of frog is amphicoelous.

Acoelous - Centrum remain flat. 9^{th} vertebra of frog is acoelous.

Heterocoelous - Centrum partly convex and partly concave on both sides.

Vertebrae of birds are heterocoelous.

Coeloplatyn vertebrae - Centrum concave anteriorly but flat posteriorly.

Platycoelous vertebrae - Centrum flat anteriorly but concave posteriorly.

(xi) In Avian skull sutures remains absent.

(xii) **Weberian ossicles -** These are modified in vertebrae in cat and fishes. These help in sound production by connecting air bladder and internal ear.

(xiii) Like mammals amphibian skull is also **dicondylic**.

Skull of reptiles and aves are **monocondylic**.

(xiv) The pelvic girdle of birds is attached to a complex structure formed by the fusion of last thoracic all lumbar and first five caudal vertebra this structure is called **synsacrum**.

(xv) Talus in Rabbit is called as Astragalus.

(xvi) Weberian ossicles are found in fishes.

(xvii) Fontanelles are temporary apertures present in the skull of a new born baby.

(xviii) Superior and inferjor articular processes of vertebrae are also called as pre and post zygapophysis respectively.

(xix) In rabbit elbow and knee joints are also called ginglymoid joints.

(xx) Cnenial crest is a ridge found is Tibia of Rabbit.

(xxi) Trochlear notch of Rabbit is also called as sigmoid notch.

(xxii) Zygomatic arch of rabbit is formed of maxilla, squamosal and jugal bone.

(xxiii) Pelvic girdles are made of two hip bones which are also called as Innominates.

(xxiv) Dentary is a membranous bone found in the lower jaw of same vertebrates like frog.

(xxv) Jaw suspension of mammals is craniostylic.

(xxvi) Pterygoid bone is a wing shaped extension of sphenoid bone in Rabbit's skull.

(xxvii) Movement of hands while walking occurs for balancing.

(xxviii) A small sessamoid bone Fabella often develops in the tendon of lateral haed of gastromenius muscles behind the knee joint.

DISORDERS OF BONES

1. Arthritis

It is caused by the inflammation of the joints. This of several types, e.g., **rheumatoid arthritis, osteoarthritis** and **gouty arthritis**.

(A) The Rheumatoid Arthritis

(Rheum = Watery secretion of the body) It is diagnosed by the presence of rheumatoid factor (a type of immunoglobulin IgM).

- It is the primary symptom of inflammation of synovial membrane.
- If it is left untreated, then the membrane thickens and synovial fluid increases, exerting pressure that causes pain.
- The membrane then starts secreting abnormal granules, called **pannus**, which after accumulating on the surface of the cartilage, cause its erosion.
- As a result, the fibrous tissues are attached with the bones and become ossified, making the joints immovable.

(B) Osteoarthritis

It is a degenerative joint disease characterised by the degeneration of the articular cartilage and proliferation of new bones. Usually, afflicted joints are of spine, knees and hands.

(C) Gouty Arthritis or Gout

It is caused either due to excessive formation of uric acid, or inability to excrete it. It gets deposited in joints as monosodium salt.

Treatment – Reduction of pain and inflammation by heat treatment and physiotherapy and, in extreme cases, replacement of the damaged joints. Traditionaly the toxin of honey bee is also used.

2. Osteoporosis

- It is an age-dependent systemic disorder characterised by low bone mass, microarchitectural deterioration of the bone, increased fragility and proneness or susceptibility to fracture.
- The elderly men and women are most susceptible.
- It may occur in a pregnant woman, In individuals under prolonged treatment of cortisone, the skeleton fails to withstand the stress of the body and bones are easily fractured.
- Imbalances of hormones like thyrocalcitonin, parathyroid and sex-hormones, deficiencies of calcium and vitamin D, menopause are the major causative factors.

IMPORTANT POINTS OF FROG SKELETON SYSTEM

1. Total number of bones in frog are 150.
2. Total number of skull bones are 30.
3. Skull of frog is dicondylic.
4. In frog, ribs are absent.
5. In frog, sternum is associated with pectoral girdle.

6. In frog, pectoral girdle is formed of episternum (cartilage), xiphisternum (cartilage) omosternum (bone) mesosternum (bone).
7. Half of the pelvic girdle of frog is osinnominatum. Each os-innominatum is formed of ilium, pubis and ischium.
8. Forelimb of frog includes humerus, radioulna, carpels, metacarpels and phalanges. Phalanges formula of hand is **02233**.
9. Hindlimb of frog includes. Femur, Tibia fibula, Astragalus, calcaneum and bones of foot.

Note :

In frog, largest and longest bone is **tibia fibula**.

Digital formula for foot in frog is 22343.

Vertebral column of frog is composed of 10 vertebrae 10th vertebrae is called **urostyle**.

EXERCISE - 1

Q.1 Part of pectoral girdle is :-
(1) Ileum (2) Glenoid cavity
(3) Acetabulum (4) Sternum

Q.2 Cervical vertebra is differentiated from other vertebra by :-
(1) Presence of odontoid
(2) Presence of transverse process
(3) Amphi platyan centrum
(4) Presence of vertebrarterial canal

Q.3 Bone of lower jaw of mammal :-
(1) Dentary (2) Jugal
(3) Both
(4) Dentary, Jugal & angulo. splenial

Q.4 Exoskeleton of rabbit have :-
(1) Hair (2) Hair & Hoof
(3) Hair & Claws (4) Hair+Claws+Hoof

Q.5 Humerus is different from femur by presence of:-
(1) Spines (2) Deltoid Ridge
(3) Glenoid cavity (4) Vertebral column

Q.6 Scapula part of :-
(1) Skull (2) Pelvic Gridle
(3) Pectoral Girdle (4) Vertebral column

Q.7 Obturator foramen present between :-
(1) Ilium & Ischium (2) Ischium & Pubis
(3) Ilium & pubis (4) None

Q.8 Long neck of Girraffe or camel due to :-
(1) More number of cervical vertebra
(2) More length of cervical vertebra
(3) Presence of muscular pads between cervical vertebra
(4) Presence of extra bony plates

Q.9 Strongest bone is -
(1) Tibia (2) Femur
(3) Humerus (4) Ulna

Q.10 Number of tarsal bone in ankle of rabbit :-
(1) 2 (2) 7
(3) 6 (4) 5

Q.11 Heel bone of rabbit :-
(1) Central (2) Meso cuneiform
(3) Ecto cuneiform (4) Calcaneal process

Q.12 Sesamoid bone of knee :-
(1) Patella
(2) Patella & Two fabellae
(3) Fabellae (4) Pisiform

Q.13 Cnemial crest part of :-
(1) Fibula (2) Tibia
(3) Femur (4) Calcaneum process

Q.14 Number of bone present 1^{st}, 2^{nd}, 3^{rd} rows of tarsals:-
(1) 2,2,1 (2) 2,3,1
(3) 2,1,3 (4) 1,2,3

Q.15 Sacro-iliac joint is:-
(1) Movable (2) Immovable
(3) lmpefect (4) None

Q.16 Which bone does not participate in formation of acetabulum:-
(1) Pubis (2) Ilium
(3) Ischium (4) None

Q.17 In Rabbit bone present between the pubis & acetabulum:-
(1) Cotyloid (2) Scapula
(3) Astragalus (4) Cuboid

Q.18 Supra trochlear fossa present:-
(1) Humerus of frog (2) Humerus of rabbit
(3) Radius of rabbit (4) Radius of frog

Q.19 Trochlea of which bone fit in sigmoid notch of ulna:-
(1) Humerus (2) Radius
(3) Femur (4) Scaphoid

Q.20 Acromian-process present in:-
(1) Pectoral girdle of frog
(2) Pectoral girdle of rabbit
(3) Pelvic girdle of rabbit
(4) Pelvic girdle of frog

Q.21 Shoulder joint present between:-
(1) Glenoid cavity of pectoral girdle &head of humerus
(2) Coracoid process of pectoral girdle & head of humerus
(3) Both
(4) None

Q.22 Number of vertebra present in frog man & rabbit-
(1) 10,12,24 (2) 10,33,46
(3) 10,33,40 (4) 10,26,33

Q.23 Typical vertebra of rabbit is :-
(1) Acoelous (2) Procoelous
(3) Amphicoelous (4) Amphiplatyan

Q.24 Feature of vertebra of mammals :-
(1) Centrum is amphi platyan
(2) Epiphysis present
(3) Inter vertebral disc present between two bone
(4) All the above

Q.25 Typical vertebra of rabbit is :-
(1) Cervical (2) Lumbar
(3) Sacral (4) Caudal

Q.26 Demifacets present at :-
(1) Thoracic vertebra (2) Lumbar vertebra
(3) Sacral vertebra (4) Cervical vertebra

Q.27 False rib in man is :-
(1) 8^{th} 9^{th} & 10^{th} rib (2) 7^{th} 8^{th}, 9^{th} rib
(3) 9^{th}, 10^{th} & 11^{th} rib (4) 6^{th} , 7^{th} & 8^{th} rib

Q.28 False ribs in rabbit:-
(1) 9^{th} & 10^{th} rib (2) 8^{th} & 9^{th} rib
(3) 8^{th} , 9^{th} & 10^{th} rib (4) 6^{th},7^{th}, 8^{th} rib

Q.29 Types of orbit in rabbit :-
(1) Tropo basic (2) Platy basic
(3) Both (4) None

Q.30 Middle ear of rabbit present in:-
(1) Prooptic bone (2) Tympanic bulla
(3) Peri-otic bone (4) Peri-optic bone

Q.31 Number of cartilagenous bone present around the foramen of magnum :-
(1) 2 (2) 4
(3) 3 (4) 2

Q.32 Type of suspension in lower jaw of rabbit:-
(1) Craniostylic (2) Auto stylic
(3) Both (4) None

Q.33 Number of bone present in skull of rabbit frog respectively:-
(1) 53+40 (2) 53+46
(3) 46+53 (4) 33+46

Q.34 Example of endo skeleton is:-
(1) Spicule of sponge
(2) Calcified plate in some mollusca
(3) Calcified plate in some echinodermata
(4) All the above

Q.35 Number of bone in axial skeleton of rabbit :-
(1) 132 (2) 128
(3) 80 (4) 126

Q.36 Total number of bones in rabbit :-
(1) 260 (2) 206
(3) 306 (4) 132

Q.37 Number of membranous bone present in each half of upper jaw :-
(1) 3 (2) 4
(3) 5 (4) 6

Q.38 Incisor present in which bone :-
(1) Premaxilla (2) Maxillae
(3) Palatine (4) None

Q.39 Cheek teeth present at :-
(1) Premaxilla (2) Maxillae
(3) Palatine (4) None

Q.40 Hard palate consist of :-
(1) Premaxilla (2) Maxillae
(3) Palatine (4) None

Q.41 Type of bone present in lower jaw of rabbit :-
(1) Cartilagenous (2) membranous
(3) Sesamoid (4) None

Q.42 Teeth are not present in which bone :-
(1) Premaxilla (2) Vomer
(3) Maxilla (4) Dentary

Q.43 Zygomatic arch compose of :-
(1) Jugal (2) Maxillae
(3) Squamosals (4) All the above

Q.44 Frontal segment in rabbit consist of :-
(1) Frontal bone (2) Pre sphenoid
(3) Orbito sphenoid (4) All the above

Q.45 Parietal segment in rabbit consist of :-
(1) Parietal & Periotic
(2) Basi sphenoid & Ali sphenoid
(3) Tympanic & inter parietal
(4) All the above

Q.46 Occipital segment consist of :-
(1) Supra occipital & Basioccipital
(2) Para occipital & Ex-occipital
(3) Both
(4) Basisphenoid & Alli sphenoid

Q.47 Membranous bone present in upper jaw :-
(1) Premaxillae & maxilla
(2) Palatine & jugals
(3) Pterygoid & squamosal
(4) All the above

Q.48 Hinge joint is :-
(1) Elbow joint
(2) Ankle joint
(3) Inter phalangeal joint
(4) All

Q.49 Pivot joint ;-
(1) At lanto. Axial joint (2) Shoulder joint
(3) Hip joint (4) None

Q.50 Study of joint known as :-
(1) Osteology (2) Arthrology
(3) Craniology (4) Kinesiology

Q.51 The skull of frog and Rabbit are -
(1) Dicondylic (2) Monocondylic
(3) Tricondylic (4) Tetracondylic

Q.52 Study of skeleton is called -
(1) Endoskeleton (2) Osteology
(3) Exoskeleton (4) Osteoblast

Q.53 Coracoid bone is found in-
(1) Pectoral girdle of rabbit
(2) Pectoral girdle of man
(3) Pectoral girdle of frog
(4) Forelimb of rabbit

Q.54 The total number of bones in upper arm is -
(1) 35 (2) 32
(3) 30 (4) 40

Q.55 The total number of bones in axial skeleton of adult human and rabbit are -
(1) 90,130 (2) 80,132
(3) 100,120 (4) 81,131

Q.56 The total number of vertebrae in man & rabbit is-
(1) 30,33 (2) 33, 30
(3) 33, 46 (4) 46, 33

Q.57 Acetabulum is the part of-
(1) Hind arm (2) Pelvic girdle
(3) Pectoral girdle (4) Fore arm

Q.58 Thoracic cage of man is formed of -
(1) Ribs (2) Sternum
(3) Thoracic vertebrae (4) All

Q.59 Which one of the following components is a part of the pectoral girdle ?
(1) Acetabulum (2) Sternum
(3) Ischium (4) glenoid cavity

Q.60 Function of skeleton is -
(1) Shape and symmetry
(2) Protection
(3) Physical supports to limbs
(4) All

Q.61 Bone of fore limb is -
(1) Femur & tibia (2) Femur & ulna
(3) Humerus (4) All

Q.62 The pectoral & pelvic girdles and the bones of the limb form-
(1) Appendicular skeleton
(2) Axial skeleton
(3) Visceral skeleton (4) Outer skeleton

Q.63 The smallest bone in rabbit's and man's skeleton is-
(1) Stapes (2) Nasal
(3) Patella (4) Dentine

Q.64 Funny bone of the body is -
(1) Humerus (2) Femur
(3) Radius (4) Ulna

ANSWER KEY

EXERCISE - 1

Q.1	2	Q.2	4	Q.3	1	Q.4	3	Q.5	2	Q.6	3	Q.7	2
Q.8	2	Q.9	1	Q.10	3	Q.11	4	Q.12	2	Q.13	2	Q.14	3
Q.15	2	Q.16	1	Q.17	1	Q.18	2	Q.19	1	Q.20	2	Q.21	1
Q.22	2	Q.23	4	Q.24	4	Q.25	2	Q.26	1	Q.27	1	Q.28	2
Q.29	1	Q.30	2	Q.31	2	Q.32	1	Q.33	2	Q.34	4	Q.35	1
Q.36	1	Q.37	4	Q.38	1	Q.39	2	Q.40	4	Q.41	2	Q.42	2
Q.43	4	Q.44	4	Q.45	4	Q.46	3	Q.47	4	Q.48	4	Q.49	1
Q.50	2	Q.51	1	Q.52	2	Q.53	3	Q.54	3	Q.55	2	Q.56	3
Q.57	2	Q.58	4	Q.59	4	Q.60	4	Q.61	3	Q.62	1	Q.63	1
Q.64	1												

EXERCISE - 2

Q.1 Skull of Rabbit / Man is :-
(1) Mono condylic (2) Dicondylic
(3) Tricondylic (4) Tetra condylic

Q.2 In Camel number of cervical vertebra is :-
(1) 6 (2) 7
(3) 8 (4) 9

Q.3 Joint between bones of human skull is :-
(1) Fibrous joint (2) Hinge joint
(3) Synovial joint (4) Pivot joint

Q.4 Smallest bone in Rabbit & Man is :-
(1) Nasal (2) Patella
(3) Stapes (4) Palatine

Q.5 Os Innominatum consist of :-
(1) Pubis (2) Ischium
(3) Ilium (4) All of the above

Q.6 Total number of bone in Appendicular skeleton of human :-
(1) 126 (2) 80
(3) 44 (4) 33

Q.7 Total number of bone in Appendicular skeleton of rabbit :-
(1) 128 (2) 120
(3) 80 (4) 37

Q.8 Longest bone of human skeleton :-
(1) Femur (2) Humerus
(3) Tibia (4) Radius

Q.9 Acromion process is part of :-
(1) Pelvic girdle (2) Pectoral girdle
(3) Vertebral column (4) Humerus

Q.10 Elbow joint is :-
(1) Ball & socket (2) Pivot
(3) Gliding (4) Hinge

Q.11 Total number of bone of human face :-
(1) 10 (2) 12
(3) 14 (4) 16

Q.12 Total number of skull bones in human :-
(1) 28 (2) 49
(3) 39 (4) 19

Q.13 Total number of skull bone in rabbits :-
(1) 53 (2) 40
(3) 39 (4) 29

Q.14 Number of floating ribs in human :-
(1) 6 pairs (2) 5 pairs
(3) 3 pairs (4) 2 pairs

Q.15 The second cervical vertebral process is called-
(1) Prezygapophysis (2) Odontoid process
(3) Metaphysis (4) Post zygophysis

Q.16 Single bone of lower jaw in human is :-
(1) Maxilla (2) Dentary
(3) Squamosal (4) Ptergoid

Q.17 Largest mammalian vertebra is :-
(1) Thoracic (2) Sacral
(3) Lumbar (4) Cervical

Q.18 Deltoid Ridge. is found in which one of following bone :-
(1) Radius (2) Ulna
(3) Humerus (4) Femur

Q.19 In rabbit the zygomatic arch is formed of :-
(1) Premaxilla & jugal & squamosal
(2) Maxilla & jugal & squamosal
(3) Premaxilla & Maxilla & jugals
(4) Premaxilla & jugals

Q.20 Pelvic girdle of rabbit is distinguished from that of frog by presence of :-
(1) Obturator foramen (2) Olecranon fossa
(3) Foramen magnum (4) Sigmoid notch

Q.21 Ventral wall of pubis has small bone in rabbit called :-
(1) Cotyloid (2) Coracoid
(3) Pubis symphysis (4) Ilium

Q.22 Astragalus calcaneum are found in :-
(1) Hind limb of man (2) Hind limb of rabbit
(3) Fore limb of man (4) fore limb of rabbit

Q.23 Sigmoid Notch is also called as :-
(1) Sciatic Notch (2) Digital Notch
(3) Olecranon Notch (4) Furcular Notch

Q.24 Digital formula of Manus (Hand) of rabbit is :-
(1) 23333 (2) 03322
(3) 33332 (4) 02233

Q.25 Digital formula of foot (Pes) of rabbit is :-
(1) 03332 (2) 03333
(3) 03322 (4) 23333

Q.26 Heaviest vertebra in man is :-
(1) Atlas (2) Axis
(3) Lumber (4) Thoracic

Q.27 Joint between Incus & stapes is present :-
(1) Ball & socket joint (2) Hinge joint
(3) Pivot joint (4) Gliding joint

Q.28 Joint between malleus & incus is :-
(1) Gliding joint (2) Ball & socket joint
(3) Pivot joint (4) Hinge joint

Q.29 Cervical vertebra 7 in number in all except :-
(1) Sea horse (2) Polar bear
(3) Sloth (4) All

Q.30 Atlas - Axis joint is :-
(1) Hinge joint (2) Saddle joint
(3) Pivot joint (4) None

Q.31 Vertebral column of rabbit consist of :
(1) 46 vertebra (2) 42 vertebra
(3) 33 vertebra (4) 26 vertebra

Q.32 Inter vertebral disc is a
(1) Cartilage bone in the body
(2) Pad in the centrum of a bone
(3) Pad between two centrum
(4) None of above

Q.33 Axis vertebra identified by :
(1) Olecranon process (2) Odontoblast
(3) Odontoid process (4) None

Q.34 Typical vertebra of frog is :-
(1) Amphicoelous (2) Procoelous
(3) Acoelous (4) Opisthocoelous

Q.35 A joint between humerus and radio Ulna :
(1) Ball & socket (2) Pivot
(3) Gliding (4) Hinge

Q.36 Total number of vertebra in Man :
(1) 30 (2) 33
(3) 40 (4) 35

Q.37 Pterygoid is :-
(1) Cartilage (2) Cartilaginous bone
(3) Membranous bone (4) Long bone

Q.38 Fabellae bones are associated with :-
(1) Angular joint (2) Elbow joint
(3) Knee joint (4) Neck joint

Q.39 In rabbit, the jaw suspensorium is :-
(1) Auto stylic (2) Amphi stylic
(3) Cranio stylic (4) Hyostylic

Q.40 Olecranon process is :-
(1) Proximal end of Ulna
(2) Distal end of Ulna
(3) Proximal end of Tibia
(4) Proximal end of Humerus

Q.41 Cotyloid bone is found in :-
(1) Pelvic girdle of frog
(2) Pelvic girdle of rabbit
(3) Pectoral girdle of rabbit
(4) Pectoral girdle of frog

Q.42 Bony sockets of jaws in which the teeth are implanted are known as :-
(1) Alveoli (2) Fossae
(3) Dentaries (4) Thecae

Q.43 Haversian system found in :
(1) Atlas vertebra of rabbit
(2) Ilium of rabbit
(3) Femur of rabbit (4) Tibiofibula of frog

Q.44 Sacrum in rabbit is formed by fusion of :
(1) 3 vertebrae (2) 4 vertebrae
(3) 8 vertebrae (4) 6 vertebrae

Q.45 If the olecranon process of a rabbit is broken the rabbit will :
(1) Not run (2) Limp
(3) Run very fast (4) None of these

Q.46 The presence of tympanic bulla is characteristic of :-
(1) skull of frog (2) skull of rabbit
(3) skull of both (4) None

Q.47 Scales are exoskeleton of -
(1) Reptiles (2) Fishes
(3) Both (4) None

Q.48 Angular process present in :-

(1) Dentary (2) Maxilla

(3) Phalanges (4) Premaxilla

Q.49 Acoelus or amphiplatyan centrum vertebrae present in-

(1) Frog (2) Rabbit

(3) Salamander (4) All

Q.50 Number of bone present in upper jaw of rabbit;-

(1) 10 (2) 12

(3) 14 (4) 16

Q.51 Lower jaw of mammals is formed by :-

(1) Dentary only

(2) Dentary & jugal

(3) Dentary & Hayo mandibularies

(4) Dentary, Merkel's cartilage

Q.52 The vestigeal notochord called nucleus purposus is found in :-

(1) Pelvic girdle (2) Inter vertebral disc

(3) Centrum (4) skull

Q.53 Which one forms heal in rabbit :-

(1) Tarsus

(2) Astragalus calcaneum

(3) Metatarsals

(4) Calcaneal process

Q.54 Strongest bone of axial skeleton is -

(1) Tibia (2) Mandible

(3) Humerus (4) Ulna

Q.55 The nutrient foramen is present in :-

(1) skull of frog

(2) Tibiofibula of frog

(3) Radius - Ulna of rabbit

(4) Pelvic girdle of frog & rabbit

Q.56 Which vertebra has long & backward directed neural spine in rabbit :-

(1) Cervical (2) Lumbar

(3) Thoracic (4) Sacral

Q.57 Neuro cranium (part of skull) includes :-

(1) Cranium (2) Olfactory capsule

(3) Optic capsule (4) All the above

Q.58 Formula of vertebral column of rabbit :-

(1) $C_6T_{12}L_6S_4C_{15}$ (2) $C_7T_{12}L_7S_4C_{16}$

(3) $C_7T_{12}L_5S_4C_{15}$ (4) $C_7T_{12}L_7S_5S_{16}$

Q.59 Bone which enclose tympanum in mammals is:-

(1) Tymphanic bulla (2) Petrous bone

(3) Temporal (4) Parietal

Q.60 Spinal cord passes to brain through :-

(1) Foramen of monro

(2) Foramen of magendie

(3) Foramen of ovale

(4) Foramen of Magnum

Q.61 The odontoid process of axis vertebra in mammals is regarded as :-

(1) A process of Neural spine

(2) Remnant of centrum of atlas vertebra

(3) Rib of axis vertebra

(4) Centrum of atlas vertebra

Q.62 Which of following helps in rotation of the neck:-

(1) Atlas (2) Axis

(3) Cervical

(4) Occipital condyle of skull

Q.63 Astragalus & calcaneum are also known as :-

(1) Tibiale & fibulae

(2) Meta tarsals & tarsal

(3) Carpal & metacarpals

(4) None

Q.64 Largest foramen of human body is :-

(1) Foramen ovale

(2) Foramen of magendie

(3) Foramen of magnum

(4) Foramen of monro

Q.65 Stapes is modification of :-

(1) Hypomandibular (2) Palatine

(3) Quadrate (4) Squamosal

Q.66 2 Pairs of false ribs present in :-

(1) Man (2) Rabbit

(3) Frog (4) None

Q.67 True rib are 7 pairs in :-

(1) Rabbit (2) Man

(3) Both (4) one

Q.68 Saddle joint is absent in :-

(1) Human (2) Rabbit

(3) Both (4) Frog

Q.69 Which bone attach with tibia at ankle of rabbit:-

(1) Navicular (2) Astragalus

(3) Cuboid (4) Cunciform

Q.70 Presence of obturator foramen is feature of :-

(1) Frog (2) Cockroach

(3) Rabbit (4) None

ANSWER KEY

EXERCISE - 2

Q.1	2	Q.2	2	Q.3	1	Q.4	3	Q.5	4	Q.6	1	Q.7	1
Q.8	1	Q.9	2	Q.10	4	Q.11	3	Q.12	1	Q.13	1	Q.14	4
Q.15	2	Q.16	2	Q.17	3	Q.18	3	Q.19	2	Q.20	1	Q.21	1
Q.22	2	Q.23	3	Q.24	1	Q.25	2	Q.26	3	Q.27	1	Q.28	4
Q.29	3	Q.30	3	Q.31	1	Q.32	3	Q.33	3	Q.34	2	Q.35	4
Q.36	2	Q.37	3	Q.38	3	Q.39	3	Q.40	1	Q.41	2	Q.42	1
Q.43	3	Q.44	2	Q.45	2	Q.46	2	Q.47	3	Q.48	1	Q.49	2
Q.50	2	Q.51	1	Q.52	2	Q.53	4	Q.54	2	Q.55	2	Q.56	3
Q.57	4	Q.58	2	Q.59	1	Q.60	4	Q.61	2	Q.62	2	Q.63	1
Q.64	3	Q.65	1	Q.66	2	Q.67	3	Q.68	4	Q.69	2	Q.70	3

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 A vertebra having convexity both in front and behind is- **(AFMC 1993)**
(1) Acoelous (2) Procoelous
(3) Amphicoelous (4) Amphiplatyon

Q.2 Long bones function in- **(CBSE 1993)**
(1) Support
(2) Support, erythrocyte and leucocyte synthesis
(3) Support and erythrocyte synthesis
(4) Erythrocyte formation

Q.3 Trochanters occur in- **(CPMT 1994)**
(1) Humerus (2) Femur
(3) Radio-ulna (4) Tibia-fibula

Q.4 Acromion process is part of-**(MPPMT 1994)**
(1) Vertebral column (2) Pelvic girdle
(3) Femur (4) Pectoral girdle

Q.5 Part of the body having a single pair of bones is- **(MPPMT 1994)**
(1) Pelvic girdle (2) External ear
(3) Wrist (4) Lower jaw

Q.6 Comparative study of skulls is- **(Orissa JEE 1995)**
(1) Craniology (2) Conchology
(3) Malacology (4) Osteology

Q.7 Longest bone of frog is- **(Bih. PMT 1995)**
(1) Humerus (2) Tibia-fibula
(3) Femur (4) Radio-ulna

Q.8 Haversian system is diagnostic feature of- **(APMEE 1995)**
(1) Avian bones (2) Reptilian bones
(3) Mammalian bones (4) Bone of all animal

Q.9 Feeling of fatigue after running fast for some time is due to- **(CPMT 1996)**
(1) Loss of energy
(2) Accumulation of lactic acid in muscle
(3) Formation of succinic acid
(4) Formation of biuret crystals

Q.10 In mammals the lower jaw is made of- **(DPMT 1984, 1985, Bih. PMT 1996)**
(1) Maxilla (2) Dentary
(3) Mandible (4) Ethmoid

Q.11 Sesamoid bone is derived from-**(DPMT 1996)**
(1) Cartilage (2) Areolar tissue
(3) Tendon (4) Ligament

Q.12 Which one has the maximum glycogen- **(BHU 1996)**
(1) Liver (2) Muscles
(3) Nerves (4) Kidneys

Q.13 Ankle joint is- **(CBSE 1997)**
(1) Pivot joint (2) Ball and socket joint
(3) Hinge joint (4) Gliding joint

Q.14 Epiphysial plate is involved in- **(BHU 1997)**
(1) Formation of bone (2) Elongation of bone
(3) Thickness of bone (4) All the above

Q.15 Inter-articular disc occurs in- **(BHU 1997)**
(1) Wall of heart (2) Wall of liver
(3) Pubic symphysis
(4) In between two vertebrae

Q.16 Acetabulum is part of- **(CPMT 1997)**
(1) Pelvic girdle (2) Pectoral girdle
(3) Fore arm (4) Upper arm

Q.17 Number of bones in hind limb of human is- **(CBSE 1998)**
(1) 21 (2) 24
(3) 30 (4) 14

Q.18 Number of vertebrae in axial skeletal of frog leaving urostyle is- **(CPMT 1998)**
(1) 10 (2) 12
(3) 15 (4) 9

Q.19 Biceps are attached with- **(RPMT 1998)**
(1) Radius (2) Ulna
(3) Femur (4) Humerus

Q.20 Bones of pelvic girdle forms a cavity in which head of the femur is fitted are - **(RPMT 1998)**
(1) ilium only (2) ilium and ischium
(3) ilium, ischium and pubis
(4) ischium and pubis

Q.21 Lower jaw of Rabbit articulates with - **(RPMT 1998)**
(1) jugal (2) alisphenoid
(3) squamosal (4) parietal

Q.22 Which of the following is not an odd digitate pentadactytlus - **(RPMT 1998)**
(1) Donkey (2) Camel
(3) Zebra (4) Rhinoceros

Q.23 Joint between atlas and axis is-**(CBSE 1999)**
(1) Pivot joint (2) Saddle joint
(3) Angular joint (4) Hinge joint

Q.24 Astragalus and calcaneum are part of- **(Pb.PMT 1999)**
(1) Fore limb (2) Hind limb
(3) Scapula (4) Clavicle

Q.25 Coracoid is component of- **(BHU 1999)**
(1) Fore limb (2) Skull
(3) Pectoral girdle (4) Pelvic girdle

Q.26 Olecranon process occurs in- **(BHU 1999)**
(1) Femur (2) Radius
(3) Humerus (4) Ulna

Q.27 Two halves of pelvic girdle are joined together by- **(BHU 1999)**
(1) Pubic symphysis
(2) Ischiac symphysis
(3) Ischiopubic symphysis
(4) By fusion

Q.28 Deltoid groove is present in : **(RPMT 1999)**
(1) Radio-ulna (2) femur
(3) tibio-fibula (4) humerus

Q.29 Sutural joints are present between- **(MPPMT 2000)**
(1) Thumb and metatarsal
(2) Humerus and radio-ulna
(3) Parital of skull
(4) Glenoid cavity and pectoral girdle

Q.30 Which one is a bone of skull- **(CBSE 2000)**
(1) Atlas (2) Femur
(3) Tibia (4) Pterygoid

Q.31 Joint of sternum and ribs is- **(CBSE 2000)**
(1) Cartilaginous (2) Fibrous joint
(3) Angular joint (4) Hinge joint

Q.32 Myoglobin occurs in- **(AFMC 2000)**
(1) White muscle fibres (2) Red muscle fibres
(3) Involuntary muscles (4) All the above

Q.33 Coccygeal bone occurs in- **(CPMT 2000)**
(1) Skull (2) Pectoral girdle
(3) Vertebral column (4) Pelvic girdle

Q.34 Immediate source of energy for muscle contraction is- **(AFMC 2000)**
(1) Glucose (2) GTP
(3) Creatine phosphate (4) ATP

Q.35 Synovial fluid is present in- **(Har. PMT 2000)**
(1) Spinal cavity (2) Cranial cavity
(3) Freely movable joints
(4) Fixed joints

Q.36 EDTA injected into muscles combines with Ca^{2+} and- **(Pb. PMT 2000)**
(1) Stops contraction
(2) Causes contraction
(3) Slows down contraction
(4) None of the above

Q.37 Mentomeckelian is specially characteristic bone of : **(RPMT 2000)**
(1) *Rana tigrina* (2) *Aquas*
(3) *Bos indicus* (4) *Felis domestics*

Q.38 Haversian canals are found in the- **(MPPMT 2001)**
(1) Bones of birds (2) Bones of mammals
(3) Bones of frog (4) Cartilage

Q.39 From outer to innerside the sequence of three bones present in the middle ear of mammals is- **(CPMT 2001)**
(1) Incus, Malleus, Stapes
(2) Malleus, Incus, Stapes
(3) Malleus, Stapes, Incus
(4) Stapes, Malleus, Incus

Q.40 Obturator foraman is present in- **(CPMT 2001)**
(1) Pectoral girdle of frog
(2) Pectoral girdle of rabbit
(3) Pelvic girdle of frog
(4) Pelvic girdle of rabbit

Q.41 In frog, the vertebra with an anterior convex surface is- **(UP-CPMT-2001)**
(1) atlas (2) urostyle
(3) 8th vertebra (4) 9th vertebra

Q.42 Obturator foramen is found in- **(UP-CPMT-2001)**
(1) frog's pelvic girdle
(2) frog's pectoral girdle
(3) rabbit's pelvic girdle
(4) rabbit's pectoral girdle

Q.43 Which is the largest bone of middle ear- **(BHU 2002)**
(1) Incus (2) Malleus
(3) Stapes (4) Cochlea

Q.44 Largest smooth muscle is present in- **(UP CPMT 2002)**
(1) Leg
(2) Thigh
(3) Uterus of pregnant woman
(4) Urethra

Q.45 Pelvic girdle of rabbit consists of - **(UP-CPMT-2002)**
(1) ilium, ischium and pubis
(2) ilium, ischium and coracoid
(3) coracoid, scapula and clavicle
(4) ilium, coracoid and scapula

Q.46 Bones formed by ossification of a tendon is called– **(MP-PMT-2002)**
(1) Membrane bone (2) Dermal bone
(3) Sesamoid bone (4) Cartilage

Q.47 Fibulare bones are associated with- **(MP-PMT-2002)**
(1) Elbow joint (2) Knee joint
(3) Neck joint (4) Angular joint

Q.48 Thoracic cage of man is formed by- **(MP-PMT-2002)**
(1) Ribs and thoracic vertebrae
(2) Ribs, sternum and thoracic vertebrae
(3) Ribs and sternum
(4) Ribs, sternum and lumbar vertebrae

Q.49 Jaw suspension characteristic of mammals is- **(MP-PMT-2002)**
(1) Amphistylic (2) Craniostylic
(3) Autocliastylic (4) Hyostylic

Q.50 Joint between humerus and ulna is- **(RPMT 2003)**
(1) Saddle joint (2) Hinge joint
(3) Fibrous joint (4) Ball and socket

Q.51 The parasphenoid bone in frog forms- **(UP-CPMT-2004)**
(1) base of cranium (2) floor of cranium
(3) dorsal side of cranium
(4) dorsolateral side of cranium

Q.52 Ear ossicle, incus is modified form of which bone- **(MP-PMT-2004)**
(1) Jugal (2) Articular
(3) Quadrate (4) Hyomandibular

Q.53 An acromian process is characteristically found in the- **(CPMT-2005)**
(1) Pelvic girdle of mammals
(2) Pectoral girdle of mammals
(3) Skull of frog
(4) Sperm of mammals

Q.54 The parasphenoid bone in frog forms- **(MP-PMT-2005)**
(1) Base of cranium
(2) Floor of cranium
(3) Dorsal side of cranium
(4) Dorsolateral side of cranium

Q.55 Smallest bone in rabbit is- **(RPMT-2006)**
(1) Femur (2) Carpals
(3) Stapes (4) Nasal

Q.56 Metabolic arthritis is commonly called as - **(CMC Vellore-2006)**
(1) Rheumatism (2) Gout
(3) Tuberculosis (4) Cancer

Q.57 In human body, which one of the following is anatomically correct- **[AIPMT-2007]**
(1) Collar bones – 3 pairs
(2) Salivary glands– 1 pairs
(3) Cranial nerves– 10 pairs
(4) Floating ribs– 2 pairs

ANSWER KEY

EXERCISE - 3

Q.1	4	Q.2	2	Q.3	2	Q.4	2	Q.5	1	Q.6	1	Q.7	2
Q.8	3	Q.9	2	Q.10	3	Q.11	3	Q.12	2	Q.13	3	Q.14	2
Q.15	4	Q.16	1	Q.17	3	Q.18	4	Q.19	4	Q.20	3	Q.21	3
Q.22	1	Q.23	1	Q.24	2	Q.25	3	Q.26	4	Q.27	1	Q.28	4
Q.29	3	Q.30	4	Q.31	1	Q.32	2	Q.33	3	Q.34	4	Q.35	3
Q.36	1	Q.37	1	Q.38	2	Q.39	2	Q.40	4	Q.41	4	Q.42	3
Q.43	2	Q.44	3	Q.45	1	Q.46	3	Q.47	2	Q.48	2	Q.49	2
Q.50	2	Q.51	2	Q.52	3	Q.53	2	Q.54	2	Q.55	3	Q.56	2
Q.57	4												

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.
(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
(3) If Assertion is True but the Reason is False.
(4) If both Assertion & Reason are false.

Q.1 **A :** Locomotion enables the animal to find its partner.
R : Locomotion enables the animal to shift its entire body from place to place.

Q.2 **A :** Movement of body parts serves to change the body posture.
R : Body parts move in relation to body axis.

Q.3 **A :** There are similarities between the locomotion of unicellular organisms and multicellular animal.
R : Ciliary, flagellar and amoeboid movement occur in unicellular organisms.

Q.4 **A :** Locomotion in *Hydra* is carried out by two types of contractile cells.
R : Muscle fibres are lacking in *Hydra*.

Q.5 **A :** Starfish moves through crawling.
R : Starfish utilise a flow of water over the surface, for movement.

Q.6 **A :** Skeleton helps in blood cell formation.
R : Blood flows through skeleton.

Q.7 **A :** Skeleton serves as a storage depot.
R : Skeleton stores carbohydrate and protein.

Q.8 **A :** Ball and-socket-joints are the most mobile joints.
R : Synovial fluid is present here.

Q.9 **A :** Arthritis or inflammation of a joint makes the joint painful.
R : Some toxic substances are deposited at the joint.

Q.10 **A :** The contraction and relaxation of muscle fibre are controlled by nerve impulses.
R : The threshold stimulus is the minimum stimulus required for the beginning of contraction.

Q.11 **A :** Muscle twitch is related with tetanus.
R : Tetanus is caused by many nerve impulses at a time.

Q.12 **A :** Human skeleton also helps in hearing.
R : Internal ear of man is surrounded by bony labyrinth.

Q.13 **A :** Jaw suspension of man is craniostylic.
R : Squamosal of lower jaw is suspended from dentary of upper jaw.

Q.14 **A :** Human vertebrae are called amphiplatyan type.
R : Centrum of vertebrae is flat on both sides.

Q.15 **A :** Osteoarthritis is also called wear and tear disease.
R : In osteoarthritis, there is inflammation and degeneration of cartilages at the joints.

Q.16 **A :** Osteoporosis is characterized by increases in density of bones.
R : There is increased activity of the osteoblasts.

Q.17 **A :** Intervertebral discs are tough and strong than the pinna of man.
R : Intervertebral discs are formed of fibro cartilages while pinna is with calcified cartilage.

Q.18 **A :** Birds are with pneumatic bones.
R : Air sacs make the bones lighter which helps in the flight of the birds.

Q.19 **A :** In muscle concentration, length of the both A-bands and I-bands decreases.
R : Both myosin of A-bands and actin of I-bands are contractile proteins and decrease in size during muscle contraction.

Q.20 **A :** During exercise, a person undergoes fatigue very soon.
R : During this period, muscle fibres undergo oxygen debt.

ANSWER KEY

EXERCISE - 4

Q.1	2	Q.2	2	Q.3	2	Q.4	1	Q.5	2	Q.6	3	Q.7	3
Q.8	2	Q.9	3	Q.10	2	Q.11	2	Q.12	2	Q.13	3	Q.14	1
Q.15	1	Q.16	4	Q.17	3	Q.18	1	Q.19	4	Q.20	1		

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

INTEGUMENTARY SYSTEM

INTRODUCTION

- Skin together with its derivative constitutes the integumentary system of the body.
- Skin is largest, functional organ of the body having 16-18% of the body weight.
- Skin is called **Jack of all trades**.
- Skin is ecto-mesodermal in origin.
- Skin of mammals possess **spy lines**, which is very distinct on palm and fingers. Every human has particular spy lines. No, two human, can have similar, finger print. (Quetlets rule)
- Total surfce area of skin in an adult person is about 1.6 m^2.
- Furrow (sulci cutis) and ridges (cristae cutis) are also present on the skin of Palm and Soles.

Note :

- Study of finger prints is called **Dactyloscopy**.
- The skin of rabbit is adopted for complete exposure to air due to terrestrial mode of life it is soft, but thick and dry completely covered with a thin blanket of hair called **palage**. Palage prevent excessive loss of heat. Presence of dense palage on rabbit shows that its native place is **Europe**.
- Skin in mammals are attached with underlying skeletal muscle layer by **tela subcutanea**.

Note :

- In human female after delivery, clear and permanent lines appears on the skin of abdomen these lines are called **linea gravidarum** after each delivery number of these lines becomes more and more dense.

GENERAL HISTOLOGY OF SKIN

Histologically, the skin is formed of two distinct layer, outer epidermis (ectodermal) and inner dermis (mesodermal).

EPIDERMIS

General character

- Epidermis develops from ectoderm.
- It has no blood capillary and is nourished by dermis which contain blood capillary.
- It is composed of keratinized stratified squamous epithelium and is extremely thick in palm and sole. It is thinnest in conjuctiva of eyes.

Epidermis is composed of five layers which are as follows : (from inside to outside)

Stratum malphighi

Stratum spinosum

Stratum granulosum

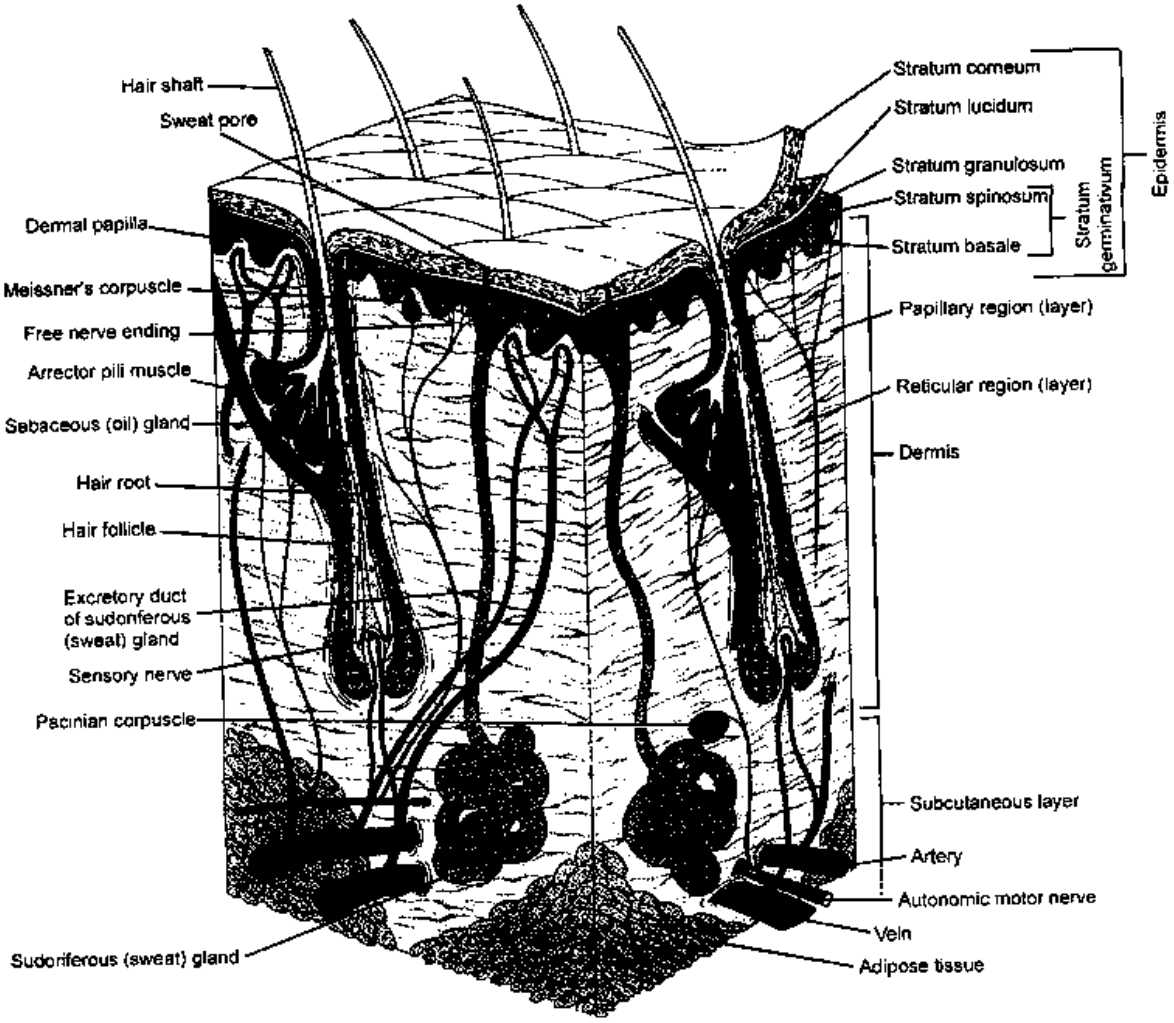
Stratum lucidium

Stratum corneum

1. Stratum malphighi

- It is innermost living layer and composed of single layer of columnar cells. When these cells spread outside the skin their shape changes from columnar to cuboidal.
- At many places on this layer elevation and depression are found. The elevation is called **(Rete pegs)**.

- The cells of the layer remain in touch with dermis, hence get, nutrition from it.
- This layer, undergoes, massive, mitotic divisions throughout the life and produce new cells which moves upward and forms new layer consistently.
- At numerous places, in between the cells pigmented dendritic cells are found, these cells are called **melanophores** or **melanocytes**.
- Melanocyte arise from melanoblasts which are present at the junction of epidermis with dermis.



- In cytoplasm of melanocytes numerous granules are found called **melanosomes**.

  In this granules melanin is synthesized. **Melanin** is a pigment of black colour.
- Melanin get synthesized from amino acid **tyrosine**. Enzyme **tyrosinase** induces melanin synthesis.
- In an organism (man in particular) inability of synthesis of an enzyme tyrosinase leads to a genetical disease **albinism**. In albinism a person lacks pigment completely.

Note :

- Melanin prevents skin cancer and mutation which leads to cancer, It absorbs harmful radiation (U.V.radiation).
- In lower vertebrate like amphibian and reptilian pigmented cells are found in dermis, these cells are called **chromatophores**. These pigmented cells of lower vertebrates have capacity to change colour of the pigment, this unique capacity is called **metachrosis**.

- Mammals, birds lacks this quality and capacity. On basis of pigment, chromatophores are of numerous types-

(a) Melanophores

In it melanin pigment is found.

It is of brown and black colour.

(b) Guanophores

In it crystal of guanine is found.

It is bright white in colour.

(c) Lipophore

Yellow coloured pigment lipids are found, called chromolipids. eg. Carotene.

Note :

- In fishes, amphibians, and reptilians, capacity of colour changing is controlled by MSH which is secreted by middlelobe of pituitary.

2. Stratum spinosum

- This is a stratum of six or seven sub layers of cell next to the stratum malpighi
- Cell of these layers are **polyhedral.**
- It provides **rigidity** to the epidermis.
- In cytoplasm of the cells of this layer numerous Golgi complex and mitochondria are found.

3. Stratum granulosum

- The cells of this layer are flattened or diamond shaped.
- Their nuclei are denser and cytoplasm contain the basophilic and **keratohyaline protein**.

4 Stratum lucidium

- This is the fourth layer which is not always seen.
- In these the keratohyaline, granule first dissolve and then transform into a protein, **eleidin**. Which is semi transparent and water proof and acts as a barrier layer.

5 Stratum corneum

- It is thickest and outermost layers of epidermis with 99% dead cells. The cells dies because of keratinisation and cornification.
- Composed of 8 to 10 layers
- It lack nucleus.
- Cells of this layer are scale like
- Eleidin present in cytoplasm get transformed into nonliving **keratin** which is **sceloprotein**.
- Majority of cells of this layer are non-living.
- It is thick at palm and sole.
- In this layer some living cells are found, which secretes hormones, these hormones controls the cell division of malphighi layer.
- S.corneum undergoes periodic shedding in pieces. This is called as Ecdysis. Complete shedding called sloughing occurs in snakes.

Note :

- Exoskeleton is formed from this layer in mammals and other vertebrates.

  eg. Hair, Nails, Wings beak etc.

DERMIS

General character

- Dermis originates from **mesoderm**.
- It is 2-3 times thick in comparison to epidermis.
- It is composed of connective tissue. In it white collagen fibres, white elastic fibres and unstriated muscle fibres are found.
- Elastin fibre provides flexibility whereas, collagen provides strength which makes dermis strong.
- Dermis is thick in male in comparison to female. From dermis leather is obtained, to obtain leather epidermis is dissolved, and this process is called **Tanning**.

Note :

Preservation of complete skin along with hairs are called **Taxidermy**.

Layers of Dermis

Dermis is composed of two layers :

Papillary layer

Reticular layer

1. Papillary layer (Pars Papillaris)

It is outer layer

This layer at many places remains embedded in epidermis called **dermal papilla**.

Collagen fibres are less in this layer.

Its lines are called (lines of langerhans)

In this layer tactile corpuscles or meisners granules are found. It is found in large number at the tips of fingers.

2. Reticular layer (Pars Reticularis)

It is thick in comparson to papillary layer.

It this layer at numerous places **mast cells**, **macrophages** and **melanin pigment** are found.

Large number of collagen fibres are found in this layer. These fibre is responsible for stretching of skin.

STRATUM ADIPOSUM (PANNICULUS ADIPOSUS)

This layer is composed of adipose tissues and lies just below dermis.

This layer is extremely thick in whale, elephant, rhino, and called **blubber**.

Functions of stratum adiposum

(i) It acts as **shock absorber**.

(ii) It is site of food storage.

(iii) It acts as heat insulator.

(iv) It helps in attaining shape to the body.

DERIVATIVES OF SKIN

Derivatives of skin includes

- Epidermal gland
- Exoskeleton structure
- Integumentary receptor

EPIDERMAL GLAND

Epidermal gland of skin includes :

- Sweat gland
- Sebaceous gland
- Meibomian gland
- Lacrymal gland
- Mammary gland
- Tyson gland
- Zeis gland

1. Sweat gland

- Sweat gland is also called sudoriferous gland.
- Sweat glands are simple coiled or simple branched tubular glands located in deeper zone of dermis.
- It is at most places merocrine gland but in some parts of body it is apocrine gland.
- In man over 2.5 million sweat glands is found, maximum on palm and sole, and is absent on **glanspenis** and lips.
- It is absent in dog, whale, shrew,, moles, cetacean, spinyanteater, sirenia.
- Red coloured sweat is produced in **Kangaroo**, **Hippopotamus** and **Rhesus monkey**.
- In rabbit maximum sweat glands found on lips.

Functions of Sweat gland

The chief function of sweat gland is as follows :

(i) Thermoregulation (ii) Excretion (iii) Water balance

2. Sebaceous gland

- Sebaceous gland is also called **oil gland**.
- Sebaceous gland generally remain associated with hair follicle but it may exist without hair follicle like in **glans penis**.
- It is branched alveolar gland, **holocrine** in nature.
- It secrets sebum which makes the skin and hair water proof.
- In sebum cholesterol is found which synthesizes vitamin D in presence of sunlight.
- In human being sebaceous gland is not found on palm, sole, forehead & face (maximum)

3. Meibomian gland

- Meibomian gland is modified sebaceous gland.
- It is found in the dense connective tissue plate (tarssus) that support the free edges of each eyelid.
- It opens into follicle of eye lashes
- It produces oily secretion which keeps the cornea moist and prevent from getting dried, moreover only secretion forms a thin film over the layer of lacrimal fluid.

4. Lacrimal gland

- Lacrimal gland is tear gland found beneath upper eyelids and produce watery secretion (tears) to keep eyes moist.

5. Mammary gland

- Mammary gland is modified sweat gland. It is compound tubulo alveolar, apocrine gland.
- It is characteristic feature of mammals, present in both sex, in human male it is vestigeal.
- In rabbit **4-5 pairs of mammary glands** are found on abdomen; whereas in human it is one pair.

Note :

- Study of mammary gland is called **Mastology**.
- Early milk which comes out after child birth is called **colostrum**.

6. Perineal gland or Inguinal gland

- These glands are found around the anus of rabbit and releases certain thin liquid of typical smell which attract animal of opposite sex. **Pheromones** are found in secretion of these gland.
- Except human it is found in all mammals.

7. Tyson gland

- It is modified sweat gland, apocrine glands, present in skin of prepuce of **glans penis**.
- It produces smegma which lubricates the glanspenis, during copulation.

8. Zeis gland

- Zeis gland is modified sebaceous gland found in skin of eye lashes.
- It opens into hair follicles of eyelashes.
- Its secretion keeps eyelashes smooth and supple.

9. Ceruminous gland

- Ceruminous gland is modified sebaceous gland, Holocrine
- It is found in skin of external auditory canal.
- It secrets cerumin which is called ear wax.
- It protects ear drum.

EXOSKELETON STRUCTURE

- Exoskeleton of skin is composed of **keratin**.
- Exoskeleton of skin includes, hairs scales, nail, horn claws, feather.

Hair

Hairs are characteristic feature of mammals. It develops as a thickening of the stratum germinativum of the epidermis.Each hair lies in a tubular pit called hair **follicle**.

Hair follicle

Hair follicle is composed of 2 layers outer layer and inner layer.

Outer layers is composed of stratum spinosum like cells whereas inner layers is composed of 3 sub layer, which are as follows.

(a) Cuticle (b) Huxley layer (c) Henley layer

Cuticle - It is innermost layer and is composed of dead, flat cells.

Huxley layer - Nucleus of this part of cells is horney.

Henley layers - Within cells of this layers **cuboidal nucleus** is found.

At the base of the hair, hair follicle invaginates inward to form **hair papilla**. Within hair papilla bunch of blood capillaries and nerve fibres are found.

Structure of hair

- Hair shaft - Part of hair which comes out of epidermis called hair shaft.
- Hair root - Hair root is slightly bulged called hair bulb. The cells of hair bulb just above hair papilla are live and divisible and is called **germinal matrix of hair**. Due to division of these cells, hair increases in size.

Note :

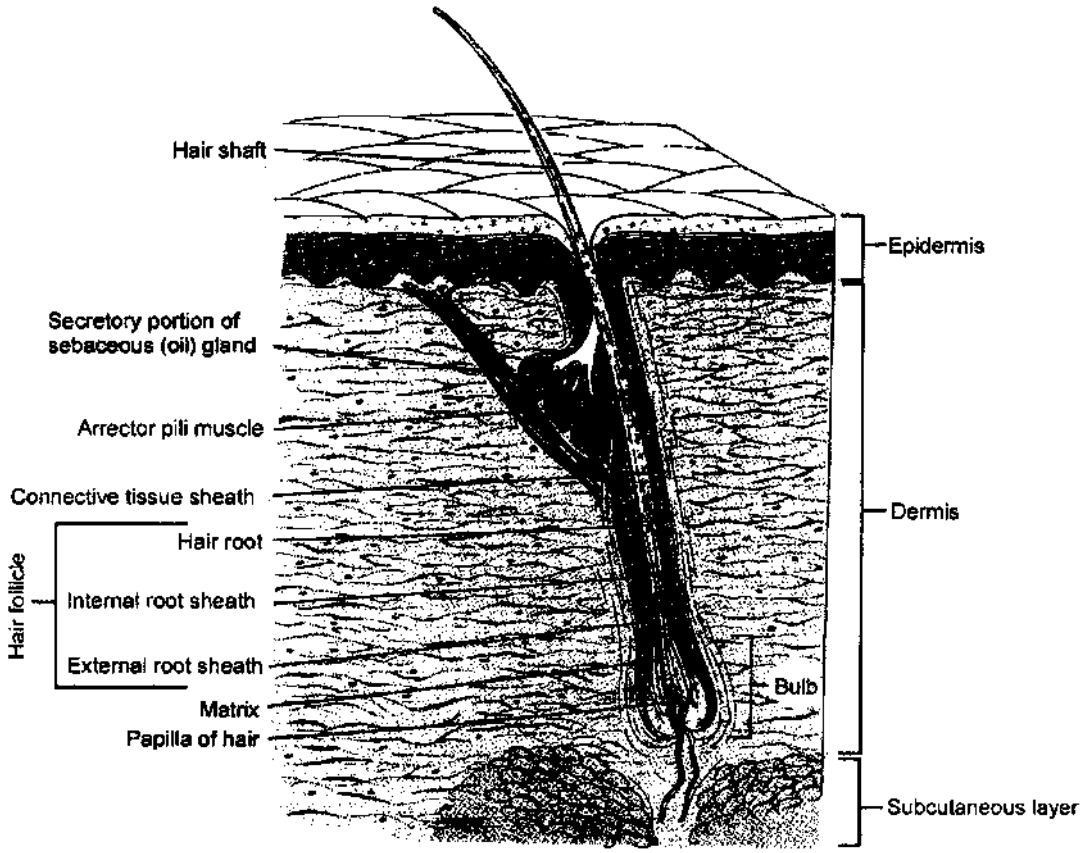
- Except germinal matrix of hair rest part of hair is composed of dead & keratinized cells.

Arrector Pilli

An arrector pilli muscles connect each hair with basement membrane of epidermis. When **arrector pilli** contracts it squeezes the oil out from the sebaceous gland, it results in errection of the hair. This process is

called Goose flesh. The contraction of arrector pilli muscle takes place due to adrenalin and sympathetic stimulation.

In T.S. of hair possess 3 regions :



- **Medulla -** It is large, vacuolated moderately keratinized cells is found.
- **Cortex -** It is middle layer heavily keratinized cells are found.
- **Cuticle -** It is outer most layer. It is Heavily keratinized overlapping cells are found having their free ends directed upward. Melanocyte present in hair bulb produces and transfer melanin to the cortical cells of the hair.

Note :

- In old age hair turns grey because air spaces between the cells of the medulla increases in number and pigment formation decreases.
- In old age hair loss becomes more because of reduction of blood supply.
- Hair on human body is vestigeal organ.

Functions

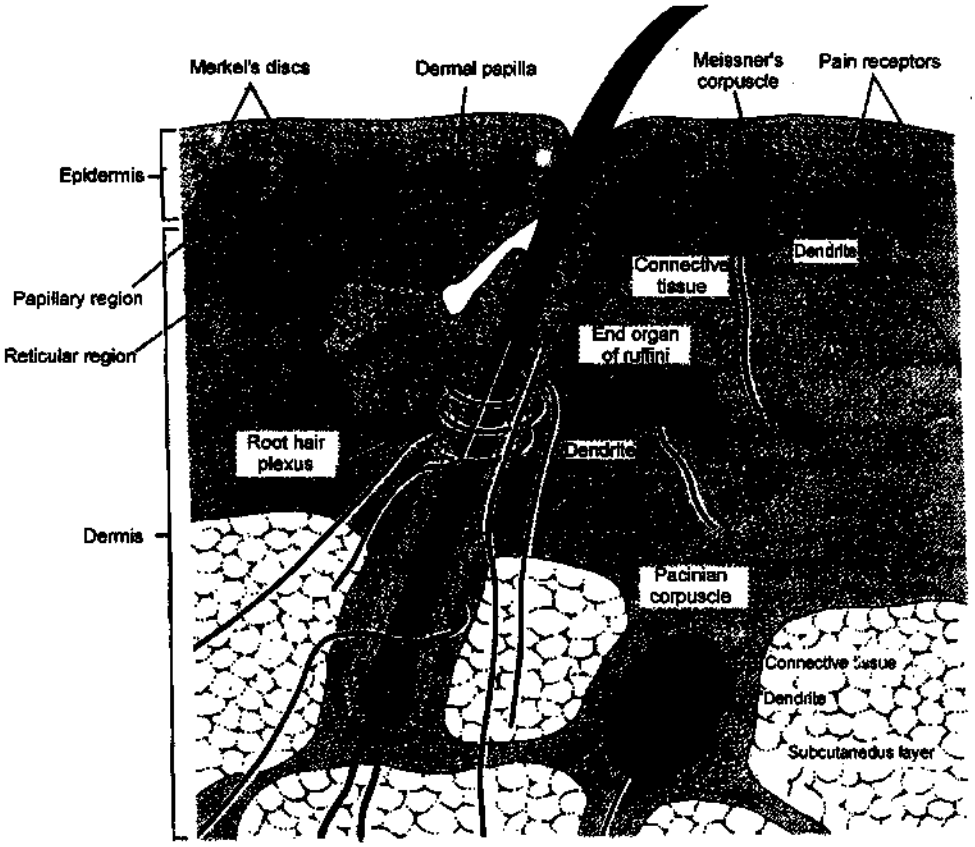
- Eyelashes, hairs in the nostril and ear canal, Keep out dust particles.
- Hair follicle helps in repairing the epidermis injured by burns and because it is deeply seated and retain stratum germinitavum.

INTEGUMENTARY RECEPTOR

1. Algesireceptor

- It is pain receptor.
- It is composed of naked nerve fibre.
- In human body 40 lakhs algesi receptor are found.

- It is maximum in all cutaneous receptor



Structure and location of cutaneous receptors

2. Tangoreceptor

- It provides sense of touch.
- In human body 5 lakhs **tangoreceptor** is found it is of numerous type which are as follows :

(a) Meissener's corpuscles

- It is found mainly and in maximum numbers on nipple, glanspenis, lips, end of finger tips, on palm, clitoris etc.

Note : Those meissners corpuscles which are found on external genital organ are called **genital corpuscles**.

(b) Merkel's discs

- Merkel's discs are found in epidermis are their junction with dermis of human and other mammals. These are absent in Rabbit.

3. Pacinian corpuscles (Proprioreceptors)

- Pacinian corpuscles are pressure receptors or baroreceptor.
- It is found deep in dermis.

4. End bulb of Krause or end organs of Ruffini

- Both are thermo receptor.
- Bulb of Krause is sensitive to Cold. (frigidoreceptors)
- End organ of Ruffini is sensitive to Hot. (Caloreceptors)

FUNCTIONS OF SKIN

(a) **Protection** - Skin forms cover on organs and protects the body from mechanical injury.

(b) **Safety against sunburn -** Melanin of epidermis gives protection against ultravoilet rays of sun, these rays causes sunburn.

(c) **Excretion** - The skin removes the excess of water, lactic acid, traces of urea and some salt (chiefly NaCl) from the blood as sweat. As a result of keratinization, horny dead cells are produced constantly, sheeding of corneal layer is a kind of excretion.

(d) **Secretion -** Skin secrets numerous important substances which is very important for survival of an animal. Preen gland in bird produces oil for water proofing their feather.

(e) **Chemical defence** - The sweat, oil and wax from skin gland contain lactic acid and fatty acid. These acids make the pH acidic enough to kill or retard the growth of many bacteria and fungi.

(f) **Nourishment -** The skin is capable of forming vitamin D from a cholesterol derivative in the presence of sunlight.

(g) **Barrier to germs and poison -** The outer hard and horney layer of insect checks the entry of microrganisms in the body.

(h) **Heat conservation -** Hair tend to trap a layers of air which insulates the body, reducing heat exchange with the environment. In some mammals such as sheep and rabbit, air retaining capacity is increased by the hairs sticking together to make a belt, subdermal fat also prevents body heat.

(i) **Regulation of body temperature -** The normal body temperature of man is 98.4 ºF. (37ºC). The temperature is maintained in all seasons. The sweat cools the skin if it get overheated. In winter, blood capillaries which lead to skin undergo constriction called **vasoconstriction**, as a result heat not get lost from the body. In contrast, in summer dilation takes place in blood capillaries which is called **vasodilation,** as a result heat get lost from the body.

Note :

In summer rabbit erect their ears as a result heat is lost through blood capillaries of ear.

- In summer dogs loses their body temperature through tongue by excessive salivation and panting .

SPECIAL POINTS

- During embryonic conditions, soft hair is called **lanugo**.
- In leucoderma skin pigment is not found at some places.
- Brown fat found in neonates, it prevents neonates from cold.
- During sweating PH of skin becomes 3 to 5.
- Sweat, saliva, tears possess **lysozyme**, which destroys microorganism.
- About 80 to 100 hairs are lost per day.
- Thinnest skin occurs over the eyelids. Thinnest epideris is of conjuctiva.
- **Bradykinin**- When body temperature rises the sweat gland release potent vasodilator peptide **bradykinin**, which dilates blood vessel to lose heat quickly.
- Vibrissae - These are special long, stiff sensory hair on the side of the mouth of certain mammals, such as rabbit and lion.(Vibrioreceptors)
- Seborrhoea - Oversecretion of sebaceous glands is called seborrhoea.
- The skin of older people becomes loose and wrinkled because elasticity of dermis decreases.
- During life time 23 kg of skin is shed.
- Goose flesh is also called **cutis anserina** (Erection of Hairs on skin).
- Colour variation in human being depends upon amount and colour of melanin rather than the number of melanocytes.
- Hippoptamus have sweat glands only on pinnal.

EXERCISE - 1

Q.1 Dermis develops from :–
(1) Ectoderm (2) Endoderm
(3) Visceral mesoderm (4) Mesoderm

Q.2 The substance responsible for making the stratum lucidum layer transparent is :–
(1) Eleidin (2) Keratin
(3) Keratohyalin (4) Albumin

Q.3 Vibrissae of Rabbit are :–
(1) Sensory organ (2) Nervous organ
(3) Female organ (4) Male organ

Q.4 Which one of the following muscles are responsible for moving and shaking the skin –
(1) Arrector pilli (2) Collagen fibres
(3) Paniculus carnosus (4) Sphincter muscles

Q.5 Lacrimal glands produces :–
(1) Sebum (2) Mucous
(3) Tear (4) Sweat

Q.6 Sebum is secreted by :–
(1) Ceruminous glands (2) Sweat glands
(3) Sebaceous glands (4) Mammary glands

Q.7 Hairs of man are :–
(1) Hollow (2) Solid
(3) Colourless (4) None

Q.8 Healing of wound takes place by :–
(1) St. corneum (2) St. malpighi
(3) Both (4) None

Q.9 Oil glands of the body are :–
(1) Sweat glands (2) Sebaceous glands
(3) Ceruminous glands (4) All of the above

Q.10 Xanthophores contain–
(1) Yellow pigment (2) Black pigment
(3) Green pigment (4) None

Q.11 Chromatophores are associated with :–
(1) Temperature regulation
(2) Respiration
(3) Colour changing
(4) None

Q.12 Exoskeleton is absent in :–
(1) Fishes (2) Amphibians
(3) Reptiles (4) Mammals

Q.13 Herbert corpuscles are found in :–
(1) Skin of mammals
(2) Buccal cavity of birds
(3) Ligament and tendon
(4) Rectum of frog

Q.14 Receptors of hunger pongs and pain are present in alimentary canal. These are known as :–
(1) Visceral receptors (2) Extero receptors
(3) Somatic receptors (4) None

Q.15 Receptors of the skin are called :–
(1) Gland receptors (2) Somatic receptors
(3) Visceral receptors (4) Intero receptors

Q.16 In nasal passage, the turbinal bones are present in which of the following groups :–
(1) In all vertebrates (2) Amphibia
(3) Mammals (4) None

Q.17 Receptors which are sensitive to pain are :–
(1) Tangorecptors (2) Frigido receptors
(3) Rheoreceptors (4) Nociceptor

Q.18 Nasal cavity has large number of :–
(1) Blood cells (2) Sensory cells
(3) Cuboidal cells (4) None

Q.19 Grandy's corpuscles are found in :–
(1) Frog (2) Birds
(3) Rabbit (4) All

Q.20 Dermis of mammalian skin is mainly composed of
(1) Muscular tissue (2) Connective tissue
(3) Epithelial tissue (4) All of the above

Q.21 Pigment of hair occur in :–
(1) Hair sheath (2) Cortex
(3) Medulla (4) Hair follicle

Q.22 Which of the following hormone is involved in homiothermy :–
(1) Glucocorticoids (2) Insulin
(3) Thyroxine (4) Adrenaline

Q.23 The fibres that make the skin elastic are :–
(1) Collagen fibres
(2) Yellow fibres
(3) Smooth muscle fibres
(4) Striated muscle fibres

Q.24 Peritoneum of rabbit invests its :–
(1) Erythrocytes (2) Integument
(3) Heart & lungs (4) Visceral organs

Q.25 In the mammalian skin, the adipose tissue is found:–
(1) In the epidermis (2) In the muscles
(3) In the dermis (4) Below the dermis

Q.26 Keratin of the integument is the :–
(1) Mucoprotein (2) Scleroprotein
(3) Cartilage (4) Bony tissue

Q.27 In rabbit, the thermoregulatory mechanism is basically–
(1) A neuro endocrine synergisue
(2) An endocrine based phenomenon
(3) A neural process
(4) A compound sensory neuro endocrine integrative mechanism

Q.28 Sweat glands are located in–
(1) Granular layer of epidermis
(2) Dermis
(3) St. malpighi (4) St. lucidum

Q.29 Integument does not perform the function of–
(1) Absorption (2) Protection
(3) Excretion (4) Circulation

Q.30 The brown colour of the skin is due to :–
(1) Haemoglobin (2) Haemoerythrin
(3) Porphyrin (4) Chromophils

Q.31 Stratum Iucidium is found in :–
(1) Epidermis below stratum corneum
(2) Dermis
(3) Epidermis where root hair follicles occur
(4) Dermis and secrete keratin

Q.32 Cutaneous glands are :–
(1) Gastric glands (2) Sebaceous glands
(3) Thyroid gland (4) Thymus gland

Q.33 Meibomian glands of rabbit are modification of–
(1) Sweat glands (2) Oil glands
(3) Mullerian glands (4) Tonsils

Q.34 If skin has lesions, the food must contain-
(1) Green vegetables (2) Ca & Fruits
(3) Ca (4) Vitamin C

Q.35 Skin is made up of -
(1) Dermis (2) Epidermis
(3) Both of these (4) None of these

Q.36 Which is apocrine gland-
(1) Meibomian gland (2) Zeis gland
(3) Tyson gland (4) Moll gland

Q.37 Which is holocrine gland-
(1) Mammary gland (2) Ceruminous gland
(3) Meibomian gland (4) Perineal gland

Q.38 Hair shaft consist of-
(1) Cuticle (2) Cortex
(3) Medulla (4) All of the above

Q.39 The function of skin is-
(1) Sexual attraction (2) Chemical defence
(3) Storage of food (4) All of the above

Q.40 Propria receptors respond to-
(1) Mechanical stimuli (2) Chemical stimuli
(3) Both 1 & 2 (4) None of these

Q.41 The horns of Rhinoceros are composed of-
(1) Bone (2) Cartilage
(3) Chitin (4) Keratin

Q.42 Cerumen is secreted by-
(1) Apocrine sweat glands
(2) Holocrine sebaceous glands
(3) Apocrine mammary glands
(4) Merocrine sweat glands

Q.43 Derivative of sweat glands is-
(1) Moll's gland (2) Scent gland
(3) Sebaceous gland (4) Mammary glands

Q.44 Silver colour of many fishes due to-
(1) Iridiocytes (2) Leukocytes
(3) Chromophores (4) Dermocytes

Q.45 Stratum corneum is-
(1) Dead mid-dermal layer
(2) Dead and innermost dermal layer
(3) Dead outermost epidermal layer
(4) Outermost dermal layer

Q.46 Stratum corneum is absent in-
(1) Bony fish (2) Amphibians
(3) Reptiles (4) All the above

Q.47 The scales characteristic of the cartilaginous fish are-

(1) Casmoid (2) Ganoid

(3) Placoid (4) Cycloid

Q.48 Periodical shed of epidermal covering in snakes is called-

(1) Dysis (2) Ecdysis

(3) Keratinization (4) None of these

Q.49 The gland cells and nerve plexus is-

(1) In between outer and inner epithelial layers

(2) In the outer epithelial layers

(3) In the inner epithelial layers

(4) Amidst ectodermal cells

Q.50 In mammals melanocytes give protection from-

(1) UV-rays (2) Infrared rays

(3) X-rays (4) Visible light

Q.51 Dermal papillae are present on-

(1) Tips of fingers (2) Palm of hand

(3) Sole of foot (4) All of these

Q.52 Hair increases every day-

(1) 4 mm (2) 1 mm

(3) 8 mm (4) 3 mm

Q.53 Stratum germinativum is an epithelium of the type-

(1) Squamous (2) Ciliated

(3) Columnar (4) Cuboidal

ANSWER KEY

EXERCISE - 1

Q.1	4	Q.2	1	Q.3	1	Q.4	3	Q.5	3	Q.6	3	Q.7	1
Q.8	2	Q.9	2	Q.10	1	Q.11	3	Q.12	2	Q.13	2	Q.14	1
Q.15	2	Q.16	3	Q.17	4	Q.18	2	Q.19	2	Q.20	2	Q.21	2
Q.22	3	Q.23	2	Q.24	4	Q.25	4	Q.26	2	Q.27	4	Q.28	2
Q.29	4	Q.30	3	Q.31	1	Q.32	2	Q.33	2	Q.34	4	Q.35	3
Q.36	4	Q.37	3	Q.38	4	Q.39	4	Q.40	3	Q.41	4	Q.42	1
Q.43	4	Q.44	1	Q.45	3	Q.46	1	Q.47	3	Q.48	2	Q.49	1
Q.50	1	Q.51	4	Q.52	2	Q.53	3						

EXERCISE - 2

Q.1 Skin effect due to pattern of lines is called :–
(1) Dermatoglyphics (2) Taxidermy
(3) Dermatology (4) Liner graridarum

Q.2 Which of the following induces goose flesh :–
(1) Adrenal Cortex (2) Adrenal medulla
(3) Pituitary (4) Thyroxine

Q.3 Goose flesh in severe cold :–
(1) Reduces heat loss from body
(2) Increases heat loss from body
(3) Protects animal from external shocks
(4) Decrease activity of sweat glands

Q.4 Dense pelage is characteristic of animal inhabiting:–
(1) Cold Climate (2) Warm climate
(3) Tropical climate (4) Aquatic

Q.5 Skin epidermis is composed of :–
(1) Fibrous connective tissue
(2) Areolar tissue
(3) Stratified columnar epithelium
(4) Stratified squamous epithelium

Q.6 Which layer of skin possibly secretes harmones:–
(1) St. Malpighi (2) St. Lucidum
(3) St. granulosum (4) St. corneum

Q.7 Barrier layer refers to :–
(1) St. corneum (2) St. lucidum
(3) St. spinosum (4) St. germinivatum

Q.8 Dermis of rabbit is differentiated in :–
(1) St. compactum and St. spongiosum
(2) Papillary and Subcutaneous layer
(3) Papillary and reticular layer
(4) Parietal and visceral layer

Q.9 Which type of sweat glands secrete a pale sweat–
(1) Eccrine (2) Apocrine
(3) Holocrine (4) Endocrine

Q.10 In which layer of skin blood capillaries are absent:–
(1) Dermis (2) Epidermis
(3) Subcutaneous layer (4) Muscle layer

Q.11 Integument consist of :–
(1) Skin
(2) Skin + skin derivatives
(3) Skin + glands (4) Skin + hairs

Q.12 Integument of rabbit :–
(1) Conserves heat in winter
(2) Looses heat during summer
(3) Protects body (4) All the above

Q.13 Preservation of whole skin is called :–
(1) Tanning (2) Taxidermy
(3) Teratology (4) Toxicology

Q.14 Complete absence of melanin pigment in skin is called :–
(1) Albinism (2) Cretinism
(3) Alkaptunuria (4) Colour blindness

Q.15 Cell of stratum malpighi are :–
(1) Oval (2) Flat
(3) Columnar (4) Spherical

Q.16 Pigmented dendritic cells occur in :–
(1) Stratum malpighi (2) St. granulosum
(3) St. corneum (4) St. lucidum

Q.17 Which layer is thickest in sole and palm :–
(1) Corneum (2) Spinosum
(3) Granulosum (4) Subcutaneous

Q.18 Horns, Nails and hairs composed of :–
(1) Collagen (2) Elastin
(3) Keratin (4) Cutin

Q.19 Primary function of sweat glands is :–
(1) Thermoregulation (2) Excretion
(3) Osmoregulation (4) None of these

Q.20 Main function of mammalian skin is :–
(1) Removal of excess water
(2) Excretion
(3) Storage of food
(4) Acting as receptor organ

Q.21 Pressure receptors in skin :–
(1) Meissner's corpuscles
(2) Merkel's disc
(3) Pacinian corpuscles (4) Krause corpuscles

Q.22 Which of the following stimulated by cold :–
(1) End organ of Ruffini
(2) Meissner's Corpuscles
(3) End bulb of Krause
(4) Whiskers

Q.23 The tips of penis and Clitoris are more sensitive because of :–
(1) Genital corpuscles
(2) Sebaceous glands
(3) End organ of ruffini
(4) Pacinian corpuscles

Q.24 Type of locomotion in rabbit is :–
(1) Plantigrade (2) Digitigrade
(3) Unguligrade (4) None

Q.25 Blubber occurs in :–
(1) Seal (2) Whale
(3) Dolfins (4) All the above

Q.26 Which bone derived from skin :–
(1) Skull bones (2) Patella
(3) Flat bones (4) All the above

Q.27 Melanocytes are :–
(1) Cuboidal (2) Round
(3) Dendritic (4) Type of neuron

Q.28 Rabbit lives in :–
(1) Grass land (2) Burrows
(3) Warren (4) Caves

Q.29 Pars papillaris and pars reticularis are the regions of-
(1) Epidermis (2) Corium
(3) Hypodermis (4) None of the above

Q.30 Arrector pili muscles are :–
(1) Voluntary
(2) Involuntary
(3) Voluntary as well as involuntary
(4) None of the above

Q.31 In rabbit, sweat glands are present in :–
(1) Near the eyes (2) The digits
(3) The lips (4) None of the above

Q.32 Horns of Rhinoceros are made up of :–
(1) Keratin (2) Chitin
(3) Bone (4) Cartilage

Q.33 Sebaceous glands secrete oily substance to:–
(1) Make body surface smooth and water proof
(2) Help in temperature regulation
(3) Keep body warm (4) None of these

Q.34 Which of the following is present in frog's skin but not in mammalian skin :–
(1) Sebaceous glands
(2) Stratum germinativum
(3) Malpighian layer (4) Mucous glands

Q.35 Mammary gland are the modification of :–
(1) Sebaceous glands (2) Sweat glands
(3) Meibomian glands (4) None of these

Q.36 Sweat glands are primarily connected with :–
(1) Dissipation of body heat
(2) Regulation of water content
(3) Removal of extra salts
(4) Destroying skin bacteria

Q.37 Mucous glands do not occur in mammalian skin because it is :–
(1) Not respiratory (2) Tough
(3) Many layered (4) Not slippery

Q.38 Nails, claws, horns and hoofs are formed by–
(1) Cartilage (2) Bone
(3) Stratum corneum of skin
(4) Skin muscles

Q.39 Ecdysis is shedding of :–
(1) Stratum corneum (2) Epidermis
(3) Dermis (4) Stratum malphigi

Q.40 Simple coiled tubular glands occur in :–
(1) Dermis of skin (2) Spleen
(3) Liver (4) Kidney

Q.41 Organs of Ruffini are receptors of :–
(1) Cold (2) Pressure
(3) Heat (4) Touch

Q.42 Blood vessels do not pierce :–
(1) Dermis (2) Endodermis
(3) Epidermis (4) None of the above

Q.43 Epidermis of skin of vertebrates comprises :–
(1) Simple epithelium (2) Stratified epithelium
(3) Transitional epithelium
(4) Columnar epithelium

Q.44 Dermis of the skin is formed of :–

(1) Adipose connective tissue

(2) Epithelial tissue

(3) Muscular tissue

(4) Areolar connective tissue

Q.45 Yellow fibers are made up of :–

(1) Ossein (2) Elastin

(3) Chondrin (4) Collagen

Q.46 Complexion of skin in human beings is a mixed effect of :–

(1) Keratin, Melanin and haemoglobin

(2) Carotene, Keratin and haemoglobin

(3) Carotene, Melanin and haemoglobin

(4) Keratin, albinism and melanin

Q.47 Maximum tactile receptors are found on :–

(1) Lips and nipples

(2) Glans penis and valva

(3) Tips of Fingers (4) All of the above

Q.48 Which cell types occur in maximum percentage in skin epidermis of mammals :–

(1) Keratinocytes (2) Melanocytes

(3) Granulocytes (4) All the above

Q.49 Naked dendrites are receptors for :–

(1) Smell (2) Touch

(3) Taste (4) None of these

Q.50 Sweat glands in Rabbit are mainly found :–

(1) Near the lips (2) Base of tail

(3) Wide spread over the body

(4) Underside of claws

ANSWER KEY

EXERCISE - 2

Q.1	1	Q.2	2	Q.3	1	Q.4	1	Q.5	4	Q.6	4	Q.7	2
Q.8	3	Q.9	2	Q.10	2	Q.11	2	Q.12	4	Q.13	2	Q.14	1
Q.15	3	Q.16	1	Q.17	1	Q.18	3	Q.19	1	Q.20	4	Q.21	3
Q.22	3	Q.23	1	Q.24	2	Q.25	4	Q.26	4	Q.27	3	Q.28	3
Q.29	2	Q.30	2	Q.31	3	Q.32	1	Q.33	1	Q.34	4	Q.35	2
Q.36	1	Q.37	1	Q.38	3	Q.39	1	Q.40	1	Q.41	3	Q.42	3
Q.43	2	Q.44	4	Q.45	2	Q.46	3	Q.47	1	Q.48	1	Q.49	2
Q.50	1												

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Mammary glands are modified-**[CPMT 1993]**
(1) Sweat gland (2) Sebaceous gland
(3) Alveolar gland (4) Oil gland

Q.2 Hair are - **[CBSE 1993]**
(1) Epidermal and made up of non living cells
(2) Dermal and made up of living cells
(3) Epidermal and made up of living cells
(4) Dermal and made up of non living cells

Q.3 Secretion of gland is- **[CBSE 1993]**
(1) Holocrine (2) Apocrine
(3) Eccrine (4) Merocrine

Q.4 Coiled tubular glands are present in- **[CPMT 1993]**
(1) Villi (2) fundus of stomach
(3) skin dermis
(4) seminiferous tubules

Q.5 Which pair respectively gives opposite characteristics of frog and rabbit- **[CPMT 1994]**
(1) carnivorous : omnivorous
(2) white-coloured : green - coloured
(3) ectothermic : endothermic
(4) None of these

Q.6 Which one of the following sets of derivatives of integumentary structures characterise birds as glorified reptiles ? **[PCS 1994]**
(1) Syrinx and scales
(2) Scales and claws
(3) Claws and uropygial glands
(4) Syrinx and uropygial glands

Q.7 'Human thermostat' is- **[RPMT 1994]**
(1) Kidney (2) Medulla oblongata
(3) Hypothalamus (4) Pineal gland

Q.8 The term 'blubber' refers to- **[Karnataka CET 1994]**
(1) a substitute for natural rubber
(2) a subcutaneous deposition of fat in whales
(3) the irregular heart-beat sounds
(4) none of these

Q.9 A main function of skin in mammals is to- **[CPMT 1995]**
(1) Provide protection
(2) Prevent bacterial infection
(3) Cool the body in hot climate conditions
(4) None of these

Q.10 In Minamata Bay, Japan which animal remained free from Minamata disease - **[CBSE 1995]**
(1) Cat (2) Dog
(3) Rabbit (4) Pig

Q.11 Vibrissae of rabbit are- **[CPMT 1996]**
(1) papillae upon skin
(2) skin webs between toes
(3) long tactile hairs upon upper lip
(4) kill any bacteria present on the skin

Q.12 Nails, hoofs and horns are derived from the tissue: **[Orissa JEE 1996]**
(1) Cartilage (2) Bone
(3) supporting tissue (4) Epithelium

Q.13 The function of the sebaceous gland in the skin of a mammal is to : **[PCS 1997]**
(1) Remove waste matter from the skin
(2) Make skin soft and oily
(3) Maintain body temperature
(4) kill any bacteria present on the skin

Q.14 Stratum germinativum is derived from which epithelium - **[CBSE 97, CPMT 1997]**
(1) Columnar (2) Cuboidal
(3) Squamous (4) Ciliated

Q.15 Which gland is present in frog's skin but not in rabbit's skin - **[MP PMT 1997]**
(1) Moll's gland (2) Mucous gland
(3) Sweat gland (4) Sebaceous gland

Q.16 In human body ectoderm is responsible for the formation of - **[BHU 1997]**
(1) Lens of eye (2) Nervous system
(3) Sweat glands (4) All of them

Q.17 Mode of secretion by sebaceous (sebum-secreting) glands is- **[CMPT 1993, 97]**
(1) Merocrine (2) Apocrine
(3) Merocrine (4) Holocrine

Q.18 Epidermis of the skin is specialized for : **[CPMT 1998]**
(1) protection (2) respiration
(3) absorption (4) all of these

Q.19 Vitamin D_3 is produced in the skin by the action of sunlight upon : **[BHU 1998]**
(1) cephalocholesterol (2) Δ 5,7-cholesterol
(3) 1,4-dihydroquinone (4) all of these

Q.20 Melanoblasts lie : **[MPPMT 1998]**

(1) In dermis

(2) In stratum corneum

(3) In stratum Malpighi

(4) At the junction of epidermis and dermis

Q.21 Cutaneous glands are- **[MPPMT 1998]**

(1) Sebaceous glands (2) gastric glands

(3) thyroid glands (4) thymus glands

Q.22 Thermoregulatory centre in mammals is located in- **[CPMT 1983, 84, 86, 88; BHU 1998]**

(1) Skin (2) Pituitary

(3) Diencephalon (4) Hypothalamus

Q.23 Pacinian corpuscles are receptor of- **[RPMT - 98]**

(1) Deep pressure (2) Pain

(3) Temperature (4) Hearing

Q.24 Exposed surface of the human body is covered by the tissue- **[RPMT - 98]**

(1) Glandular epithelium

(2) Striated squamous epithelium

(3) Ciliated epithelium (4) Epidermis

Q.25 Sharpey's fibres are invaded in- **[RPMT - 98]**

(1) Collagen (2) Muscle

(3) Bone (4) Skin

Q.26 In frog, stratum spongiosum is made up of : **[EAMCET 1999]**

(1) stratified epithelium

(2) dense connective tissue

(3) loose fibrous connective tissue

(4) none of these

Q.27 Which structure is formed by keratin ? **[RPMT - 99]**

(1) Dermal papilla (2) Hair shaft

(3) Root of hair (4) Hair follicle

Q.28 Which one of the following is a matching pair of a certain secretion and its primary role in human physiology ? **[CBSE 2000]**

(1) Saliva—tasting food

(2) Sebum—sex attraction

(3) Sweat—thermoregulation

(4) Tears—excretion of salts

Q.29 Which one of the following animal contains idiophores in its integument ? **[RPMT - 2000]**

(1) Dog fish (2) Parrot

(3) Siren (4) Orangutan

Q.30 An example of merocrine gland is- **[MPPMT 2001]**

(1) Sebaceous gland (2) Pineal gland

(3) Salivary gland (4) Mammary gland

Q.31 During aging collagen present in intercellular spaces becomes - **[MPPMT 2001]**

(1) Destroyed

(2) Impermeable and rigid

(3) More elastic (4) All of the above

Q.32 Which one of the following is compound tubular gland - **[CPMT 2001]**

(1) Sweat gland (2) Sebaceous gland

(3) Mammary gland (4) Salivary gland

Q.33 The adipose tissue in the skin is found in the : **[RPMT - 2001]**

(1) dermis (2) subcutaneous layer

(3) Malpighian layer (4) epidermal layer

Q.34 The colour of the skin is due to the presence of : **[RPMT - 2001]**

(1) Keratohyalin found in the layer stratum granulosum

(2) collagen found in the subcutaneous layer

(3) melanin present in the dermis

(4) both 'a' and 'b'

Q.35 The mammary glands are derived from: **[RPMT- 2001]**

(1) sweat glands (2) adipose tissue

(3) hair follicles (4) sebaceous glands

Q.36 Which of the following is not a function of the mammalian skin ? **[RPMT - 2001]**

(1) Display of emotions

(2) Formation of vitamin D

(3) Absorption of food stuff

(4) Excretion of water matter

Q.37 Which one of the following is not the part of the epidermis ? **[RPMT - 2001]**

(1) Stratum granulosum (2) Stratum lucidum

(3) Stratum corneum (4) Subcutaneous layer

Q.38 Maximum power of division is found in the skin layer : **[MPPMT 2002]**

(1) stratum corneum (2) stratum spinosum

(3) stratum Malpighi (4) stratum granulosum

Q.39 Shivering with cold in winter is caused by : **[MPPMT 2002]**

(1) voluntary action of striated muscles

(2) voluntory action of unstriated muscles

(3) involuntary action of striated muscles

(4) involuntory action of unstriated muscles

Q.40 Which gland is associated with fur hairs of Rabbit ? **[RPMT - 2002]**

(1) Mucous gland (2) Sweat gland

(3) Mammary gland (4) Sebaceous gland

Q.41 Body temperature is regulated by- **[Orissa JEE-2003]**

(1) Lungs, muscles and skin

(2) Skin only

(3) Circulatory system (4) Skeletal system

Q.42 A camel is able to tolerate the heat of the desert by- **[BV Pune-2003]**

(1) Storing water in hump

(2) Shunting blood to its hump

(3) Having a small ratio of surface area to volume

(4) Allowing its body temperature to drop at night

Q.43 The animals which have a built in thermostat to maintain constant body temperature is called- **[CPMT-2003, Pb. PMT-2003]**

(1) Biothermic (2) Oligothermic

(3) Homoiothermic (4) Poikilothermic

Q.44 Sudoriferous glands occur in- **[CPMT 2004]**

(1) Skin (2) Lung

(3) Kidney (4) Alimentary canal

Q.45 Melanin is secreted by- **[PCS 2005]**

(1) Erythroblasts of blood

(2) Chromatophores of skin

(3) Cells of stratum compactum

(4) Ganglions of sensory nerves

Q.46 Nails of vertebrates are derived from - **[PCS -2005]**

(1) Stratum corneum

(2) Stratum lucidum

(3) Stratum germinativum

(4) Stratum granulosum

Q.47 Function of skin of mammals is- **[RPMT-2006]**

(1) Protection

(2) Thermoregulation and sensation

(3) Excretion (4) All the above

Q.48 Gland found in the skin of eye rabbit is- **[RPMT-2006]**

(1) Perineal gland (2) Meiobian gland

(3) Lacrymal (4) Harderian gland

Q.49 Nails, Hoof and Horn are madeup of - **[RPMT-2007]**

(1) Keratin (2) Chitin

(3) Cartilage (4) Bone

Q.50 Where are cornified cells found- **[RPMT-2007]**

(1) Epidermis (2) Hypoderm

(3) Mesoderm (4) Dermis

ANSWER KEY

EXERCISE - 3

Q.1	1	Q.2	1	Q.3	1	Q.4	3	Q.5	3	Q.6	2	Q.7	3
Q.8	2	Q.9	1	Q.10	3	Q.11	3	Q.12	4	Q.13	2	Q.14	1
Q.15	2	Q.16	4	Q.17	4	Q.18	1	Q.19	2	Q.20	4	Q.21	1
Q.22	4	Q.23	1	Q.24	2	Q.25	3	Q.26	3	Q.27	3	Q.28	3
Q.29	1	Q.30	3	Q.31	2	Q.32	3	Q.33	2	Q.34	3	Q.35	1
Q.36	3	Q.37	4	Q.38	3	Q.39	3	Q.40	4	Q.41	1	Q.42	4
Q.43	3	Q.44	1	Q.45	2	Q.46	1	Q.47	4	Q.48	2	Q.49	1
Q.50	1												

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** Skin provides us safety against sunburn.
R : Melanin present in the epidermal cells absorb UV-rays of the sun that can cause sunburn.

Q.2 **A :** Arrector pili muscles, by contraction, make hair erect in cold weather.
R : Arrector pili muscles are striated to move the hair quickly.

Q.3 **A :** Skin becomes wrinkled in old age.
R : Dermis contains white (collagen) fibers.

Q.4 **A :** Human skin lacks mucous glands.
R : Vertebrate epidermis is a stratified epithelium.

Q.5 **A :** Skin acts as a nourishing organ also.
R : Skin forms vitamin D from a cholesterol derivative in the presence of sunlight.

Q.6 **A :** Finger prints help in tracing criminals.
R : Each person has a characteristic pattern of finger prints.

Q.7 **A :** Sweat produced by apocrine sweat glands may produce unpleasant odour.
R : Apocrine secreted sweat is odourless but bacterial degradation of substances present in it generates unpleasant odour.

Q.8 **A :** Humans perspire on hot days and severe exercise.
R : Sweat cools the body.

Q.9 **A :** Keratin of horny layer of skin is water proof.
R : Epidermis is a stratified squamous epithelium.

Q.10 **A :** Mammalian skin has hairy coat and subcutaneous fat.
R : Homeothermy requires retention of body's heat.

Q.11 **A :** All derivative of skin are ectodermal in origin.
R : Hairs and nails are cutaneous derivatives which derive from dermis of skin.

Q.12 **A :** All cutaneous glands are ectodermal in origin.
R : All cutaneous glands are form by invagination of epidermis in dermis.

Q.13 **A :** Mammalian skin is also called as jack of all trades.
R : Skin performs many function

Q.14 **A :** Human skin is considered as a respiratory organ.
R : Human skin eliminates some carbon dioxide in the sweat.

Q.15 **A :** Skin contributes in regulation of body temperature by loosing or preserving body heat.
R : Regulation of body temperature is primarily a function of skin only.

Q.16 **A :** During surgery, incisions are made parallel to the line of langerhans.
R : This is done to minimize the damage to integument & promote fast healing of scar.

Q.17 **A :** Cutis anserina occurs on exposure to cold.
R : It occurs to conserve heat & prevent its loss body.

ANSWER KEY

EXERCISE - 4

Q.1	1	Q.2	3	Q.3	2	Q.4	2	Q.5	1	Q.6	1	Q.7	1
Q.8	1	Q.9	2	Q.10	1	Q.11	3	Q.12	1	Q.13	1	Q.14	1
Q.15	3	Q.16	1	Q.17	1								

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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Cell Structure & Function

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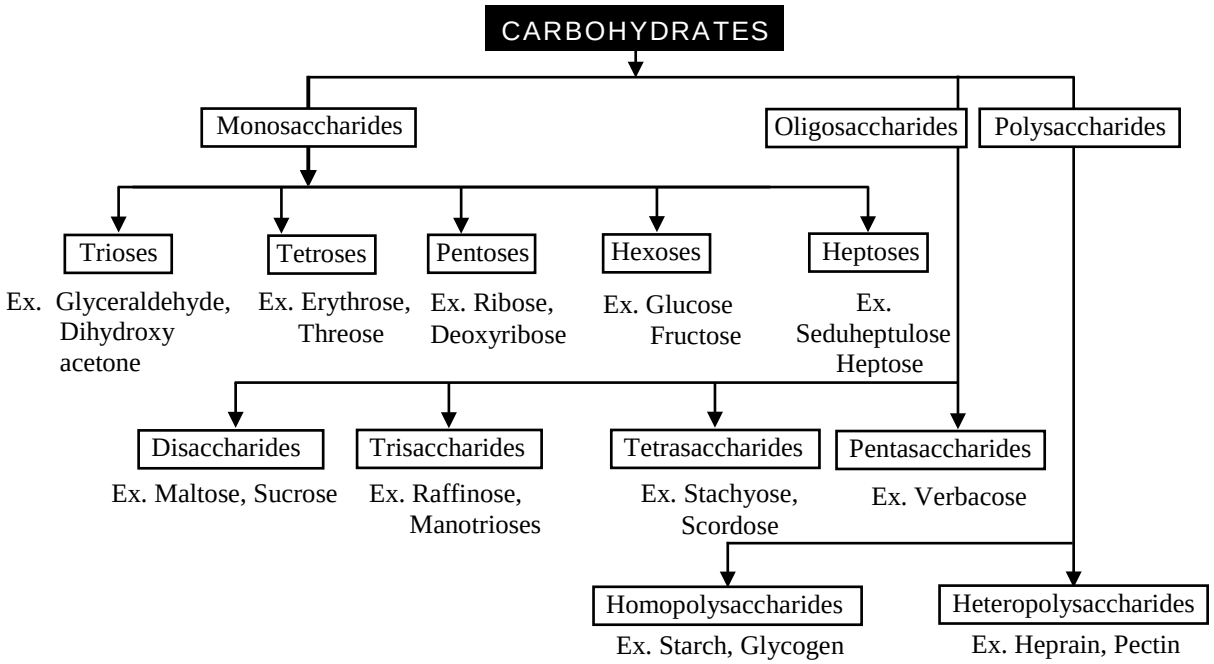
Robert Hook

BIOMOLECULE

CLASSIFICATION OF CARBOHYDRATES :



On the basis of numbers of saccharides in hydrolysis, Carbohydrates are classified as **Monosaccharides, oligosaccharides** and **Polysaccharides.**

A. Monosaccharides : -

(i) They are **simplest sugars** which can not be further hydrolysed.

(ii) In their generalized formula **x is always equal to y** i.e. number of Carbon and Oxygen atoms same.

(iii) First step of oxidation – **Phosphorylation**

(iv) All monosaccharides occur in d and ℓ form, except the **DHAP.**

$$\begin{array}{l} CH_2OH \\ | \\ C = O \\ | \\ CH_2OH \end{array}$$

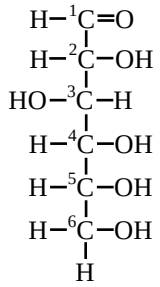
Dihydroxy acetone

(v) The structure of saccharides is either **ring or straight chain.**

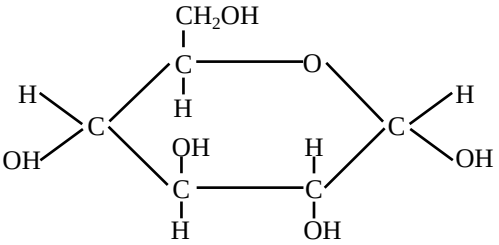
(vi) A six membered ring is known as **pyranose** and five membered ring is **furanose.**

Pyranose and furanose names were given by **''Haworth.''**

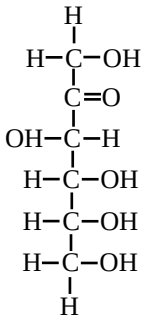
(vii) **Anomers –** In aqueous solution, Glucose occurs in cyclic structure. In anomers, position of –H and –OH groups are changed on C_1 carbon atom.



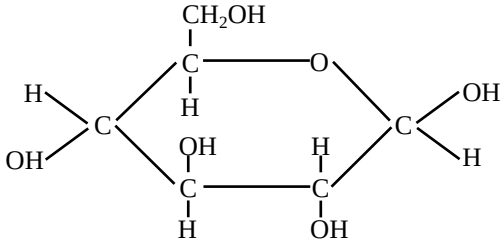
Glucose (Straight chain)



α-Glucose (Pyranose structure)



Fructose (Straight chain)



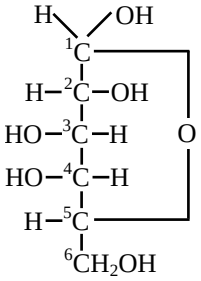
β-Glucose

Epimer : Isomer formed as result interchange of the –OH and –H groups on carbon atom 2, 3 and 4 of glucose, are know as epimer.

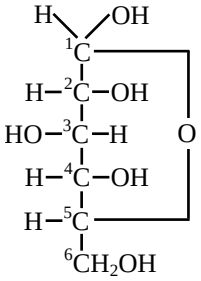
Epimer of Glucose :

Mannose (Difference on C_2 carbon)

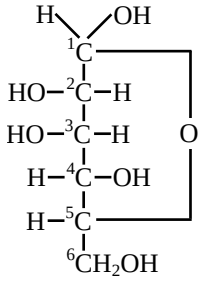
Galactose (Difference on C_4 carbon)



Galactose



Glucose



Mannose

CLASSIFICATION OF MONOSACCHARIDE				
No. of carbon atom	**Name of group**	**Example**		
	Sugar	**Formula**	**Aldose** **Suffix – ''ose''**	**Ketose** **Suffix – ''ulose''**
3	Triose	$C_3H_6O_3$	Glyceraldehyde	Dihydroxy acetone
4	Tetrose	$C_4H_8O_4$	Erythrose Threose	Erythrulose
5	Pentose	$C_5H_{10}O_5$	Ribose Xylose Arabinose **Deoxyribose** **($C_5H_{10}O_4$)**	Ribulose Xylulose
6	Hexose	$C_6H_{12}O_6$	Glucose, Galactose Mannose, Rhamnose	Fructose or Levulose

7	Heptose	$C_7H_{14}O_7$	Sedoheptose	Sedoheptulose

On the basis of number of carbon atoms monosaccharides are classified in following groups :

(i) **Trioses** – $C_3H_6O_3$ e.g. Glyceraldehyde and Dihydroxy acetone. **PGAL and DHAP are percursors of all other carbohydrates.**

(ii) **Tetroses** – $C_4H_8O_4$ e.g. Erythrose, Erythrulose

(iii) **Pentoses** – $C_5H_{10}O_5$ e.g. Ribose, Ribulose, Xylulose, Arabinose, *Deoxyribose ($C_5H_{10}O_4$)

(iv) **Hexoses** – $C_6H_{12}O_6$ e.g. Glucose Fructose, Galactose, Mannose, *Rhamnose ($C_6H_{12}O_5$)

(v) **Heptose** – $C_7H_{14}O_7$ e.g. Sedoheptulose

- Chemically all carbohydrates are **polyhydroxy aldehyde or ketones.**
- Monosaccharides with free aldehyde group are termed as ***Aldoses*** (PGAL, Erythrose, Ribose, Arabinose, Deoxyribose, Glucose, Galactose, Mannose).
- While monosaccharides with free ketone group are called ***ketoses*** (DHAP, Erythrolose, Ribulose, Xylulose, Fructose, Sedoheptulose).
- All monosaccharides are **''reducing sugars''** as their free aldehyde or ketone groups are capable of reducing Cu^{++} to Cu^{+}.

  This property is the basis of **Benedict's test or fehling's test** used to detect the **presence of glucose in urine.**
- Beside RNA **ribose sugar** is an important component of ATP, NAD, NADP and FAD
- In deoxyribose the second carbon is devoid of oxygen atom
- Arabinose occurs in **''Gum arabic''.**
- Glucose is dextrorotatory so it is called **''dextrose''**
- Glucose is found in grapes in abundant quantity so it is known as **''grape sugar''**
- Glucose is the main respiratory substrate in the body. Other types of hexose are converted into glucose by liver.
- Fructose is Laevorotatory so it is called **''Laevulose''**
- Fructose is found in honey and sweet fruits so it is called as **''Fruit Sugar''.**
- Fructose is the **sweetest sugar.**
- Galactose is not found in free stage.
- In mammalian body, galactose occurs as a part of milk sugar lactose.
- Galactose is also found as a component of **glycolipids** (for e.g. **cerebrosides**) and **pectin, Hemi cellulose** etc.
- **Mannose** not found in free state.
- Mannose occurs in **albumin of egg** and in **wood** as component of hemicellulose.
- Most sweetest chemical substance is **Thaumatine,** Obtained from a bacteria ***Thaumatococcus danielli.*** Glucose is also known as **blood sugar**. **Aspartame** is most commonly used **artificial sweetner.**
- Galactose is known **brain-sugar**

DERIVATIVES OF MONOSACCHARIDES :

(1) **Amino sugars** – Formed by the displacement of hydroxyl group from second carbon atom by amino group e.g. **Glucosamine**, **Galactosamine.**

(2) **Sugar alcohol –** Aldehyde group (–CHO) of the sugar is changed to primary alcohol (–CH_2OH). **Sorbitol** and **Mannitol** are respectively formed from glucose and mannose.

(3) **Sugar acids** – They are formed by the oxidation of terminal –CHO or –CH_2OH group of sugar to produce carboxyl group –COOH e.g. **Glucoronic acid**, **Galacturonic acid.**

(4) **Glycoside** – They are compounds formed by condensation reaction between a sugar (eg. glucose) and hydroxyl group of another substance which may be a sugar, a sterole, methanol in presence of dry HCl. They are acetel which can be hydrolysed by strong reagents like HCN, NH_2OH, $C_6H_5NHNH_2$. They cannot be hydrolysed in acidic condition. **Streptomycin is a glycoside.**

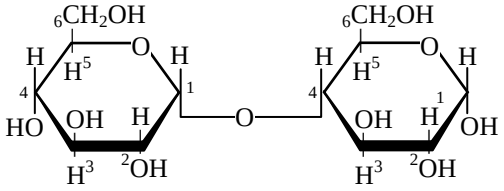
B. Oligosaccharides

Oligosaccharides are those carbohydrates which on hydrolysis yield **2 to 10 monosaccharide** units (monomers). In oligosaccharides, monosaccharides are linked together by **glycosidic bonds.** Aldehyde or ketone group of one monosaccharide reacts with alcoholic group of another monosaccharide to form glycosidic bond. One molecule of H_2O eliminates during glycosidic bond formation (**dehydration synthesis**). Direction of glycosidic bonds is usually 1'.4".

Types of Oligosaccharides : -

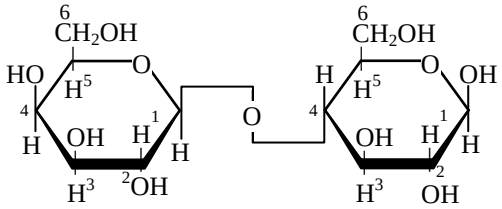
(i) **Disaccharides** – composed of **two monosaccharide** units e.g. **Maltose**, **Sucrose**, **Lactose**, **Trehalose.**

- All disaccharides are water soluble and sweet in taste, so they are known as **sugar.**



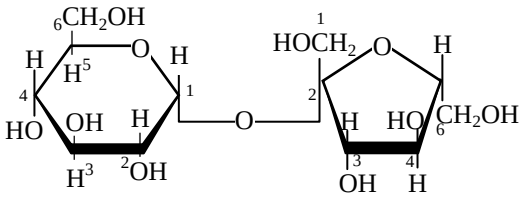
Glucose Glucose

Maltose



Galactose Glucose

Lactose



Glucose Fructose

Sucrose

- **Maltose** is commonly called **malt sugar.** It is intermediate compound in starch digestion. Maltose has 1'-4" glycosidic linkage between **α-D glucose** and **α-D glucose**
- Lactose is milk sugar with β-1'-4" glycosidic linkage between **glucose** and **galactose**
- Lactose is **least sweetest sugar**.
- Maximum % of lactose = Human milk ≈ 7%
- In plants transport of sugar is present in form of sucrose.
- Sucrose is also known as **invert sugar.**
- Sucrose is called **Cane Sugar or Table Sugar or Commercial Sugar.** Sucrose composed of **α-D Glucose** and **fructose.**

- **Trehalose** is present in **haemolymph** of insects. It has glycosidic linkage between two anomeric carbon (**α-glucose and β-Glucose**).

(ii) **Trisaccharides –** ***e.g*** Raffinose (Galactose + Fructose)

(iii) **Tetrasaccharides –** ***e.g*** Stachyose (Gal. + Gal. + Glu. + Fructose)

(iv) **Pentasaccharides –** ***e.g*** Barbascose (Gal + Gal + Glu + Glu + Fructose)

Raffinose and stachyose occur in phloem and may be employed for translocation carbohydrates.

C. Polysaccharides : -

- Poly saccharides composed of large number of monosaccharide units.
- Suffix '–an' added in their names and they are known as **glycans.**
- Pentose polysaccharides are called **pentosans** for e.g.
  Araban (from L-arabinose), xylan (from D-xylose), all these found in cell wall.
- Hexose polysaccharides are called **''hexans''** . for e.g. mannan (from mannose) **cellulose, starch** etc.
- Polysaccharides are insoluble in water and do **not taste sweet.**
- All polysaccharide are **non-reducing**
- Accroding to function, they are classified as **nutritive** and **structural**.

On structural basis polysaccharides are of two types.

(I) Homopolysaccharides : -

Composed of same monomers. Biologically important homopolysaccharides are as follows :

(a) Cellulose : - Linear polymer of **β-D-glucose** units (6000 to 10,000) . It has **β 1'-4'' linkage**. Partial digestion yields a **cellobiose units** (Disaccharide).
Cellulose is main component of plant cell wall. In **wood,** cellulose is **50%** and in **cotton,** it is **90%.**

- **Most abundant organic molecule on earth.**
- In urochordates animals their occur cellulose like material and it is called **''Tunicine''** It is also called **animal cellulose**.
- It is also used to form **Rayon fibre** (Artificial silk).

(b) Starch – It is main stored food in plants. Starch is polymer of **α-D-glucose units**. Starch consists of two types of chains.

(i) **Amylose –** 250-300 glucose units are arranged in an **unbranched chain** by **α 1'-4'' linkage.**

(ii) **Amylopectin –** A **branched chain molecule**. Approximately 30 glucose units are linked by **α-1' 4''** and **α-1', 6''** linkage.

- Amylose gives **blue colour** with **iodine**.
- Amylopectin gives **red** colour with **iodine.**
- Starch present in **potato** contains **20% amylose** and **80% amylopectin.**

(c) Glycogen – storage form of carbohydrate in animals, storage region of glycogen is **liver** and **muscles.** Storage of glycogen **liver > muscle**. Glycogen is also called as **animal starch.** Glycogen is highly branched polymer of α-D-glucose.

- Glycogen is formed by the 1'-4" bond linkage at long chain and 1', 6" bond linkage at branching point.
- Glycogen gives **red colour** with **iodine.**
- Glycogen is store food of **fungi.**

(d) Chitin – Linear polymer of **N-acetyl-D-glucosamine** with β-1', 4"-linkage.

- N-acetyl D-glucosamine is an amino acyl (-NH-CO-CH_3) derivative of β-D-glucose.
- Chitin is an important component of **exoskeleton of Arthropods** and **cell walls of fungi.**
- **Second most abundant organic molecule** on earth.
- It is also called **Fungal cellulose.**

(e) Inulin – Linear polymer of fructose units linked with β-1', 2" bonds. Inulin is found in **roots of Dahalia** and **Artichoke.** It is water soluble polysaccharide and it is used to know the **glomerular filteration rate.**

- It is **smallest storage polysaccharide.**

(f) Dextrin – Dextrin is an intermediate substance in the digestion of glycogen and starch. By hydrolysis of dextrin, glucose and maltose are formed. It also occurs as **stored food** in **yeast and bacteria.**

(II) Heteropolysaccharide –

Composed of different monosaccharide units.

(a) Hyaluronic acid – Found in **vitreous humour**, **umbillical cord, joints** and **connective tissue** in the form of lubricating agent. It also occurs in animal cell coat as binding material **(Animal cement).**

- Hyaluronic acid is made up of **D-glucouronic** acid and **N-acetyl – D-glucosamine** arranged in alternate orders. These different monosaccharides have β-1'-4" bonds and such disaccharides have β -1- 4 bonds.

(b) Chondriotin – D-glucuronic acid + N-acetyl galactosamine.

- Chondriotin occurs in **connective tissue.**
- Sulphate ester of chondriotin is main structural component of **cartilages, tendons** and **bones.**

(c) Heparin – It is **anticoagulant** of blood. Heparin is made up of D-glucuronic acid and N-sulphate glucosamine arranged in alternate order

(d) Pectins – Methylated galacturonic acid + galactose + arabinose.

- Pectin found in cell wall where it binds cellulose fibrils in bundles.
- Salts of pectin i.e Ca and Mg-pectates form **middle lamella** in plants.
- It is also called **Plant cement.**

(e) Hemicellulose – Mannose + Galactose + Arabinose + Xylulose.

- Store material – **Phytalophus (Ivory palm)**. Hemicellulose which is obtained from this plant is white, hard and shiny and it is used to form **billiard ball** and **artificial ivory.**

MUCOPOLYSACCHARIDES :

Slimy polysaccharides with capacity to bind proteins and water are called mucopolysaccharides. In plants mucilage is a common mucopolysaccharide formed of galactose and mannose units.

Hyaluronic acid, chondriotin, heparin are other examples.

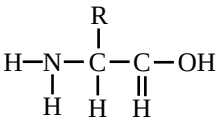
Special Points :

1. **Peptidoglycan –** Present in cell wall of bacteria.
   – Composed of **N-acetyl Glucosamine** + **N-acetyl muramic acid** + **peptide chain of 4-5 amino acids.**
2. **Agar-Agar –** It is a mucopolysaccharide which is obtained from some red algae – **Gracilaria**, **Gelidium, Chondrus.** Its is composed of **D-galactose** and **L-galactose** unit and after every 10^{th} unit a sulphate group is present it is used for preparing **culture medium** (1, 3 linkage)

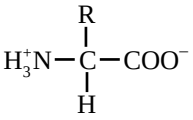
PROTEINS

Protein name is derived from a greek word which means **'' holding first place ''** (**Berzelius and Mulder**)

- Essential elements in protein are C, H, O, N,
- Most of the proteins contain sulphur. In some proteins iodine, iron and phosphorus are present.
- After water proteins are most abundant compounds in protoplasm. (**7-14%**)
- Proteins are **polymer of amino acid** (Fisher and Hofmeister). There are approximately 300 amino acids known to exist but only **20 types of amino acids** are used in formation of proteins.



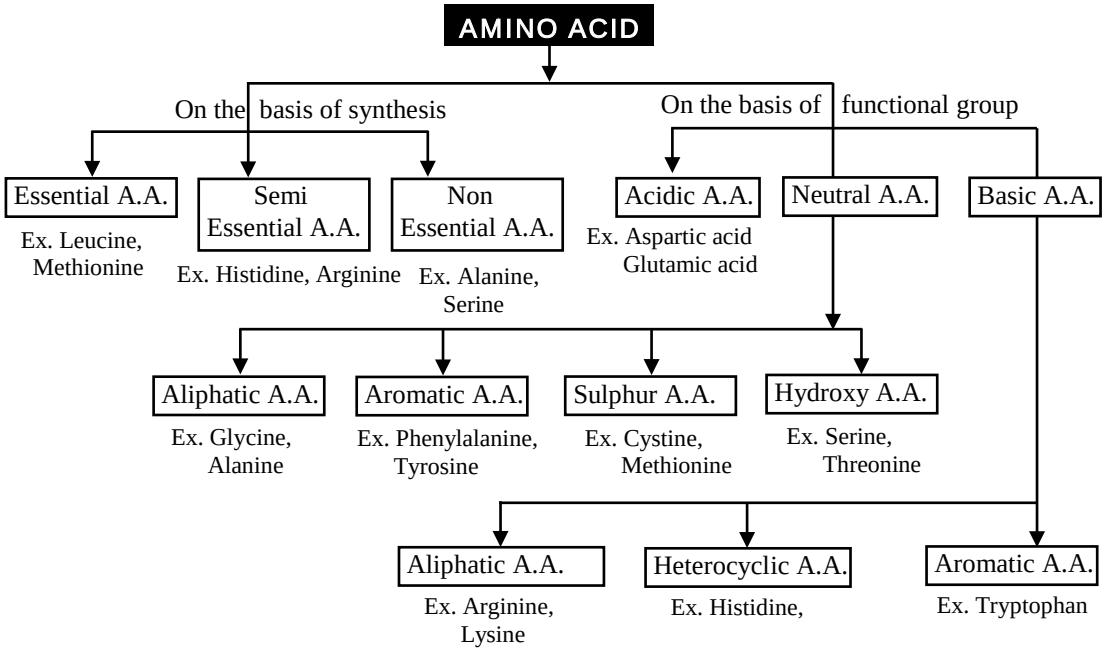
- Each amino acid is **amphoteric compound** because it contains one weak acidic group –COOH and a weak alkaline group $–NH_2$
- In protoplasm free amino acid occurs as ions **(at iso electric point)**



Zwitter ion

- **Iso electric point is** that point of pH at which amino acids do not move in electric field.
- Out of 20 amino acids, 10 amino acids are not synthesized in body of animals so they are must in diet. These called **Essential amino acid**. e.g. Threonine, Valine, Leucine, Isoleucine, Lysine, Methionine, Phenylalanine Tryptophan, arginine, Histidine. **Arginine and Histidine are semi essential.**
- 10 amino acids are synthesized in animal body so these called **Non essential amino acids.** for e.g. Glycine, Alanine, Serine, Cysteine, Aspartic acid, Glutamic acid, Asparagine, Glutamine, Tyrosine, Proline

Classification of Amino Acids –



(A) Amino acids can be classified on the basis of their group –

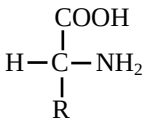
(i) **Non-polar R group –** Glycine, Alanine, Valine, Leucine, Isoleucine, Proline, Methionine, Phenyl alanine, Tryptophan.

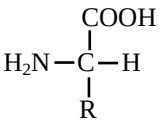
(ii) **Polar but uncharged R group –** Serine, Threonine, Cysteine, Tyrosine, Asparagine, Glutamine

(iii) **Positively charge polar R-group –** Lysine, Arginine, Histidine **(Basic Amino acid)**

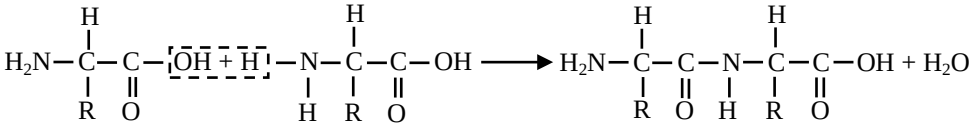
(iv) **Negatively charged polar R-group –** Aspartic acid, Glutamic acid **(Acidic Amino acid)**

Except glycine, each amino acid has two enantiomeric isomers


D-amino acid


L-amino acid

- Eukaryotic proteins have L-amino acid while D-amino acid occurs in bacteria and antibodies : Amino acids join with peptide bond to form protein.


Dipeptide

- **Peptidyl transferase** enzyme catalyses the synthesis of peptide bond.
- Property of protein depends on **sequence of amino acid** and configuration of protein molecules.

Special points on Amino acid :

- **Glycine is** the **simplest** and **tryptophan** is **complex** Amino acid.
- Cysteine, Cystine, Methionine are the sulphar containing Amino acid.
- Phenyl alanine, Tyrosine, Tryptophan Amino acids are aromatic Amino acid.
- Serine & Threonine are alcoholic amino acid.
- Histidine, Proline & hydroxyproline are heterocyclic amino acid.
- **All the amino acids are laevo-rotatory, except Glycine which is non-rotatory.**

- Amino acids which participate in protein synthesis called protein Amino acid and which do not participate called non-Protein.

eg. GABA, Ornithine, Citrulline.

- **Proline, Hydroxy proline** contain imino group $\left(-\ddot{\underset{|}{N}}H\right)$ instead of amino group so they are also called **imino acid.**

Configuration of Protein Molecule –

(1) **Primary configuration or structure –** A straight chain of amino acids linked by **peptide bonds** form primary structure of proteins. This structure of protein is most unstable. Newly formed proteins on ribosomes have primary structure .

(2) **Secondary configuration –** Protein molecules of sec. structure are spirally coiled. In addition to **peptide bond, amino acids** are linked by **hydrogen bonds** form between oxygen of one amide group and hydrogen of another amide group. This structure is of two types –

(i) **α–Helix** – Right handed rotation of spirally coiled chain with approximately $3\frac{1}{2}$ amino acids in each turn. This structure has **intramolecular hydrogen bonding** i.e. between two amino acids of same chain e.g. **Keratin, Myosin, Tropomyosin.**

(ii) **β-Helix or pleated sheath structure –** Protein molecule has zig – zag structure. Two or more protein molecules are held together by **intermolecular hydrogen bonding. e.g. fibroin** (silk).

(3) **Tertiary Structure –** Protein of tertiary structure are highly folded to give a globular appearance. They are **soluble in water** (colloid solution). This structure of protein has following bonds –

(i) **Peptide bond** = strongest bond in proteins.

(ii) **Hydrogen bonds**

(iii) **Disulphide bond –** These bonds form between – SH group of amino acid (**Methionine, Cysteine**). These bonds are second strongest bond and **stabilize tertiary structure** of protein.

(iv) **Hydrophobic bond –** Between amino acids which have hydrophobic side chains for ***e.g.*** Aromatic amino acid

(v) **Ionic bond –** Formation of ionic bond occus between two opposite ends of protein molecule due to **electrostatic attraction**

Majority of proteins and enzymes in protoplasm exhibit **tertiary** structure.

Quaternary Structure –

Two or more poly peptide chains of tertiary structure unite by different types of bond to form quaternary structure of protein. Different polypeptide chains may be similar **lactic - dehydrogenas** or dissimilar types (**Haemoglobin, insulin**).

Quaternary structure is most stable structure of protein.

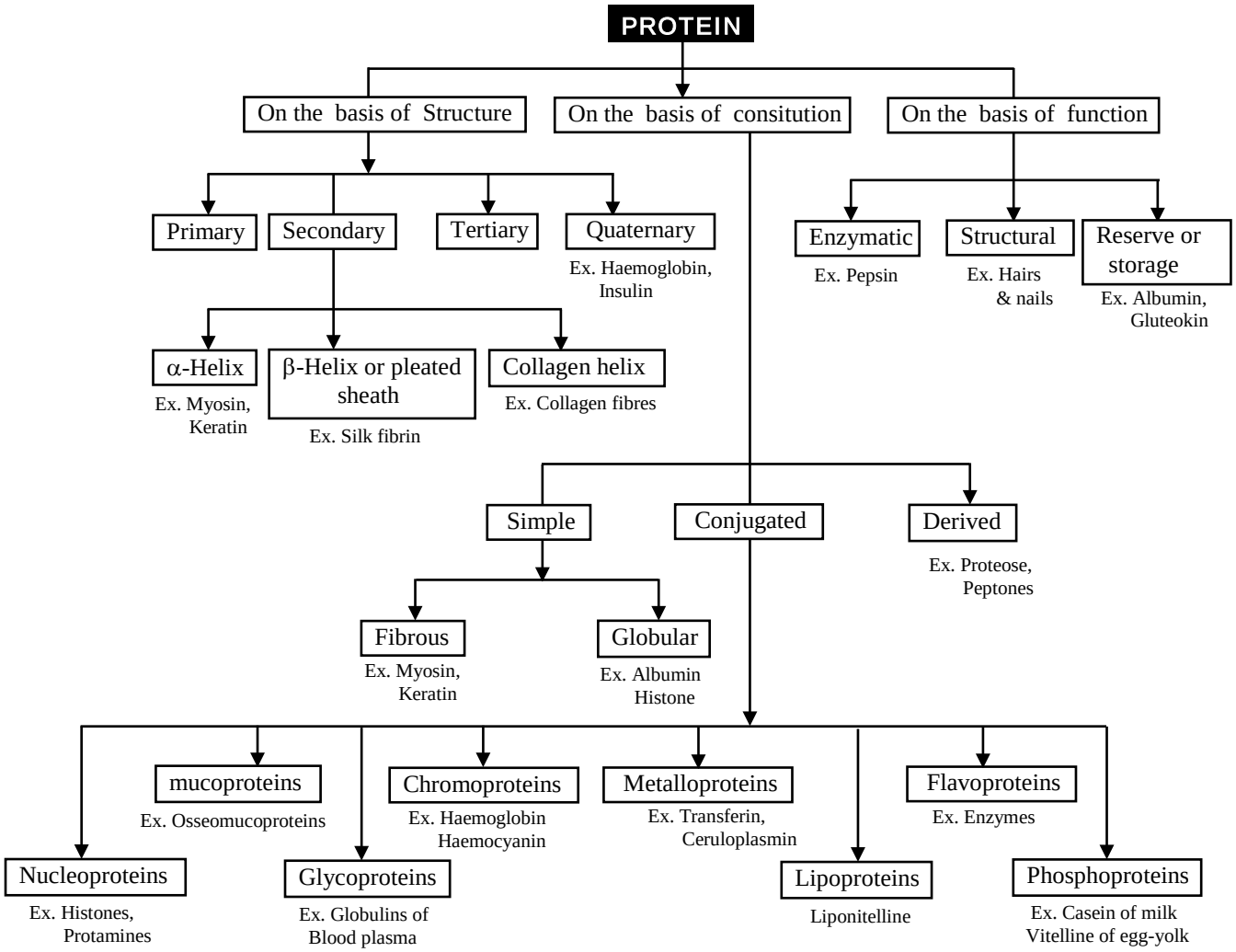
Significance of Structure of Protein –

- The most important constituents of animals are protein and their derivatives. Proteins form approximately 15% of animal protoplasm. The physical and biological properties of proteins are dependant upon their secondary and tertiary configurations. Protein is electrically charged because it has $-NH_3^+$ and $-COO^-$ ionic components. **In an acidic medium** the $-COO^-$ group of protein converts in COOH and the protein itself becomes positively charged. In contrast, in **an alkaline medium** the $-NH_3^+$ group of protein changes to $-NH_2 + H_2O$ and as a result it becomes **negatively charged.** Therefore, at a specific pH a protein will

possess an equal number of both negative and positive charges and it is at this specific pH a protein becomes soluble.

- If the pH changes towards either acidic or alkaline side, then the protein begins to precipitate. This property of protein has great biological significance. The cytoplasm of cells of organisms has an approximate pH of 7 but the pH of proteins present in it is about 6 and thus, the proteins are present in a relatively alkaline medium. Therefore, the proteins are negatively charged and also are not in a fully dissolved state. It is because of this insolubility, proteins form the structural skeleton of organismal cells. Similarly, the pH of nucleoplasm is about 7 but the pH of proteins, namely, histones and protamines, in it is relatively more. Therefore, as a result they are positively charged and do not remain fully dissolved in the nucleoplasm forming minute organelles, the most important being the chromosomes.
- As has been described above, the structural units namely amino acids of proteins contain both a carboxyl group (–COOH) or acidic group and an amino group ($–NH_2$) or alkaline group attached to the same carbon atom. Therefore, proteins depending upon the pH of the medium can exhibit both alkaline and acidic properties. Such compounds which exhibit **both acidic and alkaline properties** are called amphoteric compounds or zwitter ions. In the protoplasm, this dual property of proteins is utilized for neutralisation of strong acids and alkalis since the protein acts an an ideal buffer in either of the situations.
- Besides changes **in pH, salts, heavy metals, temperature, pressure,** etc. also cause precipitation of proteins. Because of these changes, the secondary and tertiary configuration of proteins is destroyed and many times the tertiary structured globular proteins become converted to secondary configuration fibrous proteins . Such alternations in the physical state of proteins is called **denaturation.** If the change in the medium of proteins is mild and for a short period, then denaturation of the proteins is also temporary, however, if the change in medium is strong and prolonged then denaturation is permanent and **the protein becomes coagulated**. For example, the white or albumen of egg is a soluble globular protein but on heating it permanently coagulates into fibrous insoluble form. It is clear, that strong alternations result in the denaturation of proteins and they lose their biological properties and significance. It is this reason, that cells of organisms are unable to bear strong changes and they ultimately die.

TYPES OF PROTEINS :



1. Simple Proteins - proteins which composed of only amino acid.

(i) **Fibrous Protein – *e.g.*** Collagen, Elastin, Keratin

(ii) **Globular Proteins – *e.g.*** Albumin, Histones, Globin, Protemines, Prolamines (Glaidin, Gluten, Zein), Gluteline – slimy part of gluten of wheat.

2. Conjugated Proteins – Simple protein + non protein part (Prosthetic group)

(i) **Nucleoproteins –** e.g. Chromatin, Ribosomes etc.

(ii) **Chromoprotein –** Prosthetic group is a porphyrin pigment e.g Haemoglobin, Haemocyanin, Cytochromes etc.

(iii) **Lipoprotein** eg. Cell membrane, Lipovitelline of Yolk.

(iv) **Phospho proteins –** Casienogen, Pepsin, Ovovitelline, Phosvitin.

(v) **Lecitho protein –** Fibrinogen.

(vi) **Metallo protein –** Cu-tyrosinase, Zn-Carbonic anhydrase, Mn-Arginase, Mo-Zanthine Oxidase Mg-Kinase

(vii) **Glycoproteins and Mucoproteins –** Glyco proteins have less than 4% Carbohydrates in their structure. They are most specific type proteins e.g. α, β γ-globuline of **blood group proteins**, **mucin**, **Erythropoetin** etc.

Muco proteins have more than 4% Carbohydrate e.g. **Mucoids of synovial fluid**, **Osteomucoprotein** of bones, **Tendomucoprotein of tendons, Chodro mucoprotein** of cartilage.

3. **Derived Protein –** These are formed by denaturation or hydrolysis of protein.

(i) **Primary derived proteins** are denaturation product of normal proteins e.g. **Fibrin, Myosin**

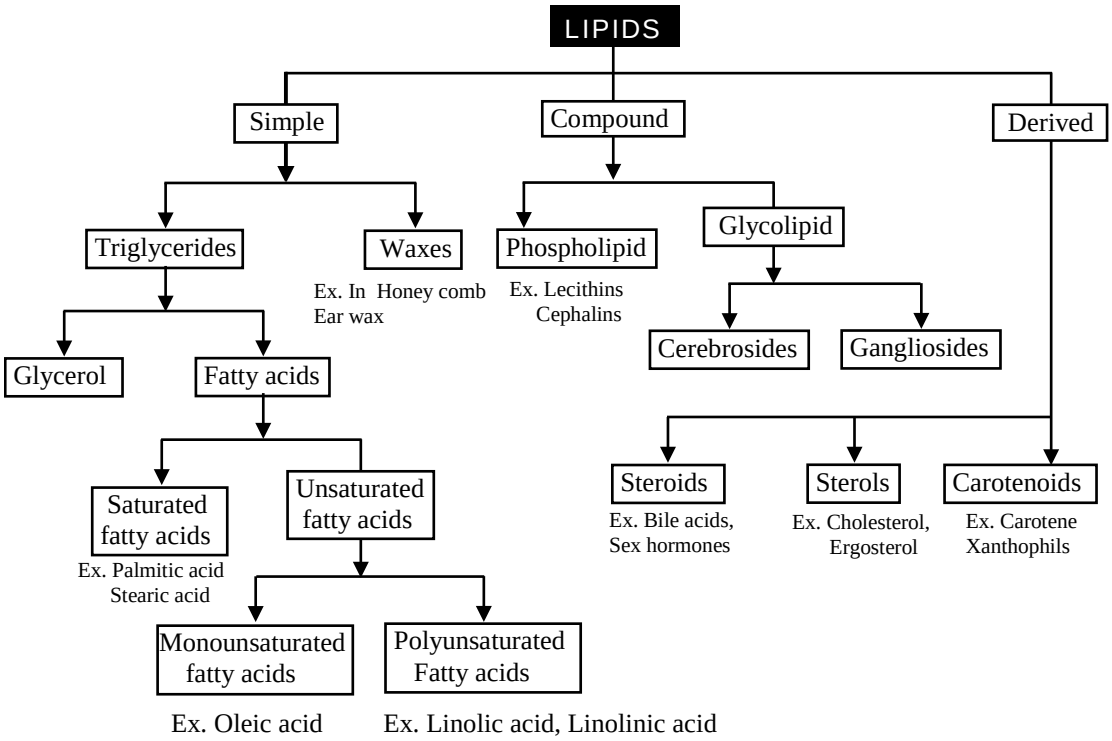
(ii) **Secondary derived proteins** are digestion products of proteins e.g. Proteoses, peptones, Peptides.

Special Point on Protein :

- **Monomeric protein :** Protein composed of one polypeptide chain.
- **Oligomeric/Polymeric/Multimeric protein :** Protein composed of more then one polypeptide chains.
- **Peptide :** A molecule short than 20 Amino acids.
- **Polypeptide :** It usually has more than 20 Amino acids.
- **Protein :** It contains miniumum 50 Amino acids or more than 50 Amino acids.

LIPIDS

- **Fat and its derivatives** are combindly known as lipid.
- Lipid term coined by Bloor.
- Compounds of C, H, O but the ratio of Hydrogen and Oxygen is not 2 : 1. The amount of oxygen is considerably very less.
- Lipids are **insoluble in water** and **soluble in organic solvents** like acetones, chloroform, benzene, hot alcohol, ether etc.
- Lipids occur in protoplasm as **minute globules.**
- Lipids do not form polymer.
- Lipids provide more than double energy as compare to carbohydrate.
- In animals, fat present in **subcutaneous layer** and working as **food reservior** and **shock-absorber.**
- Lipid require less space for storage as compare to carbohydrate because lipid molecule is **hydrophobic** and **condense.**
- Animal store **maximum amount of food** in the form of **lipid.**
- Lipid provides maximum amount of **metabolic water** as compare to carbohydrate and protein on oxidation.
- Lipids are **not strictly macromolecules.**



A. Simple Lipid or Neutral Fats -

- These are esters of long chain fatty acids and alcohol. In majority of simple lipids, the alcohol is a trihydroxy sugar alcohol i.e. **glycerol.**
- Three molecules of fatty acid linked with one molecule of glycerol. The linkage is called **"ester bond"**. such type of lipids called **Triglycerides.** Three molecules of water are released during formation of triglycerides (**dehydration synthesis**)
- Similar or different fatty acids participate in the composition of a fat molecule. Simple lipids contain two types of fatty acids.

(i) **Saturated Fatty acids –** are those in which all the carbon atoms of hydro-carbon chain are saturated with hydrogen atoms

e.g. **Palmitic acid** – $CH_3(CH_2)_{14} - COOH$

Stearic acid – $CH_3(CH_2)_{16} - COOH$

(ii) **Unsaturated fatty acids –**are those in which some carbon atom are not fully occupied by hydrogen atoms

e.g. **Oleic acid** – $CH_3(CH_2)_7\ CH{=}CH(CH_2)_7COOH$

Linoleic acid – $CH_3(CH_2)_4 –(CH{=}CH–CH_2)_2 –(CH_2)_6 –COOH$

Linolenic acid–$CH_3–CH_2 –(CH{=}CH–CH_2)_3 –(CH_2)_6 –COOH$

Polyunsaturated = fatty acids with more than one double bonds in their structure e.g. **Linoleic acid**, **Linolenic acid**, **Arachidonic acid**, **Prostagladins** (derived from archidonic acid)

- Unsaturated fatty acid also called as **essential fatty acids** because no animal is able to synthesize them.
- Simple lipids with saturated fatty acid remain **solid** at normal room temperature e.g. **fats**
- Simple lipids with unsaturated fatty acids remain **liquid** at room temperature e.g. **oils.**
- **Saturated fatty acids** are less reactive so they tend to store in body and cause **obesity.**
- Unsaturated fatty acids are more reactive so they tend to metabolise in body and provide energy.

- Oils with poly unsaturates are recommended by physicians for persons who suffer from **high blood cholesterol or cardio-vascular diseases**. This is because increasing the proportion of poly unsaturated fatty acids to saturated fatty acids, without decreasing the fats in the diet tend to lower the **cholesterol level in blood**.

Waxes – are monoglycerides with only one molecule of fatty acid attached to a **long chain monohydroxy alcohol**. Waxes are more resistant to hydrolysis as compared to triglycerides. Waxes have an important role in protection. They form **water insoluble coatings** on hair and skin in animals and stem, leaves and fruits of plants.

e.g.

Bees Wax (Hexacosyl palmitate)

Carnauba (Myricyl cerotate)which occurs on leaves, stem and fruits.

Spermaceti in skull of whale and Dolphin.

Cerumen or ear wax – occurs in external auditory canal.

Lanoline or **cholesterol ester** – occurs in blood, sebum and gonadial ducts as lubricating agent.

It is also obtained from wool of sheep.

(B) Conjugated or Compound Lipids –

(i) Phospholipids or phosphatide or phospholipins –

2 Molecules of fatty acid + Glycerol + H_3PO_4 + Nitrogenous compound. Phospholipids are most abundant type of lipids in protoplasm.

Phospholipids have both hydrophilic polar end (H_3PO_4 and nitrogenous compound) and hydrophobic non polar end (fattty acids). Such molecules are called **amphipathic.** Due to this property, phospholipids form bimolecular layer in cell membrance.

Some biologically important phospholipids are as following :

(a) Lecithin or Phosphatidyl choline

- Nitrogenous compound in lecithin is **choline**
- Lecithin occurs in **egg yolk, oil seeds** and **blood.**
- In blood lecithin functions are carrier molecule. It helps in transportation of other lipid.

(b) Cephalin – Similar to lecithin but the nitrogenous compound is **ethanolamine, cephalin** occurs in **nervous tissue**, **egg yolk** and **blood platelets.**

(c) Sphingolipids or **sphingomylins** similar to lecithin but in place of glycerol it contains an amino alcohol **sphingosine**.

Sphingolipids occur in **myelin-sheath** of **nerves**, other examples of **phospholipids** are **phosphatidyl serine, phosphatidyl inositol, plasmologens.**

(ii) Glycolipid – 2 fatty acid + sphingosine + galactose

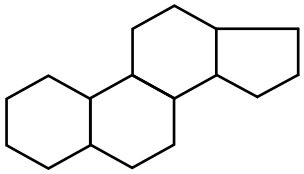
eg. **Cerebroiside** which occurs in **white matter of brain** –

Gangliosides – These occur in **nerve ganglia and spleen**. These also contain **N-acetyl neurominic acid** and glucose beside other compounds.

(iii) Derived Lipids – Lipid derived from simple or conjugated lipid. Derived lipids are complex in structure.

They are insoluble in water and soluble in organic solvents.

(A) Steroids – Steroids exhibit tetracyclic structure called **''Cyclo pentano perhydrophenanthrene** nucleus"



On the basis of functional group, steroids are of two types –

(a) **Sterols –** Alcoholic steroids e.g. **cholesterol –** Cholesterol abundantly occurs in **brain, nervous tissue, Adrenal gland** and **skin**. Cholestrol is a parent steroid. Several other biologically important steroids are derived from cholesterol. **7-dehydro cholesterol** which occurs in skin is a provitamin. On exposure to ultraviolet radiation, it transforms in **cholecalciferol** i.e. **vitamin D.**

Cholesterol is also called **''most decorated micromolecule in biology''.**

Ergosterol – It occurs in **oil seed, fungi like ergot and yeast.** Ergosterol is precursor of another form of Vitamin **D-Ergocalciferol.**

Coprosterol – Occurs in faecal matter. It forms decomposition of cholesterol by colon bacteria.

Bile acid – Bile juice contains different types of steroid acids. E.g. **cholic acid, Lithocholic acid etc.** They help in emulsification of fats.

(b) **Sterones –** Ketonic steroids, for e.g. **sex hormones**, **Adreno corticoids, ecdyson** hormone of insects, **Diosgenin** obtained from yam plant (**Dioscorea**), is used in manufacture of antifertility pills.

(B) Chromolipid = It is also called **terpene.**

Most complex lipid in protoplasm.

Chromolipids composed of repeated **isoprene units**

Example : Carotenoids, vitamin A, E, K, Natural Rubber (Polyterpene).

$$CH_2=\underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}}-CH=CH_2$$

(Isoprene)

Special Points :

Prostaglandins –

It is Derived lipid. Prostaglandins are derivatives of **PUFA** (**Polyunsaturated fatty acid**) They are helpful in **contraction of uterus** and **fallopian tube, blood clotting, Muscle contraction**.

NUCLEIC ACID

- Nucleic acid discovered by **Friedrich Meischer,** he called it nuclein.
- He discovered the nucleic acid in nucleus of pus cells.
- Term Nucleic acid given by **Altmann**
- Nucleic acid is of two types –

  (1) DNA (Deoxyribonucleic acid) (2) RNA (Ribonucleic acid)

1. DNA (Deoxyribonucleic acid)

- Nucleic acids are polymers of Nucleotides and are macromolecules.
- Nucleotides consists of **nucleosides** and **phosphate group**.

- Nucleosides consists of **Nitrogen base** and **Pento sugar**.
- 3 components of nucleotides = N_2 base + Pentose sugar + phosphate group.
- N_2 base are of two types –
  (i) Purines (Adenine, Guanine)
  (ii) Pyrimidines (Cytosine, Thymine, Uracil)

2. RNA (Ribonucleic acid)

- RNA does not follow Chargaff's Rule (RNA is normally single stranded).
- Reoviruses has double staranded RNA which follows Chargaff's Rule.
- Double stranded RNA follows Chargaff's Rule.
- Thymine absent in RNA in place of which Uracil is present.

Three types of RNA :

(i) r-RNA (Ribosomal RNA)
(ii) t-RNA (Transfer RNA)
(iii) m-RNA (Messenger RNA)

ENZYMES

- Enzymes are proteinaceous, biocatalysts.
- First enzyme discovered by **Buchner**
- Term **enzyme** was given by **Kuhne.**
- **Zymase** (from yeast) was the **first discovered enzyme. (Buchner)**
- The first purified and crystalized enzyme was **urease** (by **J.B. Sumner)** from Canavalia/Jack Bean (Lobia plant)
- **Proteinaceous nature** of enzyme was established by **Northrop** and **Sumner.**

DEFINITION

- **Enzymes are biocatalysts made up of proteins (except ribozyme), which increases the rate of biochemical reactions by lowering down the activation energy.**
- First discovered **ribozyme** was **L_{19} RNAase** by **T.Cech** from rRNA of a protozoan ***Tetrahymena thermophila*** and **RNAase P** or **Ribionuclease P** by Altman in prokaryotic cell (Nobel prize).

GENERAL PROPERTIES OF ENZYMES

Large sized biomolecules, colloid nature with high molecular weight -

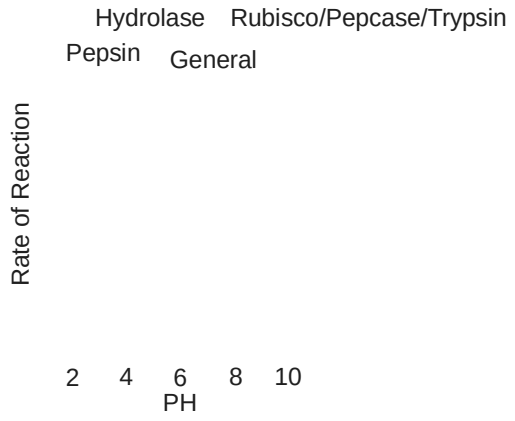
- Large size (equal to colloid particles) provide, more surface area so passes large no. of active site. Large number of substrate converted into product by one molecule of enzyme at a time.
- Highest molecular weight is of enzyme **pyruvate dehydrogenase complex** (46 lakh) participate in **link reaction** of respiration.

Proteinous nature

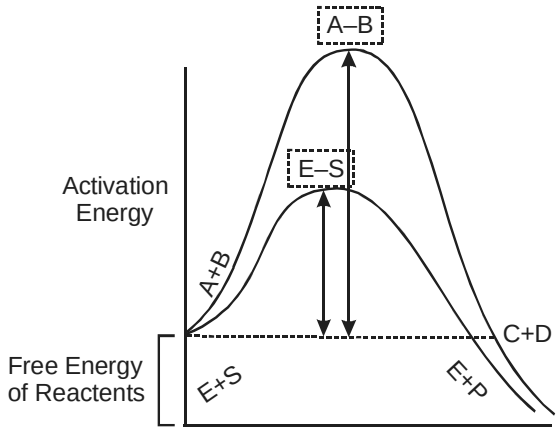
- Monomer unit of a enzyme is Amino acid
- Amino acids linked togather to form polypeptide chain
- Enzymes are polypeptide chains
- Most of enzymes arrange in **tertiary structure** of protein or **globular proteins** except isoenzyme (Quaternary st.)
- Tertiary structure of protein provides stability and water soluble nature to enzymes.
- synthesis of enzymes occurs on **ribosomes** under the control of **genes**.
- According to one gene one polypeptide hypothesis, if a enzyme is made up of same kind of polypeptide chains then synthesize under control of same gene and if made up of different kinds of polypeptide chains then synthesized under the control fo different genes. Ex. Rubisco, cytochrome oxidase, Nitrogenase.

Specificity

- Enzymes are specific for **pH**, **temperature** and **substrate**
- **pH** - The common pH range of enzymes activity is 6 - 8.
- Every enzyme works on specific pH, Pepsin-2.5 pH, Hydrolase-4-5,
- Rubisco, Pepcase-8.5 pH, Trypsin - 8.5 pH



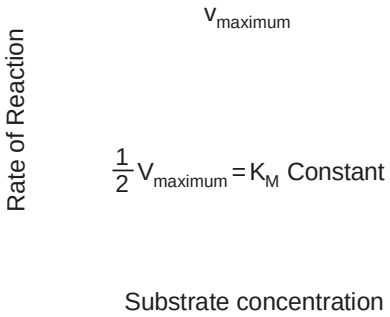
- **Temperature**
  - Common range of temperature for enzyme activity is 20 – 40°C
  - Enzymes works on body temperature of organism not on environmental temperature.
  - Enzymes of plants are affected by evironmental temperature change as plants does not show homeostasis.
  - At low temperature enzymes become functionally inactive, at high temperature denatured.
- **Substrate**
  - Every enzyme works on specific substrate.
  - Substrate binds at active site of enzyme which is made of specific sequence of amino acids and recognise it's substrate.
  - Ex. succinic dehydrogenase acts on succinic acid while pyruvate dehydrogenase acts on pyruvic acid.
- **Enzymes increase the rate of reaction by decreasing activation energy** -
  - Activation Energy - Minimum amount of energy more than the free energy of reactents required to reach the transiation state of chemical reaction or to undergo the chemical reaction.



- **Turn Over Nubmer (T.O.N) -**
  - The number of reactent moleules converted into product by one molecule of enzyme in unit time
  - Highest T.O.N is of **carbonic anhydrase** (360 lakh / minute)

$$CO_2 + H_2O \xrightarrow[\text{anhydrase}]{\text{Carbonic}} H_2CO_3$$

- **KM constant -**
  - Enymes follows the Michaelis-Menten reaction kinetics
  - It represents the substrate concentration at which rate of enzymetic reaction becomes the half of maximum velocity or rate.
  - If a enzyme passes high km constant then it's affinity towards substrate is low and rate reaction is also low.



- **Ki constant (Enzyme inhibitor complex dissociation constant)**
  - The substrate concentration at which enzyme inhibitor complex dissociate and reaction becomes normal
  - It is applicable only for competitive reversible inhibitions.

STRUCTURE OF ENZYME

Simple enzymes

- They are made up of only protein. eg. **pepsin, trypsin.**

Conjugated enzymes

They are made up of protein & non protein part.

- **Co-enzymes -** Co-enzymes are non-protein, orgainc groups, which are loosely attached to apoenzymes. They are generally made up to vitamins.
- **Prosthetic group -** When non-protein part is tightly or firmly attached to apoenzymes.

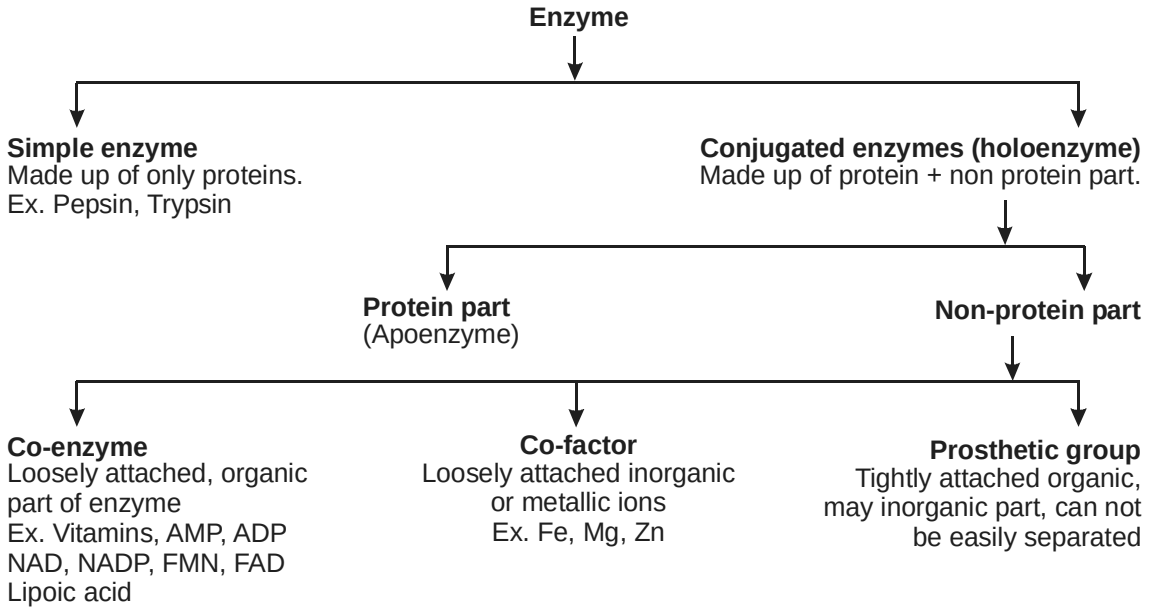
- Metal activators/**co-factros**/metallic factor :- Lossely attached inorganic co-factor eg. Mn, Fe, Co, Zn, Ca, Mg, Cu

Active site :

The part of polypeptide chain made up of specific sequence of amino acids at which specific substrate is to be binded and catalysed, known as **active site. Very specific sequence of amino acids,** at active site is determined by genetic codes.

Allosteric site :

Besides the active site's some enzymes posess additional sites, at which chemical **other than substrate (allosteric modulators)** are bind. These sites are known as allosteric sites and enzyme with allosteric sites are called as **allosteric enzymes.** e.g. **hexokinase, phosphofructokinase.**



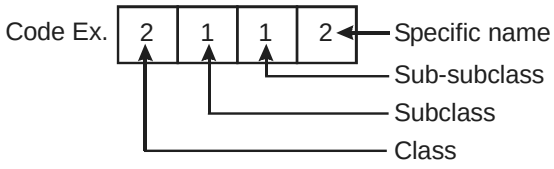
TERMINOLOGY

- **Endoenzymes -** Enzymes which are functional only inside the cells. Ex. Enzymes of metabolism.
- **Exoenzymes -** Enzymes catalysed the reactions outside the cell Eg:- **enzymes of digestion, some enzymes of insectivorous** plants, **Zymase** complex of fermentation.
- **Proenzyme/Zymogen-** These are precursor of enzymes or inactive forms of enzymes.eg. Pepsinogen, Trypsinogen etc.
- **Isoenzymes-** Enzymes having similar action, but little difference in their molecular configuration are called isoenzymes. 16 forms of **α-amylase** of wheat & 5 forms of **LDH (Lactate dehydrogenase)** 3 Forms of **Pepcase** are known. These all isoenzyme forms are synthesised by different genes and tissue and organ specific.
- **Inducible enzymes -** When formation of enzyme is induced by substrate availability. eg. Lactase, Nitrogenase, β-galactosidase.
- **Extremozymes -** Enzymes, which may also function at extremely adverse conditions (very high temperature) e.g. Taq polymerase.
- **Abzymes -** When the monoclonal antibodies (Mab) are used as enzymes.
- **Biodetergents -** Enzymes used in washing powders are known as bio-detergents eg.-amylase, lipase, proteolytic enzymes.

- **House keeping/constitutive enzymes -** Which are always present in constant amount & are also essential to cell. Ex. Enzymes of cell respiration.

NOMENCLATURE AND CLASSIFICATION

Enzyme commision of IUB-1961 divides all enzyes into 6 major classes on basis of types of reactions catalysed by them. It also proposed an international code of 4 digits for each enzyme. Suffix '-ase' is used for a enzyme.



- **Class-1 : Oxido-reductases -** These enzymes involve in oxidation-reduction reactions.

  It involves 3 sub classes (i) Oxides (ii) dehydrogenase (iii) reductase

  e.g. Cytochrome oxides.
- **Class-2 : Trasferases -** These Enzymes transfer specific group from one substrate to another.

  e.g. Transaminase, Hexokinase.
- **Class-3 : Hydrolases -** These Enzymes involve in hydrolysis reactions with help of H_2O

  e.g. Protease, Lipase, Carbohydrase. $AB + HOH \rightarrow AH + BOH$
- **Class-4 : Lyases -** Spilt the sustrate molecule without water. These Enzymes splits the specfifc covalent bonds without hydrolysis or H_2O addition. $AB \rightarrow A + B$

  e.g. Aldolase
- **Class-5 : Isomerases -** Rearrangement of molecular structure to form isomers.

  e.g. Isomerase, Epimerase
- **Class-6 : Ligases (Synthases) -** Covalent bonding of two substrates to from a large molecule. $A + B \rightarrow AB$

  e.g. Citrate synthetase, Ligase, ATPsynthase

MODE OF ACTION OF ENZYME

- **Lock and Key theory or template theory :-**

  Given by **Emil Fischer**

  According to this theory **active sites of enzymes** serve as a **lock**, at which the **reactant/substrate fits like a key. Supported by competitive inhibition.**
- **Enzyme-substrate complex theory :-**

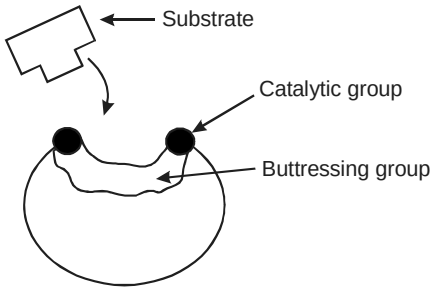
  Given by **Michaelis & Menten**

  $E + S \longrightarrow ESC \longrightarrow ESC \longrightarrow E+P$

- **Induced fit theory : -**

  Given by **D.E. Koshland** (1973-74)

– According to this theory active site is not static, but it undergoes a conformational change which is induced by specific substrate. The active site has two groups, (1) **Buttressing** (supporting) group & (2) **Catalytic group.**



– Butterssing group is meant for supporting the substrate, while the catalytic group break the substrate into product.

ALLOSTERIC MODULATION

- **Jacob & Monad.** - First discovered **L-threonine dehydratase**, inhibited by its product isoelucine.
- In the allosteric modulation, chemical or products fits in allostric sites & bring change in shape of active site of enzyme.
- Chemicals which bind at allostric site of allostric enzymes are known as **allostric modulators.**
- These modulators may be **activators** (positive modulators) or **inhibitors** (nagetive modulators) of allosteric enzymes.
- If allostric modulator positively change the configuration of active site, then called **positive allosteric modulation** and if negatively change then called **negative allosteric modulation** respctively by+ve modulator (activators) and-ve modulator (inhibitors).

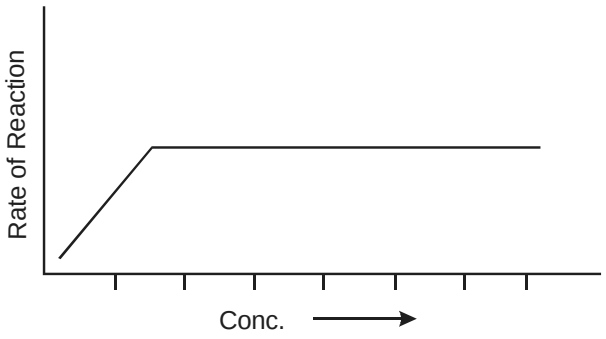
  Ex. **Phosphofructokinase** inhibited by ATP, activated by ADP.
- Some times product also binds at allostetric site and inhibits the enzyme.

  Ex. **Hexokinase** inhibited by glucose-6P and exhibits feed back inhibition.

  This is a type of reversible and non-competitive inhibition found in allosteric enzymes.
- All allosteric modulation are **not feed-back inhibition.**

FACTORS

- **pH** - Enzymes very sensitive to pH.
- **Temperature -** High temp inactivates enzyme causing their denaturation. They also get inactive at lower temp. Generally all enzymes better perform at body temp. of organism.
- **Enzyme concentration -** Increase in conc. of enzymes will increases the rate of enzymetic reaction till enough the substrate.
- **Substrate con^{n}-** Increase in substrate con^{n} increases the activity of enzymes until all the active sites of enzyme ae saturated.



• Inhibitors/Enzyme inhibition :-

– **Competitive inhibitors or competitive inhibition and reversible type -**

These are **substrate analogues,** which bind to the active site and enzymes get inhibited, such inhibition is called as competitve inhibition.

Eg. **Succinic dehydrogenase** is inhibited by its competitor **malonate.**

This is reversible inhibition. **Malonate** is known as substrate analogue of **succinate.**

- Similarly **sulpha drugs** are substrate analogue of para-amino benzoic acid **(PABA)** used in folic acid synthesis in bacterical cells. Hence these drugs are used to kill bacterial cells.
- **Non-competitve inhibitors or non competitive inhibition and irreversible type :-**

– In this type of inhibition, inhibitor substance can bind simultaneously to an enzyme, at any site and destroy the **sulfhydryl (S-H) group** of enzyme.

Example :- Toxic metals, CO, CN poisoning of cytochrome oxidase.

Such inhibition are **irreversible inhibition.**

- **Non competitive & reversible type :-**

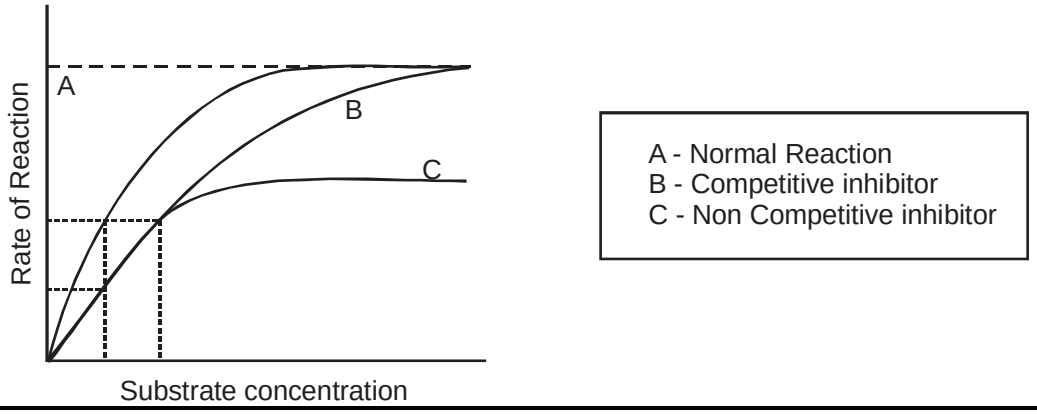
– When inhibitor binds at allosteric site reversibly.

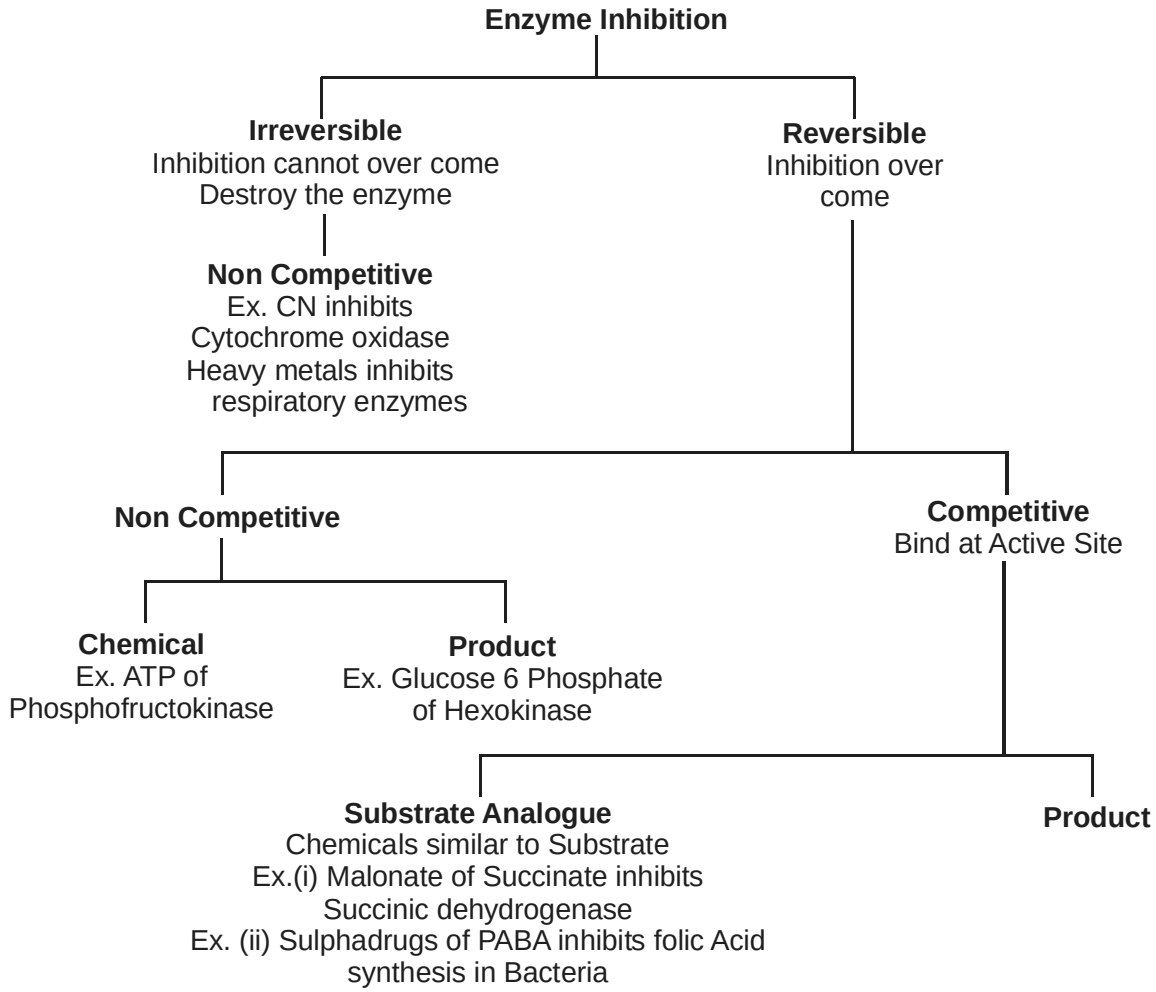
– When product of biochemical reaction inhibits the enzyme action, it is known as **product inhibition** or **retro inhibition** or **feed back inhibition.**

– The product may binds at **allosteric site** of allosteric enzyme then it is **non-competitive, reversible, allosteric inhibition** Example : **inhibition of hexokinase by glucose 6P.**

So, **product inhibition** is always **reversible inhibition.**

- If **competitive inhibitor (Reversible)** is present, then, **km** - ↑ **and V_{max} - No change.**
- If **Non competitive** (reversible) inhibitor is present, then, **Km-No change, V_{max} -Decrease**
- **Competitive inhibition** is overcome by increase in concentration of substrate.





SPECIAL POINTS OF ENZYMES

- NAD = Nicotinamide Adenine Dinucleotide
- DPN = Diphospho Pyridine Nucleotide
- NADP = Nicotinamide Adenine Dinuclotide Phosphate
- TPN = Triphospho Pyridine Nucleotide
- FAD = Flavin Adenine Dinucleotide
- FMN = Flavin Mono Nucleotide
- Co A = Adenosine Triphospho Panta thenyl thio Ethanol Acetyl Amine
- I ATP = 7.6 K cal

- **Important Coenzymes are**

Co-1 (NAD)/DPN	Niacin
Co-II (NADP)/TPN	Niacin
FAD	Riboflavin
FMN	Riboflavin
TPP	Thiamine
CO-Q	Ubiquinone
CO-R	Biotine
CO-A	Pantothenic Acid

- **Important Co-factor :-**

Fe^{++}	=	Cytochrome Oxidase, Catalase, Peroxides, Aconitase
Cu^{++}	=	Cytochrome oxidase, Tyrosinase
Zn^{++}	=	Carbonic anhydrase, Alcohol dehydrogenase
Mg^{++}	=	Hexokinase, Glucokinase, Pyruvate kinase, Pepcase, Rubisco
K^{+}	=	Pyruvate kinase
Mn^{++}	=	Arginase, Ribonucleotide reductase, Decarboxylase.
Mo	=	Nitrogenase complex, Nitrate reductase.
Se	=	Glutathione peroxidase

EXERCISE – 1

CARBOHYDRATES

Q.1 How many possibler isomers will be formed of open chain glucose molecule :
(1) 4 (2) 8
(3) 16 (4) 32

Q.2 Callose is polymer of-
(1) Fructose (2) Sucrose
(3) Glucose (4) Xylans

Q.3 Which is odd -
(1) Chitin-Carbohydrates
(2) Pectin - protein
(3) Steroid - Lipid
(4) Wax - Lipid

Q.4 Glycogen is stored in -
(1) Liver and muscles (2) Liver only
(3) Muscles only (4) Pancreas

Q.5 Which is a disaccharide -
(1) Galactose (2) Fructose
(3) Maltose (4) Dextrin

Q.6 Which substance is not carbohydrate -
(1) Starch (2) Glycogen
(3) Wax (4) Glucose

Q.7 To get quick energy one should use -
(1) Carbohydrate (2) Fats
(3) Vitamins (4) Proteins

Q.8 Which is not a polysaccharide -
(1) Sucrose (2) Starch
(3) Glycogen (4) Cellulose

Q.9 External coat composed of cellulose like material occurs in -
(1) Hemichordata (2) Urochordata
(3) Cephalochordata (4) Cyclostomata

Q.10 Monosaccharides is -
(1) Pentose Sugar (2) Hexose Sugar
(3) Glucose (4) All the above

Q.11 Sugar which is found in haemolymph of insects is called-
(1) Maltose (2) Lactose
(3) Trehalose (4) Galactose

Q.12 In which form, extra sugar is stored in the body-
(1) Glucose monosaccharide
(2) Sucrose Disaccharide
(3) Glycogen polysaccharide
(4) Fatty acid and glycerol

Q.13 Glycogen is -
(1) Polymer of amino acids
(2) Polymer of fatty acids
(3) Unsaturated fats (4) Polymer of glucose

Q.14 Sugars are-
(1) Polymers of fatty acid
(2) Polymers of amino acids
(3) Poly hydroxy aldehyde or ketone
(4) None

Q.15 Which compound produces twice the amount of energy than carbohydrates -
(1) Protein (2) Fats
(3) Vitamins (4) Glucose

Q.16 Starving person will first use from the following -
(1) Fats (2) Glycogen
(3) Blood protein (4) Muscle protein

Q.17 Translocation of sugars in flowering plants occurs in the form of -
(1) Glucose (2) Sucrose
(3) Fructose (4) Maltose

Q.18 How many are incorrect match :
A. Chondritin sulphate - Heart valves
B. Fucose+ sialic acid - Blood group substance
C. Heparin - leech anticoagulant
D. Methanogen - cellulose
E. amylopection - water soluble
F. Inulin - Urochordates
(1) ACF (2) CEF
(3) BDE (4) CDF

Q.19 Sucrose is composed of -
(1) Glucose & Glycogen
(2) Glucose & Fructose
(3) Two molecule of Glucose
(4) Glycogen & Fructose

Q.20 Which of the following sugar is found in ATP -
(1) Deoxyribose (2) Ribose
(3) Trehalose (4) Glucose

Q.21 Lactose is composed of -
(1) Glucose + galactose (2) Glucose + Fructose
(3) Glucose + Glucose
(4) Glucose + mannose

Q.22 True statements for cellulose molecule-
(1) β-1-4 linkage, unbranched
(2) β-1-4 linkage, branched
(3) α-1-4 linkage, branched
(4) β-1-6 linkage,unbranched

Q.23 Sweetest sugar among the naturally occuring sugar-
(1) Glucose (2) Fructose
(3) Sucrose (4) Saccharine

Q.24 Sugar with five membered ring is called -
(1) Pyranose (2) Furanose
(3) Dextrorotatory (4) Laevorotatary

Q.25 Which sugar occur only in mammals -
(1) Trehalose (2) Galactose
(3) Lactose (4) Mannose

Q.26 Which sugar does not give Benedict's test or Fehling's tests-
(1) Glucose (2) Maltose
(3) Fructose (4) Sucrose

Q.27 Amylose and Amylopectin occur in -
(1) Glycogen (2) Starch
(3) Cellulose (4) Chitin

Q.28 The blood group proteins of man are composed of-
(1) Glycoproteins (2) Mucoproteins
(3) Lipoproteins (4) Phosphoproteins

Q.29 Animal starch (glycogen) differs from plant starch in-
(1) Having short chain branched structure
(2) Being reserve food of animals mostly
(3) Give no blue colour with iodine
(4) All of the above

Q.30 The most commonly occuring oligosaccharides of protoplasm are-
(1) Glucose frutose & maltose
(2) Galactose, starch & glycogen
(3) Maltose, Lactose & Sucrose
(4) Ribose, deoxyribose & ribulose

PROTEINS AND AMINO ACID

Q.31 Albuminiod or scleroproteins are :
(1) Albumin containing proteins eg. ovalbumin
(2) Water insoluble fibrous proteins eg keratin, collagen
(3) Proteins present in connective tissue
(4) Proteins present in egg.

Q.32 Which group is correct :
(1) Glycoprotein – Mucin
(2) Salmin – Phosphoprotein
(3) Lipoprotein – Lecithin
(4) Cytochrome – Mucoprotein

Q.33 In infants of under 6 months of age, deficiency of protein may cause -
(1) Marasmus (2) Kwashiorkar
(3) Rickets (4) Galactosemia

Q.34 Kwashiorkar disease develops due to -
(1) Malnutrition (2) Overeating
(3) Catalysis (4) Mutation

Q.35 Which element is normally absent in proteins-
(1) C (2) N
(3) S (4) P

Q.36 Protein most abudant in human body are -
(1) Collagen (2) Myosin
(3) Actin (4) Albumin

Q.37 Common in feather and silk is -
(1) Carbohydrate (2) Fats
(3) Protein (4) Nucleic acid

Q.38 Proteins which are present in protoplasm are very important because -
(1) They provide rigidity to cell
(2) They function as biocatalyst
(3) They yield energy
(4) They are stored food

Q.39 Essential component of all living organisms -
(1) Hemoglobin (2) Protein
(3) Chlorophyll (4) Carbohydrate

Q.40 Which test is not used for proteins :
(1) Xanthoproteic test (2) Mollish test
(3) Millons test (4) Ninhydrin test

Q.41 Products of proteins catabolism -
(1) NH_3, CO_2 and Urea
(2) Urea, CO_2 and NH
(3) Urea, NH_3 and uric acid
(4) Urea, NH_3, alanine and creatine

Q.42 Unit of proteins which unite in long chains to form proteins are called -
(1) Sugar (2) Purines
(3) Pyrimidines (4) Amino acids

Q.43 Milk protein is -
(1) Lactogen (2) Myosin
(3) Casein (4) Pepsin

Q.44 The simplest amino acid is-
(1) Tyrosine (2) Lysine
(3) Glycine (4) Aspartic acid

Q.45 The amino acids which are not synthesized in the body are called -
(1) Non-essential (2) Essential
(3) Deaminated (4) All of them

Q.46 Which of the following will be different in different animals -
(1) Fats (2) Carbohydrates
(3) Proteins (4) Vitamins

Q.47 In India the best source for proteins in herbivorous persons is-
(1) Pulses (2) Potato
(3) Egg (4) Meat

Q.48 Proteins are transported in the body of herbivourous persons as -
(1) Amino acids (2) Natural proteins
(3) Enzymes (4) Nucleic acid

Q.49 The formation of protein can be considered as-
(1) Dehydration synthesis
(2) Dehydration analysis
(3) Hydration synthesis
(4) Hydration analysis

Q.50 Who won the noble prize of 1954 for unravalling the –helical structure of keratin
(1) Thomes & whatson
(2) L. Pauling & R.B. Corey
(3) Berzilius & Moulder
(4) F. sanger.

Q.51 In most of the Amino acid Metabolism the first step is :
(1) Transamination (2) Decarboxylation
(3) Transamidation (4) Deamination.

Q.52 Genetic code determines -
(1) Structural pattern of an organism
(2) Sequence of amino acid in a protein chain
(3) Variation in offsprings
(4) Constancy of morphological trait

Q.53 Which of the following amino acid is essential-
(1) Alanine (2) Glycine
(3) Tryptophan (4) Tyrosine

Q.54 Which is most important structural part of the body-
(1) Protein (2) Carbohydrates
(3) Lipid (4) Nucleic acid

Q.55 Which of the following Harmone set do not favour protein synthesis :
(1) Growth Harmone and Insulin
(2) Testosterone and Thyroxin
(3) Glucocorticoids and Parathormone
(4) Progesteron and Thymosin.

Q.56 Which protein is oxidised by light producing animals:
(1) Gramicidin (2) Leuciferin
(3) Flavin (4) Leumin

Q.57 Contractile protein is -
(1) Actin (2) Myosin
(3) Troponin (4) Tropomyosin

Q.58 Variations in proteins are due to -
(1) Sequence of amino acids
(2) Number of amino acids
(3) R-group
(4) None

Q.59 Histone is a basic protein due to -
(1) Alanine & Glycine
(2) Methionine & serine
(3) Tryptophan & tyrosine
(4) Lysine & Arginine

Q.60 Which amino acid is an important constituent of vitamin folic acid :
(1) Glycine (2) Glutamic acid
(3) Argenine (4) Lysine

Q.61 Isoelectric pH of arginine is
(1) 7 (2) less than 7
(3) more than 7 (4) 6.8

LIPIDS

Q.62 Cholesterol is synthesized in -
(1) Pancreas (2) Brunners gland
(3) Spleen (4) Liver

Q.63 Long chain molecules of fatty acids are formed by-
(1) Polymerisation of 2 carbon compounds,
(2) Decomposition of fats
(3) Polymerisation of glycogen
(4) Conversion of glycogen

Q.64 Fats in the body are formed when -
(1) Glycogen is formed from glucose
(2) Sugar level becomes stable in blood
(3) Extra glycogen storage in liver and muscles is stopped
(4) All of them

Q.65 Gaucher's dissease is concerned with which of the following -
(1) Abnormal fat metabolism
(2) Abnormal protein metabolism
(3) Abnormal carbohydrate metabolism
(4) None of them

Q.66 Lipid derivative which occur in fecal material-
(1) Cholesterol (2) Ergesterol
(3) Lanoline (4) coprosterol

Q.67 Cerebrosides & Gangliosides are -
(1) Phospholipids (2) Chromolipids
(3) Glycolipids (4) Sulpholipids

Q.68 Lecithin is chemically :
(1) Phosphatidyl choline
(2) Phosphatidyl ethanolamine
(3) Phosphatidyl serine
(4) Phosphatidyl sphingosin

Q.69 Cholesterol is an important compound in the body, because it-
(1) Regulates blood pressure
(2) Gives rise to steroid hormone
(3) Regulates filtration pressure in kidneys
(4) Is involved in Ca^{++} absorption from gut

Q.70 An antifertility steroid is-
(1) Cortisol (2) Progesterone
(3) Diosgenin (4) Estrogen

Q.71 Which of the following lipids is most abundant in cell membrane-
(1) Steroid (2) Cholesterol
(3) Phospholipid (4) Cutin

Q.72 The 'free fatty acid" (FFA) of plasma are-
(1) Metabolically inert
(2) Mainly bound to beta lipoproteins
(3) Stored in fat
(4) Mainly bound to serum albumin

Q.73 A phospholipid lecithin contains-
(1) A fatty acid, an alcohol, a phosphate group and choline
(2) A fatty acid and an alcohol
(3) A fatty acid and a phosphate group
(4) A fatty acid, an alcohol and a phosphate group

Q.74 Postaglandins are fatty acid derivaties found in trace amount. What is the role of such dervatives :
(1) Inflammatory and allergic reactions
(2) Clotting of blood
(3) Smooth muscle contraction
(4) All of the above

Q.75 Bacteria which cause tuberculosis and leprosy produce which substance that contibute to their pathogenecity-
(1) Sterols (2) Wax-D
(3) Tristearin (4) None of the above

Q.76 Esters of long chain fatty acid with long-chain monohydric alcohols are called-
(1) Fats (2) Waxes
(3) Both of the above (4) None of the above

Q.77 Naturally occuring fatty acids usually contain-
(1) Even number of C atoms
(2) Odd number of C atoms
(3) Both 1 & 2 (4) None of these

Q.78 Prostaglandins are synthesised from-
(1) Arachidonic acid (2) Oleic acid
(3) Linoleic acid (4) Linolenic acid

Q.79 Lecithin contains a nitrogenous base called as-
(1) Ethanolamine (2) Choline
(3) Inosiiol (4) Either of the three

Q.80 The density of lipoproteins increases as the protein content-
(1) Decreases (2) Increases
(3) Not related with the protein content
(4) None of these

Q.81 In sphingomyelins, the alcoholic moiety is-
(1) Glycerol (2) Acetyl alcohol
(3) Glycol (4) Sphingosin

ENZYME

Q.82 An indispensible role in energy metabolism is played by -
(1) Phosphorus (2) Lithium
(3) Sodium (4) Calcium

Q.83 Mineral activator needed for the enzymes aconitase of TCA cycle is -
(1) Mn (2) Fe
(3) Mg (4) Cu

Q.84 If the temperature is incresed above 35°C
(1) Rate of decline of respiration will be earlier than decline of photosynthesis
(2) Rate of decline of photosynthesis will be eartlier than decline of respiration
(3) Both decline simultaneously
(4) Both do not show fixed pattern

Q.85 Which of the following is coenzyme-II ?
(1) NAD (2) NADP
(3) FAD (4) None of the above

Q.86 Where does the synthesis of enzyme occur in a cell-
(1) Inside the nucleus (2) In lysosomes
(3) On the surface of ribosome
(4) Inside the vacuole

Q.87 Excess of ATP inhibits the enzyme-
(1) Phosphfructokinase
(2) Hexokinase
(3) Aldolase (Lyases)
(4) Pyruvate decarboxylase

Q.88 Enzyme cytochrome oxidase can be inhibited by :
(1) Iodo acetate (2) Cyanides
(3) Oilgomycins (4) Dinitrophenol

Q.89 Different steps in respiration are controlled by-
(1) Enzymes (2) Auxins
(3) Sugars (4) Kinins

Q.90 Which one is both structural & functional (catalytic) protein :
(1) Hexokinase (2) Myosine
(3) Ribozyme (4) Acdtyl Co-A

Q.91 The full form of NAD is -
(1) Nicotine adenosine diphospate
(2) Nicotinamide adenosine dinucleotide
(3) Nicotinamide adenine dinucleotide
(4) Nicotinamide adenine diphosphate

Q.92 First discovered Enzyme was -
(1) Isomerase (2) Transaminase
(3) Zymase (4) Transferase

Q.93 Enzyme were discovered for the first time in -
(1) Bacteria (2) Yeast
(3) Algae (4) Spinach

Q.94 Who coined the term enzyme -
(1) Pasteur (2) Buchner
(3) Kuhne (4) Summer

Q.95 Vitamin serves the function of -
(1) An enzyme (2) A coenzyme
(3) A substrate (4) A hormone

Q.96 Which of the follwoing is a coenzyme-
(1) NAD (2) NADP
(3) FAD (4) All the above

Q.97 What is NADP -
(1) An enzyme
(2) An ion carrier
(3) H_2 acceptor coenzyme
(4) A part of t-RNA

Q.98 The prosthetic group of various respiratory enzymes is -
(1) Ca (2) B
(3) Mg (4) Mo

Q.99 Most enzymes consist of two parts these are -
(1) Enzyme & substrate
(2) Enzyme & coenzyme
(3) Apoenzyme and enzyme
(4) Apoezyme & prosthetic group

Q.100 The first enzyme is isolated in crystalline form was -
(1) Catalase (2) Urease
(3) Peroxidase (4) Amylase

Q.101 In plants enzymes are present in -
(1) Only in flowers (2) Onlly in leaves
(3) All the living cells of plant body
(4) Only in parenchyma

Q.102 An enzyme is made up of -
(1) Vitamin (2) Growth factor
(3) Protein (4) Carbohydrates

Q.103 Which of the following is not an enzyme ?
(1) Oxidase (2) Pepsin
(3) Auxin (4) Trypsin

Q.104 Enzyme capable of changing thier shape are called -
(1) Apoenzyme (2) Coenzyme
(3) Allosteric enzyme (4) Co-factor

Q.105 What is the chemical nature of the majority of prosthetic groups ?
(1) Lipoidal (2) Organic
(3) Metallic (4) Alkaloidal

Q.106 Which of the following coenzyme is a derivative of pantothenic acid? (vit-B complex)
(1) NAD (2) NADP
(3) FAD (4) Co-A

Q.107 Which of the following is not consumed in a biochemical process ?
(1) Hormone (2) Enzyme
(3) vitamin (4) Nucleotide

Q.108 How the presence of an enzyme affects the activation energy of a reaction ?
(1) It becomes increased
(2) It becomes decreased
(3) It is first increaed and then decreased
(4) Activation energy in not affected at all

Q.109 The cheif enzyme found in yeast cell is ?
(1) Invertase (2) Maltase
(3) Zymase (4) Amylase

Q.110 Which of the enzyme joins the broken strands of DNA ?
(1) Nuclease (2) Kinase
(3) Ligase (4) Endonuclease

Q.111 Inhibition of succinic dehydrogenase by malonate is an example of -
(1) Competitve inhibition
(2) Non competitive inhibition
(3) Allosteric inhibition (4) Enzyme repression

Q.112 At a temperature below the freezing point an enzyme is -
(1) Unaffacted (2) Inactivated
(3) Slightly inactivated (4) Killed

Q.113 Enzyme inhibition caused by a substrate analog is -
(1) Competitive (2) Non competitive
(3) In competitve (4) Semi-competitive

Q.114 At boiling temperature an enzyme is -
(1) Denatured (2) Unaffected
(3) Inactivated (4) Killed

Q.115 Enzyme have very narrow optima for -
(1) Light (2) Temperature
(3) pH (4) Humidity

Q.116 Which enzyme is without protein?
(1) Hexokinase (2) Synthetase
(3) Endonuclease (4) Ribozyme

ANSWER KEY

EXERCISE –1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	3	2	1	3	3	1	1	2	4	3	3	4	3	2	2	2	2	2	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	2	2	2	4	1	1	4	3	2	1	1	1	4	1	3	2	2	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	4	3	3	2	3	1	1	1	2	1	2	3	1	3	2	1	1	4	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	4	1	3	1	4	3	1	2	3	3	2	1	4	2	2	1	1	2	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	1	2	2	2	3	1	2	1	2	3	3	2	3	2	4	3	3	4	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116				
Ans.	3	3	3	3	2	4	2	2	3	3	1	2	1	1	3	4				

EXERCISE – 2

CARBOHYDRATES

Q.1 The basic unit of chitin is-
(1) N-acetyl glucosamine
(2) Glucose
(3) Galactose
(4) Fructose

Q.2 The formation of glucose from non-carbohydrate materials is called-
(1) Glycogenesis (2) Glycogenolysis
(3) Gluconeogenesis (4) Glycolysis

Q.3 Glucose, galactose and fructose all have the same molecular size and composition and their absorption through the mucosal cells takes place-
(1) At the same rate
(2) Glucose is absorbed most rapidly
(3) Fructose is absorbed most rapidly
(4) Galactose is absorbed most rapidly

Q.4 Cellulose is a linear polymer of-
(1) β-glucose pyranose molecules
(2) Sucrose molecules
(3) α-glucose pyranose molecules
(4) None of the above

Q.5 Gun cotton is-
(1) Nitrosucrose (2) Nitrocellulose
(3) Nitrofructose (4) None of these

Q.6 Disaccharides and polysaccharides are formed by glycosidic bonds, sucrose is formed when glucose and frutose join between their-
(1) 1 and 4 carbon (2) 1 and 2 carbon
(3) 1 and 3 carbon (4) 2 and 4 carbon

Q.7 Three polysaccharides, starch glycogen and cellulose are structurally and biochemically distinct, even though they are polymers of same monosacharide glucose. The basis for their difference lies-
(1) The way of branching
(2) Type of bonds
(3) Both 1 and 2
(4) Only in their arrangement

Q.8 Which one of the following is epimer of glucose?
(1) Fructose (2) Galactose
(3) Cellulose (4) Ribose

Q.9 Honey contains the hydrolytic product of-
(1) Lactose (2) Maltose
(3) Insulin (4) Starch

Q.10 Human heart muscle contains-
(1) D-Ribose (2) D-Lyxose
(3) D-Xylose (4) D-Arabinose

Q.11 Which of the following compounds is found to be present in heart valves-
(1) Hyaluronic acid
(2) Chondroitin sulphate
(3) Heparin
(4) Glucosamine

Q.12 In human being, galactose is most easily available-
(1) By the conversion of glucose
(2) By the conversion of fructose
(3) By the hydrolysis of maltase
(4) By the hydrolysis of milk

Q.13 Lactose is formed in mammary gland under the influence of lactose synthetase by the reaction of-
(1) Glucose and glactose
(2) UDP-glucose and galactose
(3) UDP-galactose and glucose
(4) UDP-glucose and UDP-galactose

Q.14 Mucopolysaccharides consist of repeating units of disaccharide molecules consisting of-
(1) Two monosaccharides
(2) Glucoronic acid + amino sugar
(3) Uronic acid + acylated amino sugar
(4) Uronic acid + Amino sugar

Q.15 Which of the following is not a mucopoly-saccharide-
(1) Heparin
(2) Chondroitin sulphate
(3) Hyaloronic acid
(4) Inulin

Q.16 In case of insufficient supply of glucose, gluconeogenesis is the important source of glucose in-
(1) Muscles (2) Adipose tissue
(3) Nervous tissues (4) Liver

Q.17 The normal blood glucose level of an adult in the post absorptive state is-
(1) 40–60 mg/100 ml
(2) 80–100 mg/100 ml
(3) 120–130 mg/100 ml
(4) 160–180 mg/100 ml

Q.18 Function of brain is disturbed when the blood glucose level falls from the normal fasting value (80 mg/100 ml) to-
(1) 60 mg / 100 ml (2) 40 mg / 100 ml
(3) 20 mg / 100 ml (4) 10 mg / 100 ml

Q.19 A diasachharide formed by condensation of a tetrose and Hexose, will have general formula:
(1) $C_{10}H_{18}O_9$ (2) $C_{10}H_{20}C_{10}$
(3) $C_{10}H_{16}O_8$ (4) $C_{12}H_{16}O_{10}$

Q.20 Which one of the following is used in shatterproof glass -
(1) Cellulose nitrate
(2) Cellulose acetate
(3) Carboxylmethyl cellulose
(4) Simple cellulose

Q.21 What is the normal ratio of sugar in human -
(1) 0.01 % (2) 0.1%
(3) 1% (4) 0.18%

Q.22 Carbohydrate metabolism is controlled by-
(1) Parathormone (2) Insulin
(3) Glucose (4) Vitamin B_{12}

Q.23 Which is sweet in taste, but is not sugar-
(1) Starch (2) Saccharine
(3) Lactose (4) Protein

Q.24 The sweetest sugar is-
(1) Fructose (2) Saccharin
(3) Monellin (4) Thaumatin

Q.25 Xylitol is-
(1) Artificial sweetener
(2) Nutritive sweetener
(3) Nonnutritive sweetener (calorifree)
(4) Both '1' and '2'

Q.26 Leavulose present in honey is-
(1) Disaccharide (2) Glucose
(3) Fructose (4) pentose

Q.27 In Fehling' or Benedict's solution, a reducing sugar causes conversion of-
(1) Ferric to ferrous state
(2) Ferrous to ferrric state
(3) Cuprous to cupric state
(4) Cupric to cuprous state

Q.28 Use of artificial sweetener saccharin has been discontinued it is-
(1) Carcinogenic
(2) Liable to decompose in hot weather of tropics
(3) Bitter in the beginning
(4) All the above

Q.29 The commonly used artificial sweetener is -
(1) Acesulfame K (2) Cyclamate
(3) Aspartame (4) Saccharin

Q.30 Mannose is-
(1) Disaccharide
(2) hexosan monosaccharide
(3) Pentosan monosaccharide
(4) A tetrose

Q.31 Mannitol is-
(1) Amino acid (2) Amino alcohol
(3) Sugar alclhol (4) Sugar acid

Q.32 Inulin is a polymer of-
(1) Glucose (2) Galactose
(3) Fructose (4) Arabinose

Q.33 Raffinose is a
(1) Monosaccharide (2) Disaccharide
(3) Trisaccharide (4) Tetrasaccharide

Q.34 Most sugars are dextrorotatory which means they-
(1) Tilt light to right
(2) Rotate polarised light to right
(3) Tilt light to left
(4) Rotate polarised light to left

Q.35 A mucopolysaccharide is-
(1) Slime, phycocolloid and pectin
(2) Mucin, callose and heparin
(3) Hemicellulose, pectin and mucin
(4) Hyaluronic acid, chondroitin sulphate

Q.36 Cellulose acetate is raw meterial for-
(1) Photographic films (2) Tericot
(3) Shatter proof glass (4) All the aobve

Q.37 Smoothening agent in icc-creams and brightening agent in detergents is-
(1) Cellulose hypoxanthate
(2) Cellulose xanthate
(3) Carboxymethl cellulose
(4) All of these

Q.38 In food, starch is detected by its-
(1) Graanular form
(2) White appearance
(3) Energy reserve
(4) Blue reaction with iodine

Q.39 Cellulose eaten by grazing animals is-
(1) Passed out undigested
(2) Digested by digestive enzymes
(3) Digested by intestinal bacteria
(4) Digested by digestive enzymes of intestinal bacteria

PROTEINS & AMINO ACIDS

Q.40 Example of phosphoprotein is-
(1) Mucin (2) Fibrinogen
(3) Casein (4) Myosin

Q.41 Serotonin is derived in the body from the following amino acid-
(1) Phenyl alanine (2) Glycine
(3) Tyrosine (4) Tryptophan

Q.42 The essential amino acids-
(1) Must be supplied in the diet because the organism has lost the capacity to aminate the corresponding keto acid
(2) Must be supplied in diet because the human has an impaired ability to synthesize the carbon chain of corresponding keto acids
(3) Are indentical in all species
(4) Are defined as those amino acids which cannot be synthesized by the organism at a rate adequate to meet metabolic requirements

Q.43 Which of the following is sulphur containing amino acid -
(1) Alanine (2) Lysine
(3) Methionine (4) Argenine

Q.44 Following are Aromatic amino acid.
(1) Glucine, valine, Alanine
(2) Phenylalanine, Tyrosine, Tryoptophan
(3) Cystne, Methionine, Glutomic acid
(4) Threonine, Levcine, Argenine

Q.45 Which one is not a protein :
(1) Cytochrome (2) Myoglobin
(3) Flbrinogen (4) urea

Q.46 Proteins of silks fibres are examples of-
(1) Simple linear proteins
(2) Secondary pleated proteins
(3) Tertiary folded proteins
(4) Quarternary super folded proteins

Q.47 Histones are-
(1) Nucleic acids
(2) Nitrogen bases of DNA
(3) Proteins of eukaryotes
(4) Proteins of prokaryotes

Q.48 Growth repair and protection against diseases in our body is carried by-
(1) Vitamins (2) Hormones
(3) Proteins (4) Lipids

Q.49 The process of protein synthesis is also called-
(1) Translation
(2) Tranduction
(3) Translation & tranduction
(4) Transcription - Translation

Q.50 All α-amino acids are optically active except-
(1) Glycine (2) Alanine
(3) Serine (4) Phenylalanine

Q.51 Amino acids have net charge zero at-
(1) Every pH (2) No pH
(3) A specific pH (4) None of these

Q.52 In many proteins, the hydrogen bonding produces a regular coiled arrangment called-
(1) α-helix (2) β-helix
(3) both (4) None

Q.53 The number of amino acid present in each turn of α-helix is-
(1) 2.8 (2) 3.2
(3) 3.4 (4) 3.6

Q.54 Spirulina protein is obtained from :
(1) Blue green algae (2) Bryophyta
(3) Mycorhiza (4) Wheat

Q.55 Under normal conditions, food proteins are generally readily digested upto-
(1) 67-73% (2) 74-81%
(3) 82-89% (4) 90-97%

Q.56 The unwanted amino acid abstracted from the tissues are either used up by the tissue or in the liver converted into-
(1) Ammonia (2) Urea
(3) Ammonium salts (4) Uric acid

Q.57 Metabolism of all proteins ingested over and above the essential requirements is called-
(1) Endogenous metaolism
(2) Exogenous metabolism
(3) Both of the above
(4) None of the above

Q.58 Transamination is a-
(1) Reversible process
(2) Irreversible process
(3) Both of the above (4) None of the above

Q.59 Which one is the method used for amino acid estimation :
(1) Edmann reaction (2) Ninhydrin reaction
(3) Formol titration (4) All the above

Q.60 Protein amino acids are-
(1) Laevorotatory (2) Dextrootatory
(3) Laevorotatory except glycine which is nonrotatory
(4) Laevorotatory except glycine which is dextrorotary

Q.61 An aromatic amino acid is-
(1) Tryptohan (2) Tyrosine
(3) Phenylalanine (4) All the above

Q.62 A functional but nonprotein amino acid is-
(2) Ornithine (2) Citrulline
(3) Diaminopimelic acid
(4) All of these

Q.63 The most abundant organic molecule is-
(1) RUBISCO (2) Starch
(3) Cellulose (4) Chitin

Q.64 Most abundant portein in the human body is -
(1) Haemoglobin (2) Keratin
(3) Collagen (4) Immunoglobulin

Q.65 Oxygen transproting protein is haemoglobin. Which one is oxygen storing protein-
(1) Myoglobin (2) Actin
(3) Myosin (4) Cascinogen

Q.66 Calmodulin is-
(1) Carotene binding protein
(2) Cadmium binding protein
(3) Calcium binding protein
(4) ChlorophyII binding protein

LIPIDS

Q.67 The majority of the absorbed fat appears in the form of-
(1) HDL (2) LDL
(3) VLDL (4) Chylomicrons

Q.68 Lengthening of the carbon chain of fatty acid takes place only in-
(1) Cytosol
(2) Mitochondria only
(3) Microsomes only
(4) Mitochondria and microsomes

Q.69 Human system lacks the enzymes capable of synthesing-
(1) Oleic acid
(2) Archidic acid
(3) Linolenic acid
(4) Linoleic and linolenic acid

Q.70 Prostaglandins are used for-
(1) The induction of menstruation
(2) The prevention of conception
(3) The termination of pregnancy
(4) All the three cases

Q.71 The total amount of cholesterol in human body weighing 70 kg is about-
(1) 140 gm (2) 160 gm
(3) 180 gm (4) 200 gm

Q.72 The normal concentration of cholestrol in plasma is-
(1) 100 mg to 150 mg / 100 ml
(2) 150 mg to 250 mg /100 ml
(3) 250 mg to 500 mg /100 ml
(4) 300 mg to 500 mg /100 ml

Q.73 Essential oils are those which are-
(1) Essential for plants themselves
(2) Essential for human kind
(3) Used for soaps and cosmetics
(4) A source of perfumes

Q.74 The melting point of unsaturated fatty aicds -
(1) Increases with increase in double bonds
(2) Decreases with increase in double bonds
(3) Rises in some and falls in others
(4) These is no relationship between unsaturation and melting point

Q.75 Essential fatty acids were discovered by-
(1) Evans and Burr (2) Bloor
(3) Sutherland (4) Beevers

Q.76 Definciency of EFA causes-
(1) Follicular keratosis (2) Kidney failure
(3) Sterility (4) All the above

Q.77 Arachidonic acid gives rise to-
(1) Terpenes (2) Prostaglandandins
(3) Gangliosides (4) Cerebrosides

Q.78 Hydrogenation-
(1) Increases percentage of EFA
(2) Destroys EFA
(3) Converts waxes into neutral fats
(4) Forms conjugated linoleic acid

Q.79 Major function of PUFA is-
(1) Supply of essential fatty acids
(2) Lowering of cholesterol level
(3) Prevent atherosclerosis
(4) All the above

Q.80 Number of fatty acids present in a molecule of phospholipid is-
(1) Two (2) Three
(3) One (4) None

Q.81 In contact with water, fatty acids produce-
(1) Monolayer (2) Bilayer
(3) Trilayer (4) membrane

Q.82 A steroid that prevents fertility is-
(1) Campesterol (2) Cholesterol
(3) Diosgenin (4) Testosterone

Q.83 Wax present in human blood is-
(1) Mericyl palmitate (2) Cetyl palmitate
(3) Cholesterol palmitate
(4) Ceryul palmitate

Q.84 Lycopene, the colouring agent of Tomato, is a-
(1) Sterol (2) Terpenoid
(3) Sphingolipid (4) Phospholipid

Q.85 Rubber is-
(1) Monoterpene (2) Diterpene
(3) Tetraterpene (4) Polyerpene

Q.86 Which is the following lipid is essential part of good diet-
(1) Oleic acid (2) Linoleic acid
(3) Stearic acid (4) Palmitic acid

ENZYMES

Q.87 Allosteric inhibition of enzyme was discovered by -
(1) Kuhne (2) Krebs
(3) Jacob & Monad (4) Buchner

Q.88 Allosteric enzymes have allosteric sites for -
(1) Inhibition only
(2) Activation only
(3) Reduction in activation energy
(4) Both activation and inhibition

Q.89 Substrate concentration at which an enzyme attains half of its max. velocity is ?
(1) Half life of enzyme
(2) Km-constant of enzyme
(3) Concentration ratio
(4) None

Q.90 Part of active site of enzyme, where substrate is supported -
(1) Catalytic group (2) Butteressing group
(3) Activation chamber
(4) Ki-constant

Q.91 Who gave the name enzyme ?
(1) Sumner (2) Kuhne
(3) Buchner (4) Gay Lussac

Q.92 Who was successful in isolating an enzyme in pure and crystallized form ?
(1) Sumner (2) Buchner
(3) Kuhne (4) Gay Lussac

Q.93 Which was the first enzyme obtained in crystallized form?
(1) Zymase (2) Amylase
(3) Urease (4) Protease

Q.94 Which of these is Coenzyme I and Coenzyme II –
(1) NAD/NADP (2) NADP/NAD
(3) NAD/FAD (4) FAD/NAD

Q.95 Who discovered the enzyme called ribozyme?
(1) Holley
(2) Thomas Cech & Sydney Altman
(3) Benda & Altmann
(4) None of the above

Q.96 Which are called zymogen ?
(1) Substances digesting the enzymes
(2) Precursor substances of the enzymes
(3) Substance attached to the enzymes
(4) Enzyme found in yeast

Q.97 What are the multiple molecular forms of an enzyme called ?
(1) Isomer
(2) Isoenzyme
(3) Multiple form enzyme
(4) None of the above

Q.98 Which is the specific character of isoenzyme ?
(1) All forms express reaction specificity on one substrate only
(2) They are generally quaternary proteins
(3) They are formed by different genes
(4) All the above

Q.99 Which of these characters is of enzymes ?
(1) Colloidal nature
(2) High molecular weight
(3) Catalytic nature
(4) All the above

Q.100 What is true about enzymes ?
(1) Required in minute amounts
(2) Increase the reaction rate
(3) Available as such at the end of reaction
(4) All the above

Q.101 Enzymes are affected by –
(1) pH (2) Temperature
(3) Activator/Inhibitor (4) All the above

Q.102 What is not true about activity of enzymes ?
(1) They start the reaction
(2) They change the direction of reaction
(3) They increase the rate of reaction
(4) (1) and (2) above mentioned

Q.103 What is turn over number of enzyme ?
(1) The number of substrate molecules which is converted to products in one minute by an enzyme molecule
(2) The number of product molecules which is formed by one molecule of enzyme in one minute
(3) The number of molecules of the enzymes which is essential for forming one product molecule
(4) None of the above

Q.104 How the effect of competitive inhibitors can be nullified ?
(1) By increasing concentration of substrate
(2) By decreasing concentration of substrate
(3) By increasing concentration of enzyme
(4) By decreasing concentration of enzyme

Q.105 Which statement is correct about enzyme activity and pH ?
(1) Most enzymes are active at pH of 6-7.5
(2) Some enzymes are active at acidic or alkaline pH
(3) Each enzymes has its own separate optimum pH
(4) All the above

Q.106 Sometimes the product binds the active site of the enzyme to reduce rate of reaction. What is it called?
(1) Inhibition
(2) Competitive inhibition
(3) Feed back inhibition
(4) None of the above

Q.107 The turn over number of enzymes is related with its –
(1) Efficiency (2) Protein nature
(3) Catalytic nature (4) Specificity

Q.108 In cytochrome, Fe^{++} is linked –
(1) Tightly (2) Loosely
(3) All the above (4) None of the above

Q.109 Organic substance loosely linked to the apoenzyme is called –
(1) Coenzyme (2) Cofactor
(3) Holoenzyme (4) Prosthetic group

Q.110 Which part of holoenzyme is proteinaceous ?
(1) Apoenzyme (2) Prosthetic group
(3) Complete (4) None

Q.111 Which of these is not a coenzyme ?
(1) FMN (2) Riboflavin
(3) Thiamine (4) Fe++

Q.112 What is the minimum energy value, besides the average energy of the substrate molecules in the reaction, which is essential to make the product ?
(1) Energy barrier (2) Activation energy
(3) Vibration energy (4) All the above

Q.113 What is true about active sites of enzymes ?
(1) Active site has group of specific amino acids
(2) Active sites are small parts of enzyme and an enzyme has more than one active sites
(3) One substrate combines with active site to form the product
(4) All the above

Q.114 Which are allosteric sites?
(1) Acceptor site besides the active site
(2) That site of holoenzyme where prosthetic group binds
(3) Inhibitor site
(4) All the above

Q.115 According to the induced fit theory which are the two groups at the active site?
(1) Buttressing group/Catalytic group
(2) Buttressing group/Degrading group
(3) Catalytic group/Degrading group
(4) None of the above

Q.116 Which of these are enzymes of the class oxidoreductases ?
(1) Oxidase (2) Reductase
(3) Dehydrogenase (4) All the above

Q.117 Which are the enzymes of group transferase ?
(1) Hexokinase (2) Transaminase
(3) Both of above (4) Isomerase

Q.118 Which of these are enzyme of isomerases ?
(1) Isomerase (2) Epimerase
(3) Mutase (4) All the above

Q.119 Fructose 1-6 $DiPO_4 \xleftrightarrow{\text{Aldolase}}$ PGAL + DiHAP To which group Aldolase enzyme belongs in the above reaction ?
(1) Ligases (2) Lyases
(3) Isomerase (4) Transferases

Q.120 The lower value of Km means –
(1) Lower affinity of enzyme with substrate
(2) Higher substrate affinity of enzyme
(3) Higher enzyme activity
(4) No effect on reaction

Q.121 Which one of the following is not true for iso enzymes ?
(1) isoenzymes are quartenary proteins
(2) all forms synthesized by different genes'
(3) increse activation energy of substrate.
(4) All the above

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	3	4	1	2	2	3	2	2	2	2	4	3	2	4	4	2	2	1	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	2	2	1	3	3	4	1	3	2	3	3	3	2	4	4	3	4	3	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	4	3	2	4	2	3	3	4	1	3	1	4	1	1	2	2	1	4	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	4	3	3	1	3	4	3	4	4	4	2	4	2	2	4	2	2	4	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	3	3	2	4	2	3	4	2	2	2	1	3	1	2	2	2	4	4	4
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	4	1	1	4	3	1	1	1	1	4	2	4	1	1	4	3	4	2	2
Ques.	121																			
Ans.	3																			

Carbohydrates, Fats, Proteins

Q.1 Glycogen is stored in **[MPPMT, AIPMT 79]**
(1) Liver and muscles (2) Liver only
(3) Muscles only (4) Pancreas

Q.2 Cholesterol is synthesized in – **[MPPMT - 94]**
(1) pancreas (2) Burnners gland
(3) Spleen (4) Liver

Q.3 Which is a disaccharide – **[MPPMT - 94]**
(1) Galactose (2) Fructose
(3) Maltose (4) Dextrin

Q.4 Which element is normally absent in proteins **[RPMT - 94]**
(1) C (2) N
(3) S (4) P

Q.5 Which substance is not carbohydrate- **[MPPMT - 94]**
(1) Starch (2) Glycogen
(3) Wax (4) Glucose

Q.6 To get quick energy one should use- **[RPMT - 94]**
(1) Carbohydrate (2) Fats
(3) Vitamins (4) Proteins

Q.7 Protein most abundant in human body is – **[RPMT - 94]**
(1) Collagen (2) Myosin
(3) Actin (4) Albumin

Q.8 Which is not polysaccharide - **[RPMT - 94]**
(1) Sucrose (2) Starch
(3) Glycogen (4) cellulose

Q.9 Decreasing order of amount of organic compound in animal body- **[RPMT - 94]**
(1) Carbohydrate, Protein, fat and nucleic acid
(2) Protein, fats, nucleic acid and carbohydrate
(3) Protein, fats, carbohydrates and nucleic acid
(4) Carbohydrate, fats, Proteins and nucleic acid

Q.10 Characteristic feature of heamoglobin- **[RPMT - 94]**
(1) Reversible union with oxygen
(2) Red Colour
(3) Presence of Cu
(4) Presence of Globulin protein

Q.11 External Coat composed of cellulose like material occurs in - **[RPMT - 94]**
(1) Hemichordata (2) Urochordata
(3) Cephalochordata (4) Cyclostomata

Q.12 Common in feather and Silk is –
(1) Carbohydrate (2) Fats
(3) Protein (4) Nucleic acid

Q.13 Monosaccharide is - **[RPMT 93]**
(1) Pentose Sugar (2) Hexose Sugar
(3) Only Glucose (4) All the above

Q.14 Sugar which found in haemolymph of insects is called- **[RPMT 93]**
(1) Maltose (2) Lactose
(3) Trehalose (4) Galactose

Q.15 Which substance is most abundant in cell – **[RPMT 93]**
(1) Carbohydrates (2) Protein
(3) Water (4) Fats

Q.16 Proteins which present in protoplasm are very important because- - **[RPMT 93]**
(1) They provide definite shape to cell
(2) They function as biocatalyst
(3) They yield energy
(4) They are stored food

Q.17 Dipeptide is - **[RPMT 93]**
(1) Structure of two peptide bonds
(2) Two amino acids linked by one peptide bond
(3) bond between one amino acid and one peptide
(4) None

Q.18 Which amino acids is non essential for human body - **[RPMT 92]**
(1) Glycine (2) Phenyl alanine
(3) Arginine (4) Methionine

Q.19 In which form the extra Sugars stored in the body- **[RPMT - 91]**
(1) Glucose monosaccharide
(2) Sucrose Disaccharide
(3) Glycogen polysaccharide
(4) Fatty acid and glycerol

Q.20 Products of proteins catabolism **[RPMT 89]**
(1) NH_3, CO_2 and Urea
(2) Urea, CO_2 and NH
(3) Urea, NH_3 and uric acid
(4) Urea, NH_3, alanine and creatine

Q.21 Galactosemia disease in children can be prevented if they are provided – **[RPMT - 89]**
(1) milk less food (2) proteinaceous milk
(3) more milk (4) vitamin less milk

Q.22 Glycogen is - **[RPMT - 88]**
(1) Polymer of amino acids
(2) Polymer of fatty acids
(3) Unsaturated fats
(4) Polymer of glucose

Q.23 Carbohydrate is - **[RPMT - 88]**
(1) Polymer of fatty acids
(2) Polymer of amino acids
(3) Poly hydroxy aldehyde or ketone
(4) None

Q.24 In which form, food stored in animal body **[RPMT - 88]**
(1) Glucose (2) Glycogen
(3) Cellulose (4) ATP

Q.25 Which compound produces more than twice the amount of energy as compared to carbohydrates **[AIPMT -75, BHU 78]**
(1) Protein (2) Fats
(3) Vitamins (4) Glucose

Q.26 What is the normal ratio of sugar in human blood - **[BHU – 80,81]**
(1) .01% (2) 0.1%
(3) 1% (4) 0.18%

Q.27 Carbohydrates are stored in mammals as- **[AIPMT - 81]**
(1) Glucose in liver
(2) Glycogen in muscles and spleen
(3) Lactic acid in muscles
(4) Glycogen in liver and muscles

Q.28 Carbohydrate metabolism is controlled by- **[AIPMT -78]**
(1) Parathormone (2) Insulin
(3) Glucose (4) Vitamin B_{12}

Q.29 Fattyness is due to the excess of - **[AIPMT - 86]**
(1) Connective tissue (2) Blood
(3) Muscular tissue (4) Adipose tissue

Q.30 Which one of the following is polysaccharide **[AIPMT - 86]**
(1) Sucrose (2) Lactose
(3) Glycogen (4) Glucose

Q.31 Starving person will first use- **[AIPMT 88]**
(1) Fats (2) Glycogen
(3) Blood (4) Muscle protein

Q.32 Units of proteins which unite in long chains to form proteins, are called- **[BHU 77, 78]**
(1) Sugar (2) Purines
(3) Pyrimidines (4) Amino acids

Q.33 Milk protein is - **[BHU - 63]**
(1) Lactogen (2) Myosin
(3) Casein (4) Pepsin

Q.34 Chemically enymes are - **[AIPMT-78]**
(1) Fats (2) Carbohydrates
(3) Hydrocarbons (4) Proteins

Q.35 Long chain molecules of fatty acids are formed by - **[NCERT - 76]**
(1) Polymerisation of 2 carbon compounds
(2) Decomposition of fats
(3) Polymerisation of glycogen
(4) Conversion of glycogen

Q.36 Most simple amino acid is - **[BHU - 86]**
(1) Tyrosine (2) Lysine
(3) Glycine (4) Aspartic acids

Q.37 Fats in the body are formed when – **[NCERT -76]**
(1) Glycogen is formed from glucose
(2) Sugar level becomes stable in blood
(3) Extra glycogen storage in liver and muscles is stopped
(4) All of them

Q.38 For body growth and repair one needs- **[AIPMT - 88]**
(1) Carbohydrates (2) Fats
(3) Protein (4) Vitamins

Q.39 In India the best source for proteins in herbivorous persons is - **[NCERT - 76]**
(1) Pulses (2) Potato
(3) Egg (4) Meat

Q.40 Proteins are conducted in the body in the form of - **[NCERT - 76]**
(1) Amino acids (2) Natural protein
(3) Enzymes (4) nucleic acids

Q.41 Which is sweet in taste, but is not sugar- **[AIPMT – 83]**
(1) Starch (2) Saccharine
(3) Lactose (4) Protein

Q.42 The formation of protein can be considered as - **[AIPMT - 86]**

(1) Dehydration synthesis
(2) Dehydration analysis
(3) Hydration synthesis
(4) Hydration analysis

Q.43 Translocation of sugars in flowering plants occurs in the form of – **[RPMT - 1998]**

(1) Glucose (2) Sucrose
(3) Fructose (4) Maltose

Q.44 Sucrose is composed of – **[RPMT - 1989]**

(1) Glucose & Fructose
(2) Glucose & Glycogen
(3) Two molecules of Glucose
(4) Glycogen & Fructose

Q.45 Which of the following amino acid is essential- **[RPMT - 1997]**

(1) Alanine (2) Glycine
(3) Tryptophan (4) Tyrosine

Q.46 Which of the following disaccharides will give two molecules of glucose on hydrolysis **[RPMT - 1997]**

(1) Maltose (2) Sucrose
(3) Lactose (4) None

Q.47 Which is very most structural part of the body– **[RPMT - 1997]**

(1) Protein (2) Carbohydrates
(3) Lipid (4) Nucleic acid

Q.48 Which of the following sugar is found in ATP– **[RPMT - 1997]**

(1) Deoxyribose (2) Ribose
(3) Trehalose (4) Glucose

Q.49 Deficiency of protein leads to –**[AIPMT 1998]**

(1) Rickets (2) Scurvy
(3) Kwashiorkor (4) Carotenemia

Q.50 Lactose is composed of - **[RPMT – 1998, AIPMT 1998]**

(1) Glucose + galactose (2) Glucose + fructose
(3) Glucose + glucose
(4) Glucose + mannose

Q.51 True statement for cellulose molecule – **[AIPMT - 1998]**

(1) β-1' - 4" linkage. unbranched
(2) β-1' - 4" linkage. branched
(3) α-1' - 4" linkage. branched
(4) β-1' - 6" linkage. unbramched

Q.52 Contractile protein is - **[AIPMT - 1998]**

(1) Actin (2) Myosin
(3) Troponin (4) Tropomyosin

Q.53 Variations in proteins are due to – **[AIPMT - 1998]**

(1) Sequence of amino acids
(2) Number of amino acids
(3) R-group (4) None

Q.54 The antibodies are - **[MPPMT - 1998]**

(1) γ (Gamma)-globulins
(2) Albumins
(3) Vitamins (4) Sugar

Q.55 Which of the following does not contains metal - **[AIPMT - 99]**

(1) Glycoproteins (2) Ferritin
(3) Cytochromes (4) Chromoproteins

Q.56 Which protein found in maximum amount – **[AIPMT - 99]**

(1) Catalase
(2) Zinc carbonic anhydrase
(3) Transferase (4) RUBISCO

Q.57 Proteoglycan in cartilages which is part of polysaccharide – **[AIPMT - 2000]**

(1) Condriotin (2) Ossein
(3) Casein (4) Cartilegen

Q.58 In the genetic code dictionary, how many codons are used to code for all the 20 essential amino acids – **[AIPMT - 2003]**

(1) 20 (2) 64
(3) 61 (4) 60

Q.59 Enzyme concerned with transfer of electrons are - **[MP PMT 2002]**

(1) Hydrolasase (2) Dehydrogenase
(3) Transaminase (4) Protease

Q.60 At which pH enzymes of lysosomes are usually active ? **[MP PMT 2002]**

(1) pH 5 (2) pH 7
(3) pH 8 (4) In any pH

Q.61 Enzymes are made up of - **[CPMT 2002]**

(1) Edible proteins (2) Proteins
(3) Nitrogen containing carbohydrates
(4) Carbohydrates

Q.62 Hydrolytic enzymes, which act on low pH are called as ? **[CPMT 2002]**

(1) Protease (2) α-Amylase
(3) Hydrolases (4) Peroxidase

Q.63 Enzymes, vitamins and hormones can be classified into a single caregory of biological chemicals, becouse all of these - **[AIPMT 2005]**

(1) enhence oxidative metabolism

(2) are conjugated proteins

(3) are exclusively synthesized in the body of a living organism

(4) help in regulating metabolism

Q.64 Which of the following statements regarding enzyme inhibition is correct ? **[AIPMT 2005]**

(1) Non-competitive inhibition of an enzyme can be overcome by adding large amount of substrate

(2) Competitive inhibition is seen, when a substrate competes with an enzyme for binding to an inhibitor protein

(3) Competitive inhibition is seen, when the substrate and the inhibitor compete for the active site on the enzyme

(4) Non-Competitive inhibitors often bind to the enzyme irreversibly.

Q.65 The catalytic efficiency of two different enzyme can be compared by the - **[AIPMT 2005]**

(1) The Km value

(2) The pH optimum value

(3) Formation of the product

(4) Molecular size of the enzyme

Q.66 The graph below shows the effect of substrate concentration on the rate of reaction of the enzyme green-gram-phosphatase. What does the graph indicates ? **[AIIMS 2005]**

(1) The rate of enzyme reaction is directly proportional to the substrate concentration.

(2) Presence of an enzyme inhibitor in the reaction mixture

(3) Formation of an enzyme substrate complex

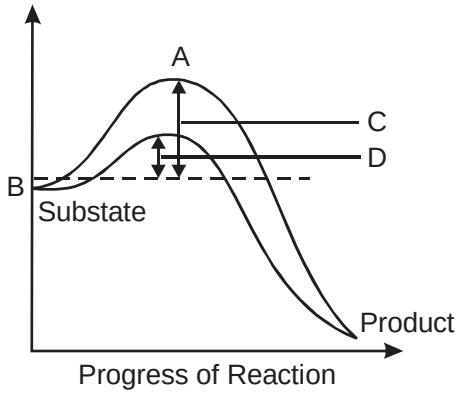
(4) At higher substrate concentration the pH increases

Q.67 An organic substance bound to an enzyme and essential for its activity is called - **[AIPMT 2006]**

(1) Apoenzyme (2) Isoenzyme

(3) Coenzyme (4) Holoenzyme

Q.68 The figure given below shows the conversion of a substrate into product by an enzyme. In which one of the four otpion (1-4) the components of reaction labelled as A, B, C and D are identified correctly? **[AIPMT-2010 (Mains)]**



Option :

	A	B	C	D
(1)	Transition state	Potential energy	Activation energy without enzyme	Activation energy with enzyme
(2)	Potential energy	Transition state	Activation energy with enzyme	Activation energy without enzyme
(3)	Activation energy with enzyme	Transition state	Activation energy without enzyme	Potential energy
(4)	Potential energy	Transition state	Activation energy with enzyme	Activation energy without enzyme

Q.69 Three of the following statements about enzymes are correct and ione is wrong. Which one is wrong? **[AIPMT-2010 (Mains)]**

(1) Enzymes are denatured at high temperatures but in certain exceptional organisms they are effective even at temperatures 80º-90ºC

(2) Enzymes are highly specific

(3) Most enzymes are proteins but some are lipids

(4) Enzymes required optimum pH for maximal activity

Q.70 The fastest acting enzyme, in the biological kingdom, is - **[Uttaranchal 2004]**
(1) Lipase (2) Amylase
(3) Peptidase (4)Carbonic anhydrase

Q.71 Urease enzyme was obtained from - **[Uttaranchal 2005]**
(1) Urine (2) Canavalia
(3) Ficus fruit (4) Pancreas

Q.72 Apoenzyme is - **[Uttaranchal 2005]**
(1) Protein (2) Vitamin
(3) cabohydrate (4) Amino acid

Q.73 The non-protein part of an enzyme is - **[West Bengal 2007]**
(1) Prosthetic group (2) Coenzyme
(3) Cofactor (4) All the above

Q.74 Ribozymes are : **[West Bengal 2007]**
(1) RNA acting as enzymes
(2) antibody acting as enzymes
(3) ribosomes acting as enzymes
(4) None of the above

Q.75 Many of the hydrolytic reactions are : **[MP PMT 2001]**
(1) Reversible (2) Irreversible
(3) Endothermic (4) Exothermic

Q.76 Enzymes concenred with transfer of electrons are : **[C.G. PMT 2005]**
(1) Hydrolysases (2) Dehydrogenases
(3) Transaminases (4) Proteases

Q.77 Enzymes are basically : **[C.G. PMT 2006]**
(1) Fat (2) Protein
(3) Nuclic acid (4) All the above

Q.78 Enzymes are sensitive to : **[C.G. PMT 2006]**
(1) Cold (2) Cell wall
(3) Heat (4) Pressure

Q.79 Enzymes are functional at :**[Jharkhand- 2005]**
(1) 10-15°C (2) 15-25°C
(3) 25-40°C (4) 30-60°C

Q.80 Which of the following inactivates the enzyme by changing its shape ? **[Jharkhand- 2002]**
(1) Competitive inhibitor
(2) Allosteric inhibitor
(3) Coenzyme (4) All of the above

Q.81 Enzymes that catalyse endergonic synthesis, coupled with exergonic hydrolysis of ATP are: **[Jharkhand- 2004]**
(1) ligases (2) isomerases
(3) lyases (4) transferases

Q.82 Proteinaceous nature of enzyme was suggested by : **[Bihar- 2003]**
(1) Summer (2) Kuhne
(3) E.Buchner (4) Northrop

Q.83 Most of the hydrolytic enzymes of lysosomes function at : **[UP CPMT- 2001]**
(1) Acidic pH (2) Basic pH
(3) Neutral pH (4) None of the above

Q.84 Kuhne : **[UP CPMT- 2004]**
(1) Discovered parathyroid
(2) Coined the term enzyme
(3) Coined the term gene
(4) Discovered enzyme

Q.85 Which of the following is not a co-enzyme - **[UP CPMT- 2004]**
(1) NAD (2) NADP
(3) FAD (4) ATP

Q.86 Cytochrome oxidase is a/an -**[MP PMT- 2007]**
(1) Exoenzyme (2) Endoenzyme
(3) Proenzyme (4) Coenzyme

Q.87 Enzymes concerned with transfer of electrons are : **[MP PMT- 2002]**
(1) Hydrolysase (2) Dehydrogenase
(3) Transaminase (4) Protease

Q.88 Yeast enzyme which converts glucose into ethyl alcohol is called : **[MP PMT- 2003]**
(1) Diastase (2) Invertase
(3) Zymase (4) Maltase

Q.89 Basically the Enzymes are : **[MP PMT- 2004]**
(1) Vitamins (2) Fats
(3) Proteins (4) Carbon

Q.90 The globular proteins undergo structural changes, in response of pH or temperature, are called - **[Uttaranchal PMT 2004]**
(1) Renaturation (2) Denaturation
(3) Combination (4) Both 'a' and 'b'

Q.91 Which of the following fatty acid is not synthesized in the human body - **[Uttaranchal PMT 2004]**
(1) Glycerol (2) Cholesterol
(3) Linoleic acid (4) Both 'a' and 'b'

Q.92 Cellulose is a - **[Uttaranchal PMT 2005]**
(1) Monosaccharide (2) Disaccharide
(3) Polysaccharide (4) Lipid

Q.93 The stored food material of muscles is - **[Uttaranchal PMT 2005]**
(1) Starch (2) Glycogen
(3) Lipid (4) Protein

Q.94 Two free ribonucleotide units are interlinked with – **[Uttaranchal PMT 2005]**
(1) Peptide bond (2) covalent bond
(3) Hydrogen bond
(4) Phosphodiester bond

Q.95 Which one of the following enzyme is responsible for the synthesis of DNA from RNA - **[Uttaranchal PMT 2006]**
(1) DNA polymerase (2) RNA polymerase
(3) Reverse transcriptase
(4) DNA ligase

Q.96 Which of the following carbohydrate is absentin honey – **[West Bengal JEE 2007]**
(1) Glucose (2) Levulose
(3) Lactose (4) Maltose

Q.97 Which of the following is not an essential amino acid - **[West Bengal JEE 2007]**
(1) Alanine (2) Valine
(3) Histidine (4) Methionine

Q.98 Which is non reducing sugar - **[West Bengal JEE 2007]**
(1) Sucrose (2) Fructose
(3) Galactose (4) Glucose

Q.99 Which of the following is a polysaccharide **[West Bengal JEE 2007]**
(1) Glucose (2) Fructose
(3) Sucrose (4) Cellulose

Q.100 Which enzyme is used in transcription - **[West Bengal JEE 2007]**
(1) Amino acyl synthetase
(2) DNA polymerase III
(3) RNA polymerase (4) DNA ligase

Q.101 The name 'protoplasm' was given by **[C.G. PMT 2004]**
(1) Hooke (2) A.K. Sharma
(3) Schwann (4) Purkinje

Q.102 The physical basis of life is - **[CG PMT 2004]**
(1) Nucleus (2) sex chromosome
(3) Protoplasm (4) DNA

Q.103 Who called the living matter of the cell as protoplasm - **[C.G. PMT 2005]**
(1) Purkinje (2) Virchow
(3) Hooke (4) Khorana

Q.104 Only R.NA. contains which of the following base - **[C.G. PMT 2005]**
(1) Thymine (2) Uracil
(3) Adenine (4) None of these

Q.105 Among the following examples which is a monosaccharide - **C.G. PMT 2005]**
(1) Glucose (2) Maltose
(3) Sucrose (4) Raffinose

Q.106 Cellulose is - **[C.G. PMT 2006]**
(1) Mono saccharide (2) Disacchride
(3) Polysacchride (4) None

Q.107 The site for protein synthesis in plants is the **[C.G. PMT 2006]**
(1) Chloroplast (2) Ribsosomes
(3) Pyrenoids (4) Mitochondria

Q.108 DNA is present in - **[C.G. PMT 2006]**
(1) Nucleus only (2)Mitochondrion only
(3) Chloroplast only (4) All the above

Q.109 Which one is polymer - **[Jharkhand 2006]**
(1) sucrose (2) Glycogen
(3) Fructose (4) Lactose

Q.110 The term protoplasm was coined by - **[Jharkhand 2005]**
(1) Virchov (2) Purkinje
(3) Dujardin (4) Kollinker

Q.111 Which of the following is a disaccharide **[Jharkhand 2003]**
(1) Glucose (2) Fructose
(3) Sucrose (4) Galactose

Q.112 The scientist who was awarded Nobel prize in 1959 for in vitro synthesis of polyribonucleotide - **[Jharkhand 2003]**
(1) Mendel (2) Calvin
(3) Khorana (4) Ochoa

Q.113 The chemical formula of starch is - **[Jharkhand 2003]**
(1) $(C_6H_{10}O_5)_n$ (2) $(C_6H_{12}O_6)_n$
(3) $C_{12}H_{22}O_{11}$ (4) CH_3COOH

Q.114 Non-essential amino acids are synthesized in the human body during - **[Jharkhand 2002]**
(1) Protein catabolism (2) Protein anabolism
(3) Both 'a' and 'b' (4) None of these

Q.115 According to modern colloidal theory the protoplasm is a polyphasic colloidal system. This was first suggested by - **[Jharkhand 2002]**
(1) Purkinge (2) Max Schultze
(3) R.A. Fisher (4) E. Strasburger

Q.116 The function of chromosome of carrying the genetic information from one cell generation to another is performed by - **[Bihar-2005]**
(1) RNA (2) DNA
(3) Histones (4) Calcium

Q.117 Richest energy compound is - **[Bihar-2005]**
(1) Creatinine phosphate
(2) ATP
(3) Carbohydrate (4) Fat

Q.118 Unit of nucleic acid is - **[Bihar-2005]**
(1) Nucleotide (2) Nucleoside
(3) Nucleic acid (4) All of these

Q.119 Number of carbons in deoxy ribose sugar is **[Bihar-2004]**
(1) Four (2) Five
(3) Six (4) Three

Q.120 Bond present between two carbohydrate molecules is - **[Bihar-2004]**
(1) Glycosidic (2) Hydrogen bond
(3) Phosphodiester (4) Amide

Q.121 In mammals, carbohydrates are stored as- **[Bihar-2003]**
(1) Glycogen in liver
(2) Lactic acid in muscles
(3) Glucose in liver
(4) Glycogen in liver and muscles

Q.122 Raffinose is - **[Bihar-2003]**
(1) Monosaccharides (2) Disaccharides
(3) Trisaccharides (4) Polysaccharides

Q.123 Prokaryotic DNA is - **[Bihar-2002]**
(1) double stranded round
(2) single stranded round
(3) double stranded straight
(4) double stranded RNA as nucleic acid

Q.124 Which one is hexose sugar - **[Bihar-2001]**
(1) Mannose (2) Galactose
(3) Both 'a' and 'b' (4) Cellulose

Q.125 Nucleoside is - **[Bihar-2001]**
(1) Polymer of nucleic acid
(2) Phosphoric acid + base
(3) Phosphoric acid + sugar + base
(4) Sugar + base

Q.126 DNA is a genetic material was proved - **[Bihar-2001]**
(1) Griffith
(2) Linus Pauling
(3) Messelson and stahl
(4) Watson

Q.127 Protein in silk thread is – **[UP CPMT- 2003]**
(1) Fibroin (2) Keratin
(3) Albumin (4) Globulin

Q.128 Amino acid derivative hormone is - **[UP CPMT- 2004]**
(1) Insulin (2) Oxytocin
(3) Erythropoietin (4) thyroxine

Q.129 Which is soluble RNA – **[UP CPMT- 2005]**
(1) hnRNA (2) rRNA
(3) mRNA (4) tRNA

Q.130 Which of the following is not found in DNA : **[UP CPMT- 2005]**
(1) adenine (2) Cytosine
(3) Uracil (4) Thymine

Q.131 The type of linkage present in carbohydrates is - **[UP CPMT- 2005]**
(1) Peptide (2) glycosidic
(3) Amide (4) Phosphate bonds

Q.132 Retrovirus have genetic material - **[MP PMT- 2007]**
(1) DNA only (2) RNA only
(3) DNA or RNA only (4) None

Q.133 Prions consists mainly of - **[MP PMT- 2007]**
(1) Protein (2) DNA
(3) RNA (4) Both 2 and 3

Q.134 RNA is not found in - **[MP PMT- 2007]**
(1) Chromosome (2) Plasmalemma
(3) Nucleus (4) Ribosome

Q.135 Which one is a laevo-rotatory sugar- **[MP PMT- 2007]**
(1) Sucrose (2) Glucose
(3) Fructose (4) None of these

Q.136 Which one is the sweetest sugar - **[MP PMT- 2007]**
(1) Glucose (2) Fructose
(3) Sucrose (4) Maltose

Q.137 Functional unit of gene is - **[MP PMT- 2001]**
(1) Muton (2) Recon
(3) Cistron (4) Codon

Q.138 T.M.V. contains - **[MP PMT- 2001]**
(1) D.N.A. (2) R.N.A. + Protein
(3) D.N.A. + R.N.A. (4) D.N.A. + Protein

Q.139 The cell wall of plants is made up to cellulose which is - **[MP PMT- 2002]**
(1) A lipid (2) A Protein
(3) A Polysaccharide (4) An Aminoacid

Q.140 The smallest RNA is - **[MP PMT- 2003]**
(1) r-RNA (2) m-RNA
(3) t-RNA (4) nuclear RNA

Q.141 The most abundant RNA of cell is - **[MP PMT- 2003]**
(1) r-RNA (2) t-RNA
(3) m-RNA (4) None of these

Q.142 Main components of ribosome are - **[MP PMT- 2006]**
(1) Protein and RNA (2) sucrose
(3) starch (4) glycogen

Q.143 Most abundant RNA of cell is – **[MP PMT- 2006]**
(1) m-RNA (2) t-RNA
(3) r-RNA (4) None of these

Q.144 Carriers of genetic information are - **[MP PMT- 2005]**
(1) t-RNA (2) DNA
(3) m-RNA (4) Nucleoproteins

Q.145 The chemical name of vitamin D is - **[MP PMT- 2005]**
(1) Riboflavin (2) Ascorbic acid
(3) Niacin (4) Calciferol

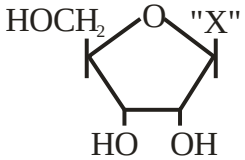
Q.146 Growth hormone affects growth by controlling the production of …at cellular level – **[MP PMT- 2006]**
(1) r-RNA (2) m-RNA
(3) t-RNA (4) None of these

Q.147 Model of DNA molecule was first proposed by- **[MP PMT- 2002]**
(1) Tatum and Beadle (2) Mc Clung
(3) Purkinje (4) Watson and Crick

Q.148 DNA or RNA segment tagged with a radioactive molecular is called :**[CPMT- 2010]**
(1) Vector (2) Probe
(3) Clone (4) Plasmid

Q.149 The main areana of various types of activites : **[CPMT- 2010]**
(1) Plasma membrane (2) Mitochondrian
(3) Cytoplasm (4) Nucleus

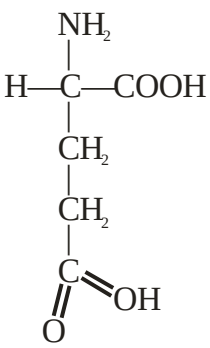
Q.150 Given below is the diagrammatic representation of one of the categories of small molecular weight organic compounds in the living tissues. Identify the category shown and the one blank component "X" in it. **[AIPMT PRE 2012]**



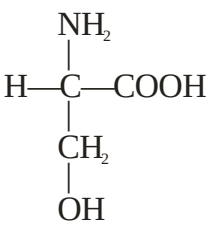
Category	**Component**
(1) Amino acid	NH_2
(2) Nucleotide	Adenine
(3) Nucleoside	Uracil
(4) Chojesterol	Guanin

Q.151 Which one out of A - D given below correctly represents the structural formula of the basic amino acid ? **[AIPMT PRE 2012]**

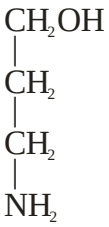
A



B



C



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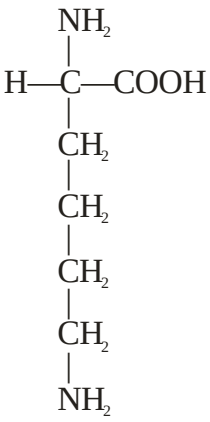


(1) D (2) A
(3) B (4) C

ANSWER KEY

EXERCISE - 3

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	1	4	3	4	3	1	1	1	3	1	2	3	4	3	3	2	2	1	3	1
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	1	4	3	2	2	2	4	2	4	3	2	4	3	4	1	3	3	3	1	1
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	2	1	2	1	3	1	1	2	3	1	1	1	1	1	1	4	1	3	2	3
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	4	2	1	2	3	4	3	1	3	4	2	1	4	1	4	2	2	3	3	2
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	1	4	1	2	4	2	2	3	3	2	3	3	2	4	3	3	1	1	4	3
Ques.	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
Ans.	4	3	1	2	1	3	2	4	2	2	3	4	1	3	3	2	4	1	2	1
Ques.	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
Ans.	4	3	1	3	4	1	1	4	4	3	2	2	1	2	3	2	3	2	3	3
Ques.	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**	**151**									
Ans.	1	1	3	2	4	2	4	2	3	3	1									

These questions consist of two statements each, printed as Assertion and Reason. While answering these Questions are required to choose any one of the following four responses.

(1) **If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.**

(2) **If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.**

(3) **If Assertion is True but the Reason is False.**

(4) **If both Assertion & Reason are false.**

Q.1 **A :** Protoplasm show conductivity.
R : Ions are responsible for transmission of stimulus.

Q.2 **A :** Valine is a protein amino acid.
R : It participates in protein synthesis.

Q.3 **A :** Nerve cells are more active as compared to bone cells.
R : In nerve cells protoplasm occurs in gel stage.

Q.4 **A :** Heparin is a natural anticoagulant inside the blood vessels.
R : It is an example of homopolysaccharide.

Q.5 **A :** Cellulose is a macromolecule.
R : It is formed by union of repeated units of fructose.

Q.6 **A :** Haemoglobin is a monomeric protein
R : It is madeup of by two polypeptide chains.

Q.7 **A :** Saturated fatty acids are non essential fatty acids.
R : They can be synthesized in animal body.

Q.8 **A :** Lipids provides more energy as compared to carbohydrates on oxidation.
R : Lipid is first respiratory substance.

Q.9 **A :** Serine amino acid is an alkaline amino acid.
R : It contain one -COOH group and two $-NH_2$ groups.

Q.10 **A :** In protoplasm protein functions as a buffer.
R : Protein molecule is amphoteric.

Q.11 **A :** Lipid require less space for storage as compared to carbohydrate.
R : Lipid is polymer of amino acid.

Q.12 **A :** Phospholipid form bimolecular layer in aqueous medium.
R : Phospholipid molecules are amphipothic.

Q.13 **A :** In unit area glycogen stores more energy as compared to starch.
R : Molecule of glycogen is more branched as compared to starch.

Q.14 **A :** Linolenic acid is essential Fatty acid for human being.
R : Human being lack the mechanism to synthesize linolenic acid.

Q.15 **A :** Alanine-glycine- tryptophan and tryptophan - glycine-alanin are two different tripeptide.
R : A polypeptide chain has direction.

Q.16 **A :** Silk fibre protein are made up of glycine, alanine and serine amino acids.
R : This fibrous protein consists of parallel β pleated sheet.

Q.17 **A :** Starch is the storage polysaccharide in plants.
R : Starch is a polymer of β-glucose.

Q.18 **A :** Glucose 6- phosphate dehydrogenase deficiency in red cells seems to protect a person from falciparum malaria.
R : The parasites that causes this disease require the pentose phosphate pathway and reduced glutathione for optimal growth.

Q.19 **A :** Milk forms interfacial boundry.
R : Milk is a coloidal solution.

Q.20 **A :** Lecithin is important in membranes.
R : Amphiatic nature.

Q.21 **A :** Glucose is dextrose.
R : Glucose open chain have 4 assymmetrical carbon.

Q.22 **A :** Histones are acidic proteins.
R : These joins to all nucleic acids.

Q.23 **A :** Water do not radially forms $-OH^-$ & $-H^+$.
R : Dissociation constant of water is very high.

Q.24 **A :** Disaccharides show optical activity.
R : Cellobiose is an example of disaccharide.

Q.25 **A :** Sucrose is a reducing sugar.
R : All disaccharides are reducing sugar.

Q.26 **A :** Whales can live in extremely cold regions.
R : They contain blubber.

Q.27 **A :** Hibernating animals store fat prior to onset of winter.
R : Migratory birds also store fat before migration.

Q.28 **A :** Souring of milk occurs due to condensation of glucose and galactose.
R : Condensation of glucose and galactose form lactic acid.

Q.29 **A :** Bacterial cell wall are not like the plant cell.
R : Bacterial cell wall is not made up of cellulose.

Q.30 **A :** Lipoproteins are conjugated proteins.
R : Lipoproteins are conjugated lipids.

Q.31 **A :** α-helix is the secondary structure of protein.
R : The haemoglobin molecule is composed of four polypeptide chains.

Q.32 **A :** Magnesium is involved in chlorophyll formation.
R : Magnesium takes part in protein synthesis.

Q.33 **A :** Iron is a minor mineral.
R : Iron is a constituent of haemoglobin, myoglobin and cytochromes.

Q.34 **A :** Frozen water requires more space and is lighter than water.
R : Ice is solid.

Q.35 **A :** Hydrogen bonding between water molecules occurs not only in liquid water but also in ice and in water vapour.
R : Hydrogen bonding exist even at 100 ^oC.

Q.36 **A :** Inulin is a storage polysaccharide.
R : Inulin is not metabolised in human body and is readily filtered through the kidney.

Q.37 **A :** Isabgol is used as medicine.
R : Husk of isabgol contains mucilage.

Q.38 **A :** Monellin is the sweetest chemical.
R : Monellin is a protein.

Q.39 **A :** Pectin produces cementing layer between adjacent plant cells.
R : Pectin is able to undergo sol = gel interchange.

Q.40 **A :** At high temperature, proteins are liable to denaturation.
R : Globular proteins are not coagulated by heat.

Q.41 **A :** Cocoon of silk fibres and spider webs are madeup of cellulose.
R : These are structures for their beautification.

Q.42 **A :** Natural silk is made up protein.
R : Artificial silk is a polysaccharide.

Q.43 **A :** Co-enzymes are usually proteins
R : Co-enzymes are synthesized in mitochondria.

Q.44 **A :** Malonic-Acid is competitive and reversible inhibitor of enzyme Succinic dehydrogenase
R : Malonic acid binds to allosteric site of this enzyme.

Q.45 **A :** Enzymes increase the rate of biochemical reactions
R : Enzymes function at near neutral pH

Q.46 **A :** Specific substrate binds at active site of thier enzyme.
R : Enzymes increase the activation energy of substrate.

Q.47 **A :** Enzymes only increases the rate of biochemical reactions
R : Enzymes are proteinaceous biocatalysts

Q.48 **A :** Enzymes are synthesized on ribosomes under the control of genes.
R : Enzymes only function inside the ribosome

Q.49 **A :** Enzymes become denatured at high temperature
R : Tertiary structure of proteins damaged at high temperature

Q.50 **A :** All enzymes are proteins.

R : Ribozymes are enzymes without proteins.

Q.51 **A :** Allosteric modulators accelerate or retard the rate of catalysis of an allosteric enzyme.

R : Allosteric modulators modulates the configuration of active site of enzyme.

Q.52 **A :** Taq polymerase is an example of extremozyme.

R : The enzyme is made up of polypeptide chain.

ANSWER KEY

EXERCISE - 4

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	1	1	2	3	3	4	1	3	4	1	3	1	1	1	1	2	3	1	1	1
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	1	4	1	4	4	1	2	1	1	2	2	2	2	1	4	2	1	2	2	3
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**								
Ans.	4	2	4	3	2	3	2	3	1	2	1	2								

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

CELL BIOLOGY

Cytology : Structural study of cell

Cell Biology : Structural & Functional study of cell.

HISTORY :

(A) Robert Hooke – He discoved the cell in 1665 examined in the thin slices of cork under his self made microscope (Magnification = 42 times). The cork seen was dead bark of spanish oak **(***Quercus suber***)**. Robert Hook coined the term "Cellula" for Honey comb like structure which later modified to cell. Actually he saw only the dead cell walls of plant cells. He published his findings in his book '**Micrographia**'.

(B) R.Virchow stated "Omnis cellula e cellula" which means all cells arises from pre existing cell. This is known as "Law of Lineage".

(C) Karl Nageli showed that cells in plants arises by the division of pre existing cell.

(D) Leeuwenhoek – Discovered living cell and Leeuwenhoek examined mud, semen, saliva, blood, Insects etc. Under his self made microscope and observe protozoans, sperm, bacteria, RBC, muscle cells etc. He called these tiny creatures as "Animalcules" and published his finding in "Secrets of nature". He is known as father of microbiology, father of bacteriology, father of protozoology.

(D) Hertwig & **R. Hooke –** Father of cytology.

(E) C.P. Swannson – Father of modern cytology.

(F) Dr. A.K. Sharma – Father of Indian cytology.

GENERAL FACTS RELATED WITH CELLS :

(A) Longest cell is nerve cell of Giraffe. (more than 1m) (90 cm in man).

(B) Largest cell is egg of ostrich (17cm x 13.5 cm dimension).

(C) Smallest cell is PPLO (Pleuro Pneumonia Like Organism).

(D) Smallest plant cell *Mycoplasma laidlawii* 0.1 μ.

(E) Centre for cellular and molecular biology is at Hyderabad.

(F) Largest plant cell – *Acetabularia* (10cm)

(G) Longest plant cell – Remie fibre (*Boehmeria nevia*)

CELL THEORY :

(A) Cell theory was proposed by **Schleiden** (Botanist, 1838) and **Schwann**. (Zoologist, 1839)

(B) According to cell theory, all livings things are made up of cells.

(C) Cell is structural and Functional unit of living being.

(D) They has power of Reproduction.

(E) All cells arise from preexisting cells.

(F) All cells are basically similar in structure and metabolic function

(G) Each cell has a unit of heredity

Exceptions to Cell Theory :

According to this theory all the living organism are made up of cells. Viruses are exception of this theory because virus lacks cell organization.

According to moderm scientists all the acellular organism - monera and protista, Xanthophytes, (Vaucharia) Phycomycetes (Rhizopus) are exception of cell theory.

TYPE OF CELLS :

On the basis of nuclear organization, cells are classified into three types [mainly two types] -

(A) Prokaryotic cell (B) Eukaryotic cell

An intermediate nuclear organization of prokaryotic and eukaryotic cell was given by **Dodge**. He told that **mesokaryotic cells** have well organized nuclear membrane, but their DNA is without histone proteins. e.g. Dinoflagellates

Multicellular organism have three types of cells regarding their capacity to divide and differentiate.

(a) Undifferentiated cells - These are the meristematic cells which possess the power of division, e.g. apical meristem

(b) Differentiated cells - These are post-mitotic specialized cells with a distinct structure and function, e.g., RBC.

(c) Dedifferentiated cells - These are specialized cells that revert to function of division for wound healing, regeneration, secondary growth etc.

DIFFERENCE BETWEEN PROKARYOTIC AND EUKARYOTIC CELL :

(A) Basis of difference is nucleus.

(B) Term prokaryote and eukaryote was given by Von Neil.

S.No.	Feature	Prokaryotes	Eukaryotes
1.	Nucleus	(a) Nuclear envelope, nucleolus are absent	(a) Nuclear envelope, nucleolus as nucleoli are present
		(b) Nuclear material consists of folded nucleoid, circular, ds DNA (G-C rich) which is not associated with proteins. (Histones are absent polyamines are present) & is called as Nucleoid, genophore or fibrillar nucleus or Incipient nucleus.	(b) Nuclear DNA is linear and is associated with proteins (Histones are present).
		(c) The nucleoid contains a single prochromosome (Haploid).	(c) The nucleus contains two to many chromosomes (Haploid and Diploid both).
2.	Size	Prokaryotic cells are smaller (0.5 – 10μm)	Eukaryotic cells are relatively large (10 – 15 μm)
3.	Cell wall	Cell wall is present surrounding plasmamembrane and is made of peptidoglycan, polysaccharides & amino acids strengthening material is murein.	Cell wall is present in some protists, most fungi & all plants but absent in animals, it is composed of polysaccharides. Strengthening material is cellulose in plants, while in fungi it is chitin.
4.	Plasma membrane	Present & bears respiratory enzymes (mesosome).	Present but lacks respiratory enzymes

5.	Photosynthetic apparatus	Takes place in Carboxysomes or lamelles or Chlorosomes in BGA (in Bacteria chromatophores membrane infoldings).	Thylakoids are present but within the membrane enclosed organelle called as chloroplast.
6.	Cell organelles	Cytoplasm lacks membrane bound cell organelles like E.R., Mitochondria, Golgibody, lysosomes etc.	Cytoplasm contains organelles.
7.	Vacuoles	Sap vacuoles are absent but gas vacuoles may occur.	Sap vacuoles in plants.
8.	Ribosomes	Ribosomes are 70s lie free in cytoplasm or joined to cell membrane. Ribosome occurs as polysomes i.e. remain united by m-RNA.	Ribosomes are 80S may lie free or bound to E.R. and nuclear envelope (70S in organelles). Polysomes are seen only during translation.
9.	Cyclosis	There are no streaming movements of cytoplasm.	Cytoplasm shows streaming movements.
10.	Cytoskeletal structures	Microtubules, micro filaments are absent	They are present
11.	Sexuality	Sexuality or true sexual reproduction absent in prokaryotic cell (In Bacteria genetic - recombination or parasexual reproduction by conjugation, transduction & transformation)	Sexuality or sexual reproduction present (Meiosis, gamete formation & true fertilization occurs)
12.	Flagella	Flagella if present is simple (without 9 + 2 arrangement) and is formed of a protein Flagellin Flagella is 20 mm in dia. It is not enclosed in cell membrane.	Flagella if present are complex, have 9 + 2 pattern & is formed of protein tubulin. It is 200 nm is dia. It is enclosed in cell membrane.
13.	Plasmids and pilli	Present	Absent
14.	Cell cycle	It is short & takes about 20–60 minutes to complete. Cell divide by Amitosis.	It is long & takes about 12–24 hours or even days to complete. Mitosis, Meiosis both occurs.
15.	Mitotic spindle	It is not formed in cell division	It is formed during cell division.
16.	Centrioles	Absent	Present (Plants - absent)
17.	Protein synthesis	Takes places in cytoplasm	Transcription in nucleus & Translation in cytoplasm on ribosomes.

18.	Example	Bacteria, Cyanobacteria (BGA) Mycoplasma (PPLO), Ricketsias, Actinomycetes. [Monera]	All plant & Animal cells including Human cells. Protista, Algae, Fungi, Protozoa.

S.No.	Feature	Animal Cell	Plant Cell
(i)	Cell wall	Cell wall is absent	It is present & is made up of cellulose.
(ii)	Vacuole	Vacuoles are absent if present are	Vacuoles are always present & are usually larger.
(ii)	Plastids	Absent	Vacuoles are always present & are usually larger.
(ii)	Mitochondria	Mitochondria are numerous & have plate–like cristae	Vacuoles are always present & are usually larger.
(ii)	Centriole	Centriole is present	Vacuoles are always present & are usually larger.
(ii)	Nucleus	Nucleus usually near the centre	Vacuoles are always present & are usually larger.
(ii)	Division	Cytoplasm divides by furrowing or cleavage method	Vacuoles are always present & are usually larger.
(ii)	Crystals	Absent	Vacuoles are always present & are usually larger.
(ii)	Plasmolysis	Due to plasmolysis animal cells	Vacuoles are always present & are usually larger.

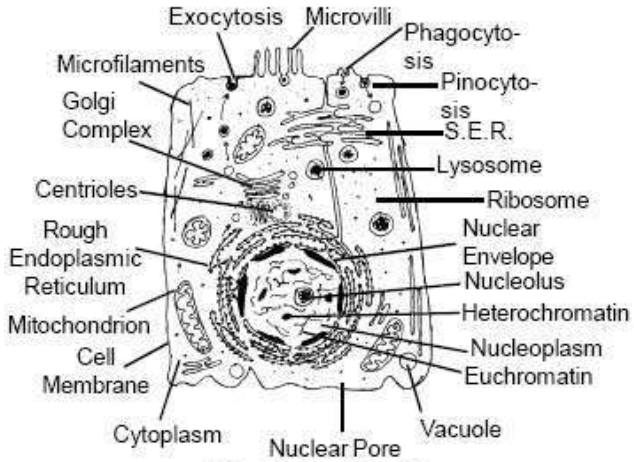


Fig.Animal Cell

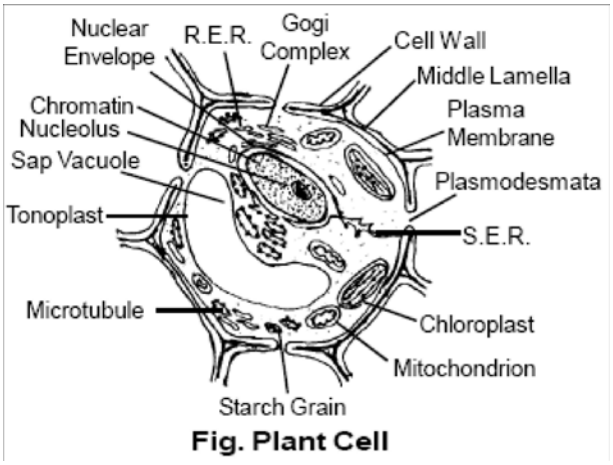
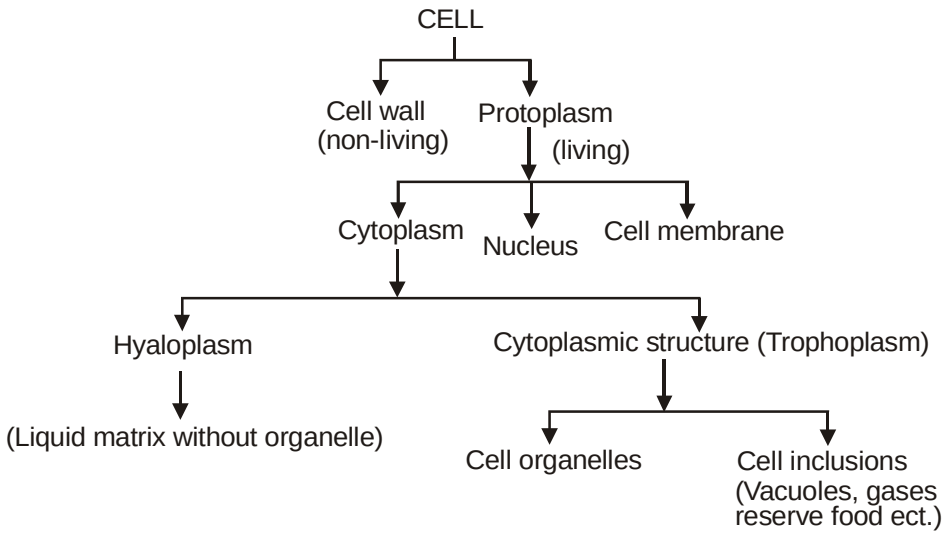


Fig. Plant Cell

STRUCTURAL ORGANISATION OF A CELL :



A typical cell is classified into three parts –

(A) Cell envelope (B) Cytoplasm (C) Nucleus

(A) CELL ENVELOPE – Plant cell has 3 layer in its envelope.

(i) Cell wall (ii) Glylocaylax (iii) Plasmamembrane

(i) CELL WALL

Each plant cell is surrounded by a rigid and **dead** cell wall. It is secretory substance of the protoplasm which protects the cell.

Generally it is made up of cellulose however the cell wall of fungi is made up of fungul cellulose or chitin and the cell wall of bacteria & BGA is made up of peptidoglycon.

Numerous threads like fibrils are found in the wall. One fibril is formed of about 250 microfibrils (main structural elements). One microfibril is also formed about 20 to 22 microfibrils which is called elementary Fibril or Micelle. One micelle is formed about 100 chains of cellulose molecules. Approximately 3000 chains of glucose molecules are found in one molecule of cellulose. Matrix is found between the microfibrils, this matrix is a gel like substance in which pectin lignin etc are found.

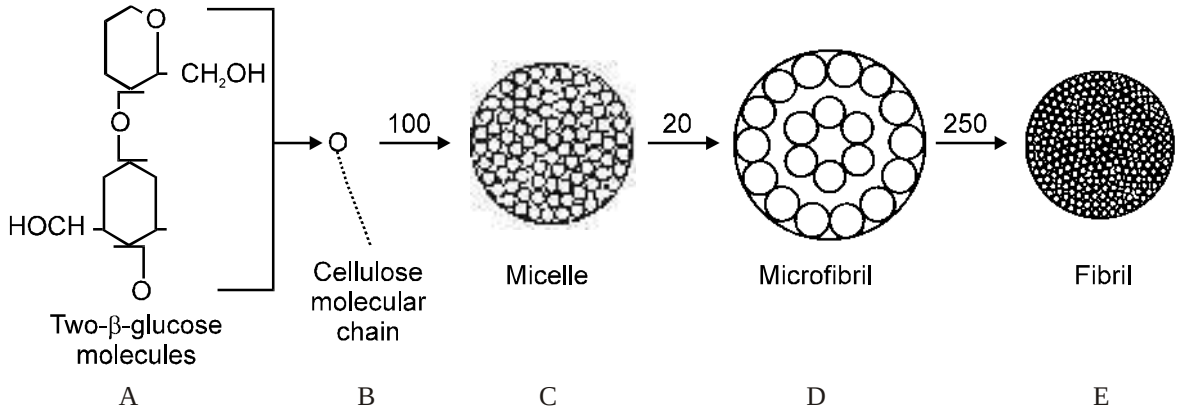


Fig. Molecular organization of cell wall

- **Layers of cell wall**
  - (i) Middle lamella
  - (ii) Primary wall
  - (iii) Secondary wall
  - (iv) Tertiary wall

Middle lamella

At the time of division the minute drops of substances of protoplasm become aligned at the equatorial plate and forms cell plate. It is formed of calcium (more) and magnesium (less) pectate (plant cement). It functions as cementing between two cells.

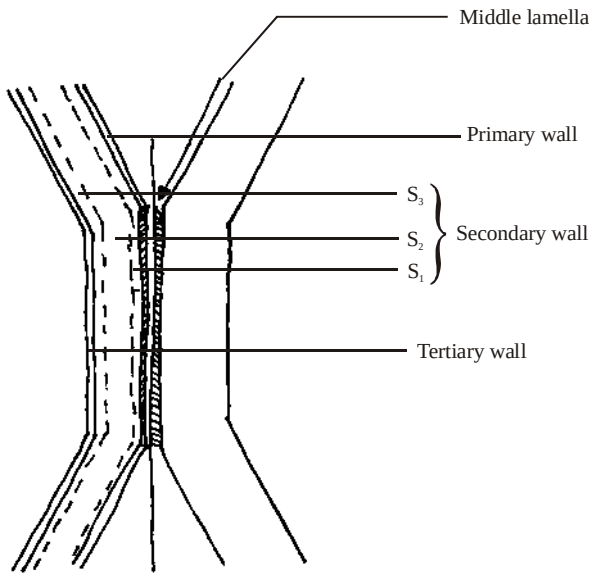


Fig. CELL WALL

Primary wall

(i) Protoplasm deposits some substances on the middle lamella due to which a soft, delicate elastic primary wall is formed. (universal layer)

(ii) Following substances are found in this wall

(a) Pectic substance (Arabinose, galactose, galacturonic acid)

(b) Cellulose

(c) Hemicellulose (mannose, Xylose, gluconic acid) (50%)

(iii) Parenchymatous cells and meristematic cells are formed of only primary wall

Secondary wall (absent in meristem cell)

(i) After the complete development of primary wall, deposition starts due to which secondary wall is formed

(ii) Generally lignin, leutin and suberin are deposited.

(iii) This wall is made up of cellulose, hemicellulose and pectin inside the primary wall.

(iv) This wall is non-elastic and thick (5 - 10 μ)

(v) It is formed of three layers in most of the cells (Thickest wall)

Tertiary wall (mainly hemicellulose & xylan)

Tertiary wall and secondary wall is commonly known as secondary thickenings. Found only in Tracheids of Gymnosperm.

Plasmodesmata

(i) The cytoplasmic bridge between adjacent cells are called Plasmodesmata (discovered by Strassberger). Plasmodesmata contains E.R. tubules called Desmotubules.

(ii) Due to presence of plasmodesmata entire protoplasm are found in the form of continuous system which is called symplast.

Growth of cell wall

A special protein called expansin helps in growth of cell wall by loosing the cellulose microfibril and addition of new cell wall material takes place in the space. Thus expansin is called as "cell wall loosening factor".

Growth of cell wall takes place by two methods :-

(A) Intussusception (B) Apposition

(A) Intussusception

(i) When the particles are deposited between the substance which are already present then this types of growth is called Intussusception Growth

(ii) This types of growth takes place in primary, secondary and tertiary cell wall.

(B) Apposition (Accretion)

(i) When the layers are desposited on to the layers which are present already , then this types of growth is called apposition growth

(ii) This types of growth takes place in secondary cell wall.

Inter cellular spaces

As compared to young cells some intercellular spaces are found in old cells. Intercellular spaces are of following three types :-

(A) Lysogenous Cavities

(B) Schizogenous Cavities

(C) Schizo-Lysogenous Cavities

(A) Lysogenous cavities

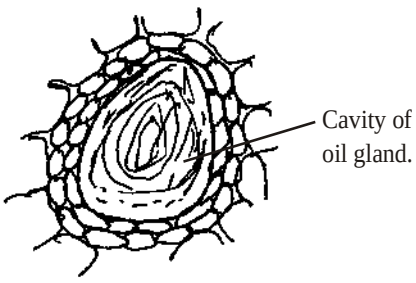
Cavities which are formed by the destroying of cells, called lysogenous cavities. e.g. Oil cavities of citrus.

(B) Schizogenous Cavities

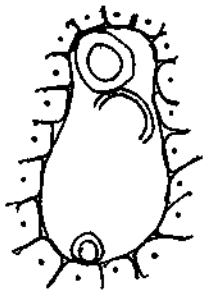
Cavities which are produced by the separation of cells from one another, called schizogonous cavities. e.g. Resin canals in pinus.

(C) Schizo-lysogenous cavities

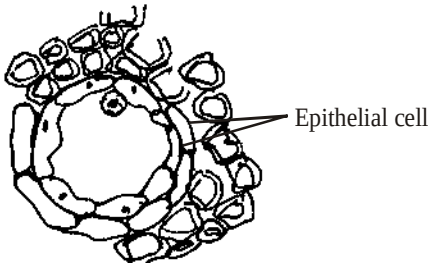
When cavities are produced by both destroying and separation of cells together then , such types of cavities are called Schizo-lysogenous cavities. e.g : Cavity in maize protoxylem.



LYSOGENOUS CAVITY OF CITRUS



SCHIZOLYSOGENOUS CAVITY OF MAIZE PROTOXYLEM



SCHIZOGENOUS CAVITY OF PINUS

Functions of cell wall

(i) Cell wall protects the protoplasm.

(ii) Cell wall gives a particular size & shape to cell & functions in form of exoskeleton of cell.

(iii) It gives a mechanical support to cell.

(iv) Cell wall is permeable so it helps in transport of water & mineral substances

(v) Cell wall plays an important role in absorption, transpiration, transport and secretion etc.

CELL COAT (GLYCOCALYX) :

It is found outside the plasma membrane in many **protistants** and animals cell. Made by **sialic acid** mucin & Hyluronic acid

Function –

(i) It provides definite shape to the cell.

(ii) It helps in recognition of microbes for defence.

(iii) It protects the underlying plasma membrane.

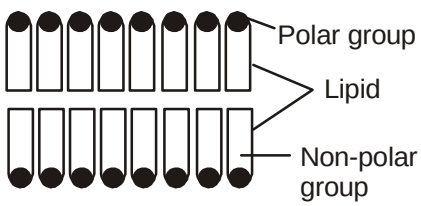
PLASMA MEMBRANE :

Term plasma lemma was given by J.Q. Plower (1885). Term cell membrane or plasma membrane was given by Nagelli. Term unit membrane was given by Robertson. At first, structure of cell membrane was studied by Overton and postulated that cell membrane is composed of a continous layer of lipid material. It is outermost boundary of animal cell. Plasma membrane is a thin selective permeable & living membrane. It is flexible and porus membrane. Plasmalemma of animal cells is elastic due to the presence of lipids.

Model of cell membrane

To describe structure of plasma membrane numerous models have been proposed but the important model are as follow :–

(A) Lipoidal model - This model was proposed by Overton. This postulated that membranes are composed of Lipid bilayer only.



Models of plasma-membrane proposed by Overton

(B) Lamellar model (PLLP) - (1935) :

(i) This model was proposed by Danielli and Davson.

(ii) It is also called trilayered, trilaminar or sandwitch model.

(iii) According to this model plasma membrane is a trilayered structure composed of lipoprotein.

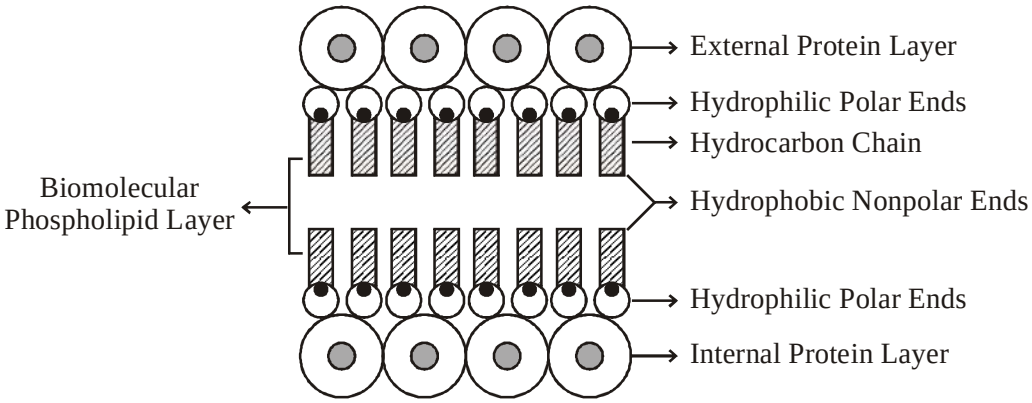
(iv) The bilayered phospho lipid is sandwitched in between two layer of protein molecule.

(v) The bilayered lipid is 35 Å thick whereas, each layer of protien is 20Å thick so plasma membrane is 75Å thick (75 – 100 Å)

(vi) The polar heads of the phospholipids molecules are directed towards protein. The two are held together by electrostatic forces.

(vii) The non polar tails of the two lipids layer is directed towards the centre, where they are held together by Vander Walls forces.

(viii) Plasma membrane is a porous membrane, it has microscopic pores of 7 to 10 Å.

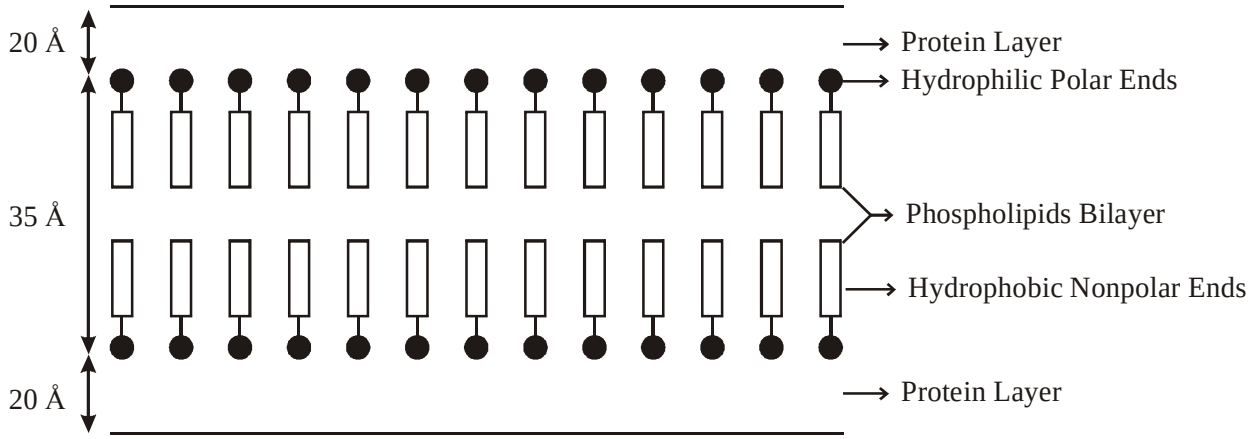


Sendwitch Model

(C) Unit membrane model [(1959) A.D.]

It was proposed by J. David Robertson. **Robertson** coined the term **unit membrane**. According to this model all the cellular and organeller membranes are structurally & functionally similar.

In this model membranes are different to each other on the basis of their chemical behavier & size.



Unit membrane Model

(D) Fluid mosaic model (1973)

This model was proposed by **Singer** and **Nicholson**. It described protein as ice bergs in a sea of lipids. It is the most accepted model.

Their is a central bilipid layer (2 layer) composed of phospholipids arranged in a specific manner. Hydrophilic polar head constitute top and bottom surfaces. Hydrophobic non polar tail end-are buried in the membrane.

Within phospholipid, bilayer, proteins are arranged in two forms.

(a) Extrinsic protein (b) Intrinsic proteins

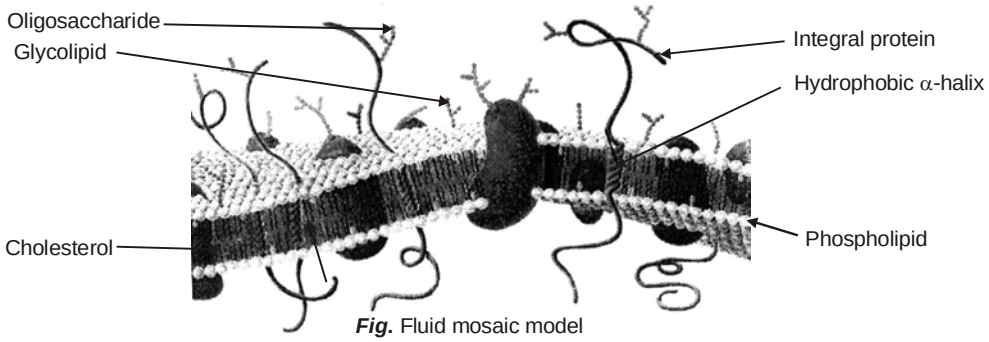


Fig. Fluid mosaic model

Plasma Membrane

Extrinsic proteins | Intrinsic proteins | Phospholipids | Carbohydrates

(a) Extrinsic protein (30%)

(i) Such proteins are arranged superficially on the outer and inner surfaces of membrane and can be easily removed by mild treatment.

(ii) Such proteins are **soluble and unstable**.

(iii) Such proteins can be seperated by change in pH.

(iv) Spectrin, Acetylcholine, Cytochromes are its best example. Spectrins are part of **cytoskeleton**

(v) Some protein like **permeases** and **translocase** function as **carrier** for the transport of materials.

(vi) Plasma membrane is an **asymmetrical structure** because carbohydrate is presents on outer surface and **spectrin protein** is present only in inner surface of plasma membrane.

(b) Intrinsic proteins (70%)

(i) Such protein partially or wholly remain embedded in phospholipid.

(ii) Such proteins can not be seperated easily.

(iii) Some intrinsic protein are confined in lipid bilayer (**Stable protein**).

(iv) Some integral proteins traverse the complete thickness of membrane. These type of protein are called as **tunnel protein** which passage water soluble material across the membrane.

(v) Some intrinsic protein extending from outside to inside are called as **transmembrane protein** eg. **glycophorin, porins.**

(vi) **Porins** founds in outer mitochondrial memberane and bacterial memberane

(c) Phospholipids

Main type of phospholipids are phosphatidylserine, phosphatidylcholine (Lecithin), cephalin. **Cholesterol** is also present in plasmamembrane. Cholestrol are more rigid than phospholipid. So it helps in stability of membrane structure at high temperature. Cholesterol is absent in membrane of prokaryote. Thus Hopanoides (Pentacyclic sterol) provides stability to prokaryotic cell membrane. The lipid act as a barrier to the entry or exit of charged polar substance.

(d) Carbohydrates

The plasma membrane of RBC and liver cell contain 5% carbohydrate Hexasamine sialic acid if carbohydrate attached to lipid it is called **glycolipid** and if attached to protein called **glycoprotein**. Carbohydrate is just 1 percent of the plasma membrane.

Oligosaccharides of the glycolipids & glycoproteins on the outer surface of plasma membranes are involved in cell to cell recognition mechanism. Best example of cell recognition is fertilisation, (where sperm & egg recognize to each other) and blood-Antigens.

Fluidity of the cell membrane

It has been demonstrated by the experiment conducted by **Frye and Edidin (1970).**

Two different animal cells i.e., human and mouse cells were taken. Human cell was labelled with red fluorescent (rhodomine dye) antibody, whereas mouse cell was labelled with green fluorescent (fluorescein dye) antibody. Both the cells were then fused using PEG and examined under the microscope. One half of the fused cell was observed green and the other half as red. They are now divided into lots. One lot is kept at 0ºC, while the other is kept at 37ºC. In the lot kept at 37ºC, there is thorough mixing of the two pigments. No mixing occurs in the fused cells kept at 0ºC, where most of membrane lipids tend to solidify. It these cells are now kept at 37ºC, pigment mising occurs showing that membrane or lipid fluidity has been restored.

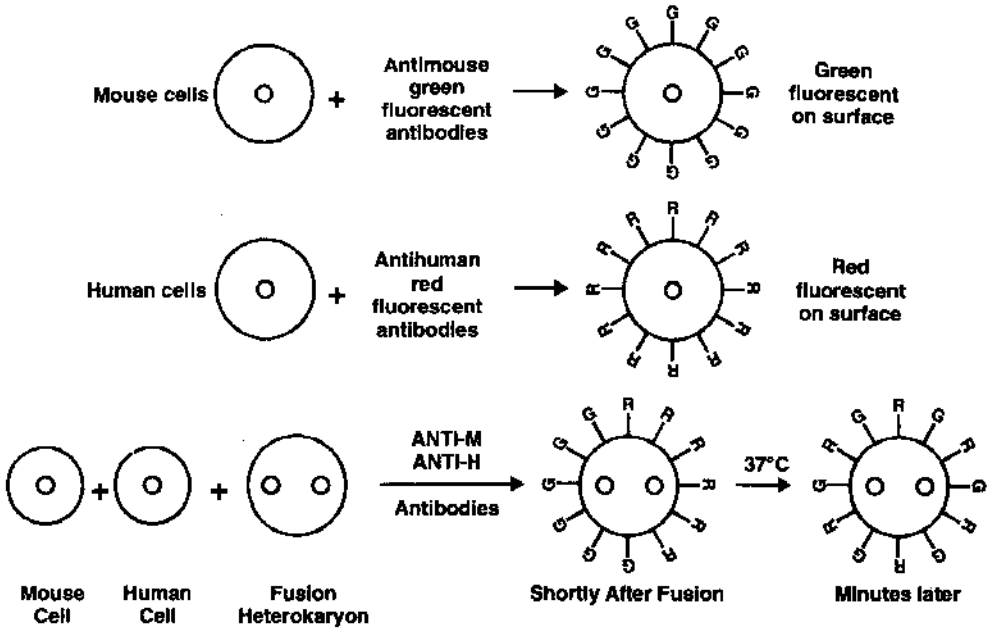


Fig. Experiment to demonstrate lateral movement of protein molecules of the membrane due to fluidity of lipid molecules

Flip-flop concept in fluid mosaic model :

Flip Flop means exchange of molecules from onse monolayer with those in the monolayer on the other side. However phospholipid bilayer has fluid property but no evidence of flip flop mechanism for protein molecule Rotational diffusion and lateral diffusion of protein and lipids is possible in membrane. Absence of flip flop movement detected by electro spin resonance (ESR) spectroscopy.

Modification of plasma membrane :

(A) Microvilli

The free surface of the epithelial cell posses extremely minute thread like structure called **microvilli**. Increase surface area for absorption.

(B) Desmosomes (zona adherence)

In certain epithelial cells plasma membrane of adjacent cells becomes thicker in certain regions s u c h local thickning of plasma membrane are called **desmosomes**. From desmosomes many minute fine fibrils known as tonofibril are radiated towards the interior of the cell. Generally occur in Epithelial cell for cell adhesion.

(C) Interdigitation

At some places the plasma membrane of adjacent cells gives out finger like projection called interdigitation. Interdigitation increase the area of the contact between cells for exchange of material

(D) Tight junction or Zona occludence - These are fused outer layers of two P.M. at the site of attachment, fused membrane has a 5-layered structure. Tight junction occur in nerve tissue at synapses.

(E) Gap junction or Nexus - These are fine protein channels (connexons) which joins two P.M. of adjacent cells with protein connexine. Desmosomes, interdigitation, tight junction and gap junction occurs in animal cell.

(F) Mesosomes

Mesosomes are plasma lemma in folding found in bacteria. In aerobic bacteria respiratory enzymes found in it.

(G) Lomasomes / Border body

Lomasomes are plasmalemma folding found in fungal cell in between cell membrane and cell wall. Discovered by Moore and Mc Aear. It is belived that it is related with formation of cell wall.

FUNCTION OF PLASMA MEMBRANE :

Main function of plasma membrane is transport. It is following types :

(A) Active transport

(i) Occurs from **lower concentration** to **higher concentration**.

(ii) During this type of transport, energy is utilized. e.g.- **Sodium pump**.

(B) Passive transport

(i) Occurs from **higher concentration** to **lower concentration**.

(ii) During this type of transport energy is not utilized.

(C) Endocytosis (Bulk transport)

(i) **Pinocytosis** or **Cell Drinking** - Term proposed by **W.H.Lewis** (1934). Ingestion of liquid material by plasmalemma in the form of vesicles or bag like structure (**Pinosome**) is called pinocytosis.

(ii) **Phagocytosis** or **Cell eating** - Term given by **Metchnikoff**. Ingestion of solid complex materials by Membranes in the form of vesicles (**Phagosome**) is called Phagocytosis.

(D) Exocytosis / Emiocytosis / Cell vomitting - Egestion of waste materials from cell through plasma membrane.

(E) Rophaeocytosis -

This is transfer of complex materials from **one cell to another cell**, through membrane in vescicular form. (Transfer of Hb from Red Bone marow cells to maturing RBCs is good example of Rophaocytosis).

(F) Plama membrane provide definite shape to the cell. Conduction of nerve impulse takes place through plasma membrane of nerve cell.Plasma membrane plays important role in recognition of various cells. e.g. Macrophages engulfes only dead RBC.

(G) The microvilli of intestinal cells increases surface area of absorption so, rate of absorption increase. The site for cells recognition are located on the surface of plasma membrane. The antigenic property of a cells are located on the surface of plasma membrane.

CYTOPLASM

Mass of protoplasm lying in between outside of nucleus and plasma membrane is called **cytoplasm**. (term - strassberger). It is colourless homogenous, translucent, amorphours and colloidal fluid. The peripheral part of cytoplasm is normally non-granular and clear and known as **ectoplasm**. The inner portion is granular and less viscous known as **endoplasm**. Liquid matrix of cytoplasm except organelles called **Ground plasm**

/ **Hyaloplasm / Cytosol**. Part of cytoplasm containing organelles & non living inclusions called **Trophoplasm**. Cell inclusions are non - living matter.

CELL ORGANELLES :

Cell organelles are organised structure of cytoplasm capable of growth and in some cases multiplication.

CELL ORGANELLES

Double membranous structure	**Single membranous structure**	**Non membranous structures**
Nucleus, Mitochondria and Plastids.	Lysosomes ,Microbodies, Golgi complex and Endoplasmic reticulum.	Ribosome and centriole.

MITOCHONDRIA

(i) Power house of cell or ATP-mill in cell.
(ii) Cell within cell / second largest organelle
(iii) Cell furanaces or storage batteries.
(iv) Most busy and active organelle in cell
(v) Semi autonomous cell organelle.
(vi) It was discovered by Kolliker 1880. (In straited muscles of insect)
(vii) It was named bioplast by **Altman** in 1886.
(viii) It was named mitochondria by **C. Benda**.
(ix) **C. Benda** stained it with **crystal voilet.**

Number

The cell in which energy requirement is high large numbers of mitochondria are reported.

(i) *Microsterias* and *Tripanosoma* & *Chlorella* (Algae) - One
(ii) *Yeast* - Less than 10.
(iii) Liver cells - 500
(iv) Kidney - 300 to 400
(v) *Chaos chaos* (amoeba) - (50,000).
(vi) Flight muscles of Birds - (5 lakh). (sarcosome)

Shape and size

Mitochondria may be spiral, rod shaped, spherical elongated or cup shaped. Yeast cell possess smallest mitochondria (0.1 μ). Oocytes of amphibians possess largest mitochondria (40 μ).

Structure

Mitochondria is made up of three component :

(A) Mitochondrial membrane,
(B) Oxysome &
(C) Matrix

(A) Mitochondrial membrane : Mitochondria is covered by **double unit membrane**. Each membrane is 60-75 Å thick and separated by a space (80 - 100 Å) called perimitochondrial space. This space is rich in coenzymes and enzymes required for oxidation of fats.

Inner membrane	Outer membrane
(i) It is projected into the central space in the form of finger like projections called cristae (ii) Cristae name was given by palade. (iii) The cristae increase the surface area and provide abundant space for metabolism. (iv) Inner membrane is selectively permeable. (v) It contains all enzymes of electron transport chain.	(i) It is not projected and continious. (ii) Cristae is not formed. (iii) The cristae is absent. (iv) Outer membrane is fully permeable. (v) It contains porine protien enzyme for tranport. (vi) It contain more Phaspholipid and Cholestrol.

Note :

(i) It outer membrane of mitochondria is removed then structure is called as mitoplast.

(ii) Outer surface of inner membrane is called C-face while inner surface called M-face.

(iii) Some sessile particles attached to outer membrane are known as "subunit of parsons".

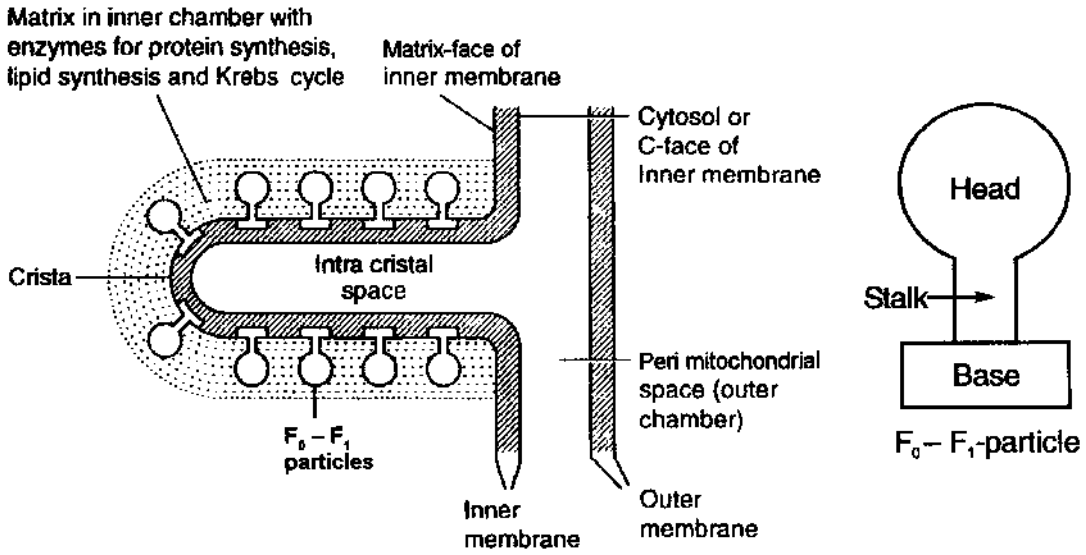


Fig. Detailed structure of crista

(B) Elementary particles or oxysome or F_1–particles

F_1 particles was at first described by Fernandez moran. It contain enzyme of electron transport system and oxidative phosphorylation. It differentiated into base, stalk and head. A mitochondria may contain 10^4–10^5 particle. The head piece (f_1) is associated with ATP synthesis by enzyme ATP base.

Base (Multiprotein complex) is also called F_0 subunit. It is embedded in inner mitochondrial membrane. F_0 subunit is also called oligomycin sensitivity conferring protiens (OSCP). (It provide tunnel for protons)

(C) Matrix

Mitochondrial matrix have enzyme for kreb's cycle. (Ribosome (70-s) - DNA, RNA enzyme). Mitocondrial DNA was discovered by Nash and Margit in 1963. Mitochondrial DNA is 1% of total DNA is a cell. It is rich is G-C content. Mitochondria of mammals have 55 s ribosomes (35s, 25s units)

Function of Mitochondria

(i) Mitochodria is site for **cellular respiration** because it contains all enzymes required for it.

(ii) Since mitochondria is a site of cellular respiration energy, (ATP) is formed in it.

(iii) Mitochondria help in **yolk formation** during the development of ovum. **(vitellogenesis)**

(iv) Mitochondria help in formation of **middle piece of sperm** during sperm maturation. **(spiral sheath)**

(v) Mitochondria help in elongation of fatty acids.

(vi) Cytoplasmic inheritance.

Note :

(i) Altman stated mitochondria is a semiautonomous cell organelle. The mitochondrial DNA carries enough information for the synthesis of about 30 proteins only but that is not enough to make a new mitochondria, so the mitochondria depend upon the nuclear DNA. Mitochondria replicate and uses cytoplasmic enzyme and other molecules of the cell, during cell division.

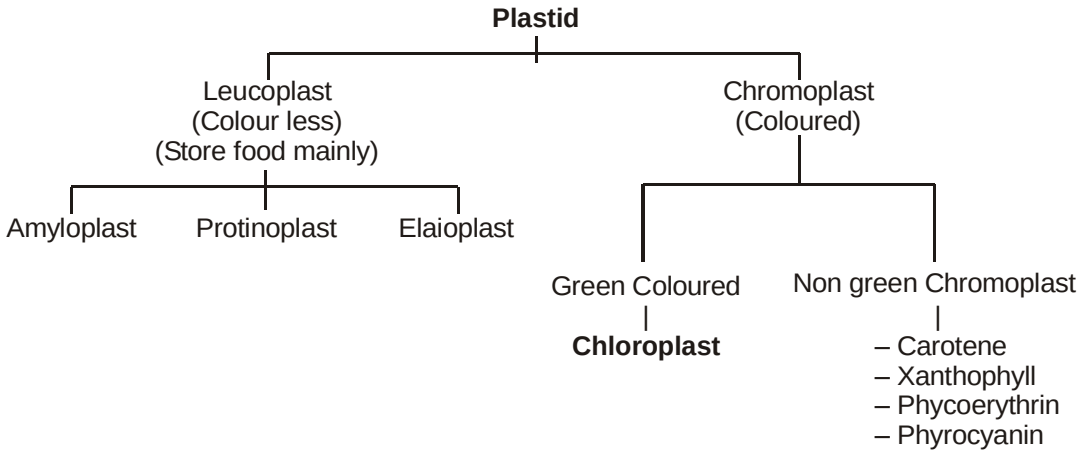
(ii) Endosymbiotic origin of mitochondria from Purple Sulphur bacteria or prokaryotic cells, explain that mitochondria are similar to prokaryotic cell. Both are similar in DNA type of ribosomes (70s). sensitivity of antibiotic (chloremphenicol) with protein synthesis and divide by amitosis.

(iii) In scurvy disease numerous mitocondria combine with each other and from large lobe called **condriosphere / chondriome**.

PLASTIDS

First all the term plastid was coined by **Haeckel**. It was discovered by **Schimper** in 1883. Plastids are found in all plant cells except bacteria, fungi and blue green algae. It may be colourless or coloured and get converted from one form of plastid to another. [Chromoplast to Chloroplast never occur]

On the basis of colour these are following two types –



Leucoplast

These are **colourless** and irregular in shape. These are found in those cells in which light is not available e.g. under ground stem and root. These are found in parenchymatous cells, sex cells, embryonic and meristematic cells. On the basis of storage of food leucoplast are divided in the following three types :

(A) Amyloplast

(i) These are of large size and store starch.

(ii) These are found in root, seed and stem.

(B) Protienoplast (Aleuronoplast) :

They store **proteins** and are found in seeds (pulses).

(C) Elaioplast :

They store **fats** & **oil** and are found in seeds. They are also called **olleosome**. [castor, groundnut]

(D) Etioplasts :

These are plastids without pigments, stored food and lamellar structures. These plastids occur in etiolated plants due to the absence of light

Chromoplast

Non-green plastid. Chromoplast is found in fruits and flower. They exhibits red, orange and red yellow colour. Chromoplasts also occurs in petals but colour of petals are mainly due to water soluble pigments occurs in cell sap. e.g. Anthocyanin - (Blue or violet or red pigment) Anthoclor (yellow pigment Beta cyanin - Beetroot) Chromoplast contains following types of pigments

(1) Carotenoids

It is of orange, red or yellow colour. Due to soluble in fats these are called lipochrome. These are found in all parts of plants and for its synthesis light is not necessary.

It is of following two types –

(a) **Carotene :** Redcolour of chillies and red tomatoes is due to the red pigment "Lycopene" of chromoplasts. Yellowish - orange colour of fruits are due to α-carotene, β-carotene and γ-carotene. β-carotene is precursor of vitamin-A. Richest source of β-carotene are carrot roots.

(b) **Xanthophylls**

These yellow coloured carotenoids are also called Xanthols. Fucoxanthin is found in brown algae which provides brown colour to algae.

(2) Phycobilins

(a) Water soluble in nature.

(b) These are of following three type and found in blue green algae & red algae.

(i) Phycoerythrin

(ii) Phycocyanin

(iii) Allophycocyanin

(3) Chromatophores - These are clusters of pigment granules in cytoplasm of **photosynthetic bacteria**. In blue-green algae pigments are located on membranous lameller structures, scattered in Cytoplasm. These structures are known as chlorosomes or Lamellisomes or Carboxysomes.

Chloroplast

First of all Mayer seen it in plant cell and named Autoplast. Schimper discovered it and term chloroplastid was given. Chloroplast name was given by Errera. Due to presence of chlorophyll in these plastids leaves and parts of plants exhibits green colour. These are found in the mesophyll of leaves and chlorenchyma region of higher plants. Due to presence of DNA & RNA chloroplast is known as Semiautonomous organelle and Cell within cell. DNA of chloroplast was discovered by **Ris & Plaut**. (Upto 14% DNA of cell)

(A) Structure

In lower plants (e.g. Algae) chloroplast structure are as followings :

(a) Cup shaped – *Chlamydomonas*

(b) Girdle shaped – *Ulothrix*

(c) Spiral shaped – *Spirogyra*

(d) Reticulate shaped – *Oedogonium*

(e) Stellate shaped – *Zygnema*

Chloroplast has an envelope composed of two unit membranes. Blank space is found between unit membrane which is called periplastidial space. In this bilayered membrane bounded structures, the proteinaceous matrix is found, which is called stroma. Stroma contains a variety of particles, osmiophilic droplets, Strands of RNA and DNA (ds, circular, naked) Ribosomes, Enzymes and Dissolved salts.

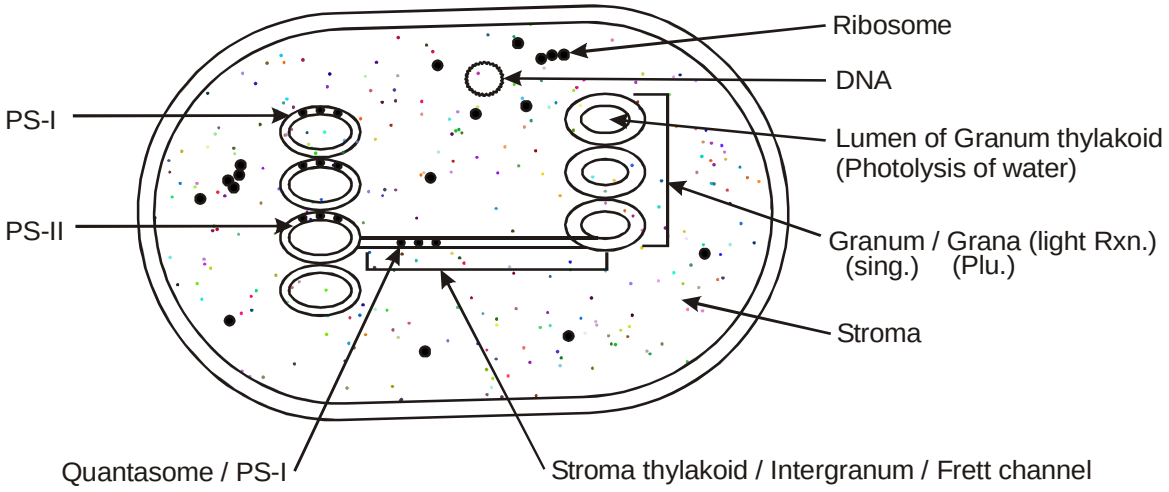


Fig. Chloroplast

Rubisco is the most abundant enzyme on the earth. It made 16% protein of the chloroplast. In the stroma many membranes which are running parallel to each other throughout the length of the chloroplast, called Thylakoid lamellae. Thylakoid Lamellae have some rounded flat, sac-like structures stalked one above the other, these structures are called Granum thylakoid. Thylakoid was discovered by Menke. The group of granum thylakoids is called grana (plural), different grana are connected with the help of tubular connections called Frets or Intergranum. A photosynthetic functional unit, which consists of about 230 to 400 molecules of various pigment (Chl-a, Chl-b, carotenes, xanthophylls etc.) is called as Quantasomes (By Park & Biggins 1964). Main pigment of chloroplast is chlorophyll. It was discovered by **Pelletier** & **Caventou**. The following types of chlorophylls are found in plants -

(A) Chlorophyll 'a'

This chlorophyll is found in all photosynthetic organism except **photosynthetic bacteria**, so it is also called as **universal chlorophyll**.

(B) Chlorophyll 'b'

This chlorophyll is found in all higher plants and in green algae but not present in algae of other group.

(C) Chlorophyll 'c'

It is found in brown algae (Phaeophyceae) and diatoms.

(D) Chlorophyll 'd'

It is found in red algae (Rhodophyceae).

(E) Chlorophyll 'e'

It is found in Xanthophyceae e.g. Vaucheria.

(F) Bacteriochlorophyll - a

It is found in photosynthetic bacteria

(G) Bacteriochlorophyll 'b' : It is found in Rhodopseudomas

(H) Chlorobium chlorophyll : It is found in green sulphur bacteria

Function :

The chloroplasts perform following functions like;

(i) Photosynthesis - light reaction (in thylakoids), Dark reaction (in stroma)

(ii) Storage of starch, vitamin K, E, Rubisco protein and iron etc.

ENDOPLASMIC RETICULUM :

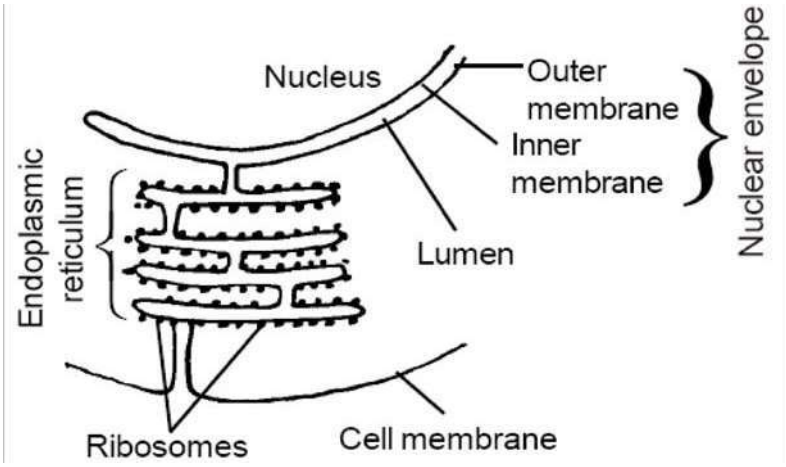
Endoplasmic reticulum was discovered by Porter in 1945. It was first of all observed under light microscope by Garnier in 1897. The term E.R. was first of all used by Porter. It was named ergastoplasm by Garnier. Robertson described relationship inbetween endoplasmic reticulum and plasma membrane. It is absent in Prokaryotes, present in all eukaryotes except germinal cells and mature mammalian erythrocytes. It is found scattered in whole cytoplasm. Structure of E.R. is like the golgi body but in E.R. cisternae, vesicles and tubules are isolated in cytoplasm and these do not form complex. Golgi body is localised cell organelle while E.R. is widespread in cytoplasm. E.R. is often termed as "System of membranes"

Structure

(i) Endoplasmic reticulum is composed of lipoprotein. Protein constitute 60 % whereas lipids 40%.

(ii) Endoplasmic reticulum is network of highly branched fine tubules.

(iii) Its one end, is connected with nuclear membrane whereas other end with plasma membrane.



Ultrastructure of endoplasmic reticulum

(iv) It is composed of three types of forms which are as follows.

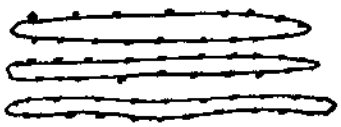
1. Cisternae 2. Vesicles 3. Tubules

1. Cisternae

(a) It is elongated flattened, **unbranched** tubular structure which are found arranged in parallel rows.

(b) It is generally granular due to presence of ribosome.

(c) It is mainly found in cells actively indulged in protein synthesis like in liver, pancreas etc.



Cisternae

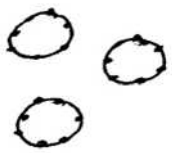
2. Vesicles

(a) It is rounded oval form of 25-500 micron.

(b) It is found well scattered in the cytoplasm.

(c) It is mainly found in protien forming cells.

(d) It is also granular structure.



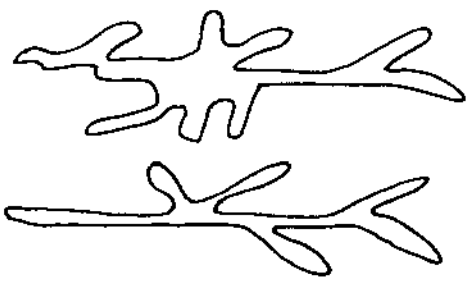
Vesicles

3. Tubules

(a) It is tubular, **highly branched**, found near the cells membrane.

(b) It is smooth structure, because ribosome is absent from its surface.

(c) It is mainly found in cells associated with **synthesis of cholesterol, glycerides, hormones** etc.



Tubules

Type of E.R.

S.No.	Smooth ER	Rough ER
(a)	Ribosome-absent	Ribosome-present
(b)	Mainly present near the cell membrane	Mainly present near the nucleus
(c)	Found in cell related with synthesis of fat, glycogen and steroides	Found in cells related with synthesis of Protein
(d)	Mainly formed of tubules	Mainly formed of cisternae & vesicle
(e)	Less stable	more stable
(f)	Eq. Adipose tissue, Muscles	Eq. Liver, Pancrease
(g)	SER get originated from RER by loss of ribosome.	RER arises by evagination of outer nuclear membrane.

Note :

(i) Ribosome are attached to ER by a glycoprotein called ribophorin-I & II

(ii) SER of pigmented epithelial cells of retina is called myeloid body.

(iii) RER of nerve cells is called nissle's granules (Ergastoplasm)

(iv) **Sarcoplasmic reticulum** occurs in skeletal and cardiac muscles. Sarcoplasmic reticulum stores Ca^{+2} and energy rich compounds required for muscle contraction. It is modified S.E.R.

(v) **T-tubules -** these are transversely arranged tubules in skeletal and cardiac muscle cells. These transmits stimulus for contraction of muscls.

(vi) Microsomes are fragments of E.R. associated with ribosome. It was was first discovered by **Claude** in 1951. It is obtained by high speed **centrifugation**.

Functions

(i) E.R. acts as cytoskeleton and provide mechanical support and shape to the cell.

(ii) E.R. helps in the formation of primary lysosome, Golgi body, microbodies etc.

(iii) E.R. also helps in synthesis of nuclear envelope during telophase.

(iv) It helps in lipid synthesis.(Phospholipid, Steroid hormone & Cholestrol)

(v) It helps in glycogenolysis. (glycogen $\rightarrow$ glucose)

(vi) It helps in synthesis of ascorbic acid.

(vii) **Intracellular exchange -** E.R. forms intracellular conducting system. Transport of materials in cytoplasm from one place to another may occurs through the E.R.

(viii) **Cellular metabolism -** The membranes of the reticulum provides an increased surface for metabolic activitities within the cytoplasm.

(ix) **Detoxification -** Smooth ER concerned with detoxification of drugs, pollutants and steroids.

(x) **Cytochrome P_{450}** in E.R. act as enzyme which function in detoxification of drugs and other toxins.

(xi) It provides the precursor of secretory material to golgi body.

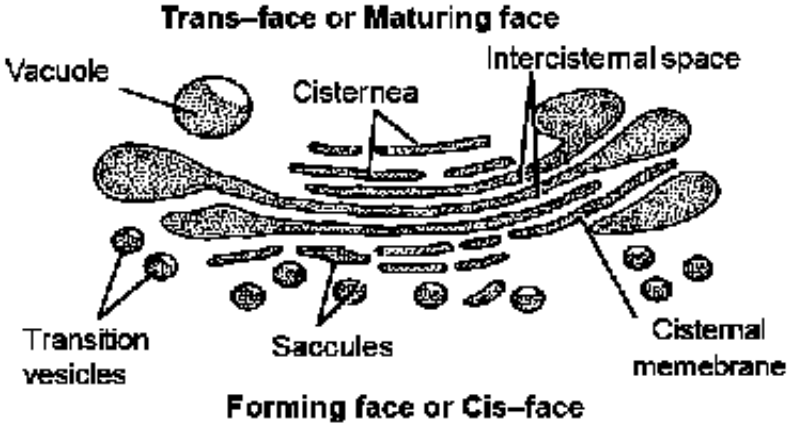
GOLGI COMPLEX :

It is also called as Lipochondrian, Dalton complex, Idiosome, Baker's body, Golgi body. In plant cell it is also called dictyosome. It was discovered by Camilo golgi in nerve cells of owl and cats. Baker at first stained it with Sudan black reticular apparatus. Golgi body is termed as "Principal director of macromolecular trafic in cell" or middle men of cell. Found in large number in secretory and glandular cells. The cytoplasm surrounding Golgi body have fewer or no other organelles. It is called zone of exclusion. Golgi bodies are pleomorphic structures because component of golgi body are differ in structure & shape in different cells.

Structure

It is composed of lipoprotein. Protein is 60% whreas lipid is 40%. Golgi body originated from ER. Structure of golgi complex described in detail by Dalton and Felix. In golgi body 4 types of structure is found which are as follows.

1. Cisternae 2. Vesicles 3. Vacuole 4. Tubules



Internal Structure of golgi body

1. Cisternae

(a) It is elongated flattened sac and **unbranched tubules**.

(c) It is curved structure with swollen ends present one upon the other.

(c) The curved convex structure is directed towards nucleus(cis-face / forming face), whereas (maturing face / trans face) is directed towards plasma membrane.

(d) The functional unit of golgi apparatus is cisternae.

2. Vesicles

(a) It is numerous droplet like structure.

(b) They are found around convex surface or edges of cisternae.

(c) It is formed by budding from cisternae. Filled with secretory materials.

3. Vacuole

It is large round structure found around concave or edges of cisternae.

4. Tubules

These are **branched** and irregular tube like structure associated with cisternae.

Function

(i) Cell Secretion is cheif function of golgi body is secretion (export) of macromolecules.

Stepes of Secretion :

(a) Golgi body recieve the materials from E.R. through its cis-face.

(b) **Glycosidation** and **Glycosylation** of proteins and lipids takes place in golgi body and it yields **glycoprotiens** and **glycolipids**.

(c) After chamical modification materials are packed in vesicles. These vesicles are pinched of from trans face of golgi body and discharged out side the cell (Reverse pinocytosis).

(ii) During spermatogenesis it forms Acrosome of sperm.

(iii) Lysosome get formed from it.

(iv) It is helpful in synthesis and storage of yolk & vitelline membrane of egg.

(v) It is helpful in synthesis of melanin pigment.

(vi) In plant cell it forms cell plate (phragmoplast).

(vii) It stimulate mitochondria for the production of ATP.

(viii) It helps in synthesis of carbohydrate. Mainly polysaccaride (cell wall material).

(ix) Secretion of Zymogen from Pancrease. Lactoprotein from mammary glands & Hormones.

(x) Mucilage secretion by root cells.

(xi) Secretion of hormone by endocrine glands is mediated through golgibody.

LYSOSOME

Lysosome is also called sucidal bags. It was discovered by Christan De Duve (1955) accidently when he was working on rat liver cell to isolate certain enzyme. P.Matile (1964) reported in plant cells. In begening it was named paracanalicular bodies. First observed by Novikoff.

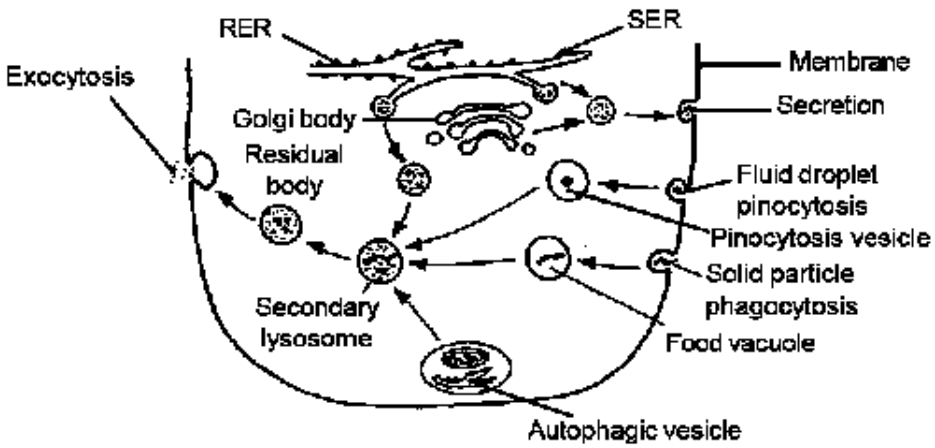


Fig. Differnt types of Lysosome

It is absent in prokaryotic cells, RBC and sperm. These are found in abundant in Phagocytic and secreted cells like WBC, Kupffer's cells, pancreatic cells, liver cells & Fungi. Lysosome get originated from plasma membrane by the process of pinocytosis or phagocytosis. Biogenesis of Lysosome system of GERL (Golgi Associated Endoplasmic Reticulum) from which Lysosomes arise.

E.R. $\rightarrow$ Golgi bogy $\rightarrow$ Lysosome

Note :

(i) In 1973 Pit and Galpin discovered its presence in higher plants. In majority of higher plants large food vacuole act as a lysosome.

(ii) In bacteria space in between cell wall and cell membrane act as a lysosome. (periplasmic space)

Structure

Lysosome shows **polymorphism** (Different morphological and physiological stages).

(i) It is round, sac like structure bounded by single unit membrane composed of lipoprotein.

(ii) It is filled with granular matrix. In matrix nearly 50 acid hydrolases is found which are digestive enzyme.

(iii) Acid hydrolases are capable of hydrolysing all classes of macromolecules.

Following are the important acid hydrolases found in lysosome.

S.No.	Enzyme	Substrate
(i)	Nuclease	Nucleic acid.
(ii)	Protease	Protein.
(iii)	Glycosidase	Polysaccharides.
(iv)	Lipase	Lipids.
(v)	Phosphatase	Phosphate linked compounds.
(vi)	Sulphatase	Sulphate linked bonds

All enzymes found in lysosome requires acid for their action, hence called **acid hydrolases**. These enzyme function at **pH-5**. Membrane of lysosome has an **active H^+ pump** mechanism which produce acidic pH in lumen of lysosome.

Type

Lysosome attains four different form so it is called **polymorphic** organelle. The four forms are as follows-

(a) Primary Lysosome

(b) Secondary Lysosome

(c) Residual body

(d) Autophagic Vacuole

(A) Primary Lysosome (Protolysosome).

(i) The primary lysosome or prelysosome are small sac like bodies.

(ii) These are secreted directly by endoplasmic reticulum and cisterne of golgi complex and get filled with inactive enzyme.

(B) Secondary lysosome (Heterophagosome or digestive vacuoles)

(i) When the primary lysosome fuses with the other vacuoles (pinosome / phagosome) it is called secondary lysosome.

(ii) In it active enzymes are found.

(iii) It is also called phagolysosome.

(C) Residual body / Tertiary Lysosome

(i) Secondary lysosome + Undigested food = Residual body.

(ii) After the products of digestion have been absorbed in to the cytoplasm. The undigested remains are left in the lysosome, it is called residual body.

(iii) This moves to the surface and throws the contents by exocytosis.

(iv) It is also called telolysosome.

(D) Autophagic Lysosome (Autophagosomes or cytolysosomes)

(i) This type of lysosome, contain part of its own cells (Generally unwanted structure) and digest it

(ii) It is a part of the normal activity by which old organ cells are digested and new ones are formed.

(iii) It occurs more frequently during differentiation.

Function

(i) **Intracellar digestion / Heterophagy -** Lysosome digests substance which enter within a cell by phagocytosis and pinocytosis.

(ii) **Extracellular digestion -** Lysosomes of osteoclast (bone eating cells) dissolve unwanted part of bones. (Extracellular digestion also occurs by fungal lysosomes)

(iii) **Autophagy -** Lysosome digest old and damaged cell, during this process, lysosome get brust, and enzyme enclosed within lysosome get released. This mechanism is called autolysis. (starvation) Unwanted organs of embryo are destroyed by autolysis, Cathepsin of lysosome digests the tail tadpole of frog during metamorphosis.

(iv) Lysosome help in digestion of harmful substance WBC digest bacteria, germs, viruses and help to give defence to the body.

(v) Lysosome help in dissolving the egg membrane, during fertilization.

(vi) **Crinophagy -** Excessive secretory granules of hormone in endocrine gland may be digested by lysosomes. This event is called **crinophagy**. **Thyroglobin** stores in thyroid gland with in its follicles and after crinophagy by proteases it produces **thyroxine**.

RIBOSOME

Ribosome was discovered & termed by Palade. Ribosome was at first seen by Claude in electron microscope in animal cell. Ribosome was discovered by Robinson and Brown in plant cell of bean roots. Ribosome are without any membrane. Ribosomes are the smallest and largest in number organelles in a cell. Ribosome are also called as "Organelle with in an organelle" & "Protein factory of cell".

Structure

It is composed of RNA and Protein. 55 s ribosome in mitochondria of mammal.

Each rirosome composed of two subunits i.e. larger and smaller subunits. Larger subunit is dome shaped and smaller unit is ovoid. Smaller subunit has a platform, a cleft & head. The larger subunit has a protuberance, a ridge and a stalk. Larger subunit also contains a tunnel which opens in cavity of E.R.

80s = 60s + 40s

70s = 50s + 30s

Magnesium ion is essential for the binding the ribosome sub units.

Mg^{+2} form **ionic bond** with phosphate groups of r–RNA of two subunits. Minimum 0.001 M Mg^{+2} concentration is required for structural formation of ribosomes. If Mg^{+2} concentration increased 10 times then ribosome dimer are formed.

In prokaryotes ribosome originate in cytoplasm. In eukaryotes ribosome originates in nucleolus. There fore nucleolus is also called as ribosomal factory. After synthesis move to cytoplasm where protein synthesis occur. The proper folding and transport of proteins is assisted by specific proteins called chaperons.

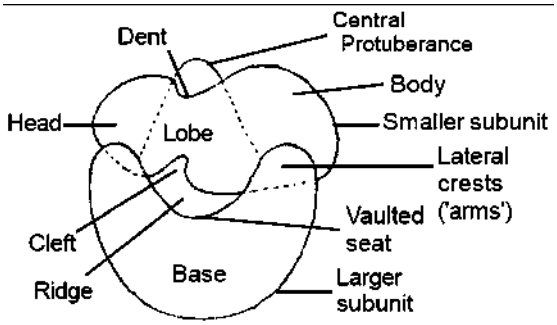
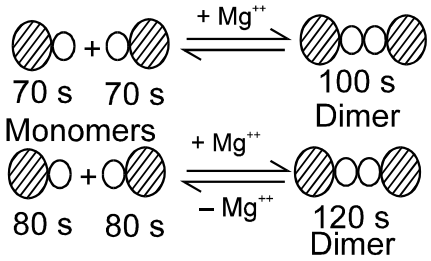


Fig. Stoffler and wittman's model of ribosome



Types

Ribosome is mainly of two types, which are as follows –

Prokaryotic Ribosome (60% RNA + 40% protein)	Eukaryotic ribosomes (40% RNA + 60% Protein)
(i) Prokaryotic ribosome is 70S type and have two subunits 50S and 30S. **(A) 50S** (i) It is larger subunit. (ii) Its base is spherical. (iii) RNA found is **23'S rRNA** and **5S rRNA**. S = Swedberg unit or Sedimentation rate. **(B) 30S** (i) It is small subunit. (ii) Its base is rod like. (iii) RNA found is **16S rRNA**.	(i) Eukaryotic ribosome is 80S type and composed of 60S and 40S subunits. **(A) 60S** (i) It is larger subunit. (ii) It contain **28S**, **5S**, **5.8S rRNA**. (iii) Larger subunit contains Peptidyl transferase enzyme. This is an example of Ribozyme. (Noller 1992). A-site and P-site present in this unit **(B) 40S** (i) It is smaller subunit. (ii) It contain **18S rRNA**.

Function

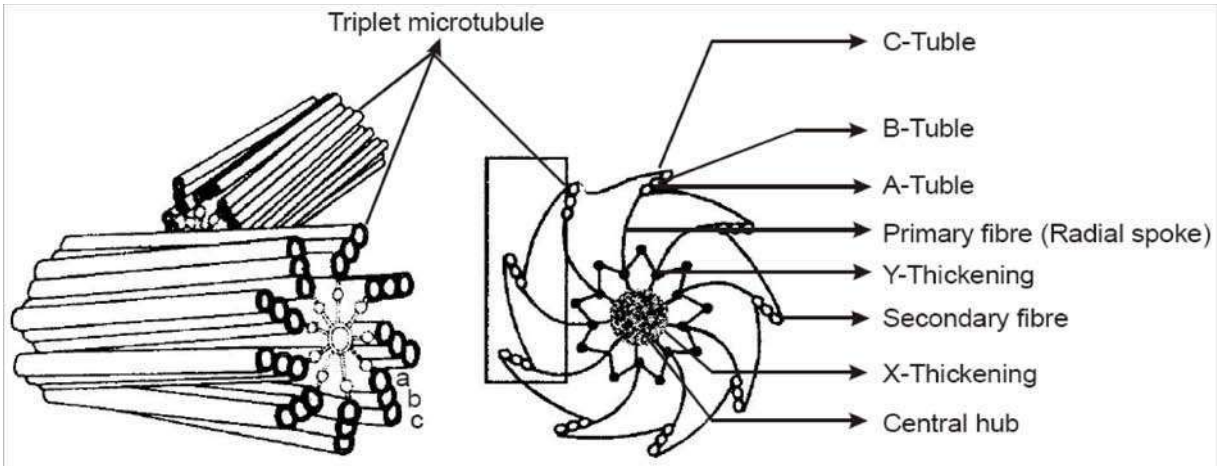
Main function of ribosome is **protein synthesis** so called protein factory or cell engine.

CENTROSOME :

Centrosome was discovered by Benden. Boveri named as centrosome. Centrosome is absent in higher plants. Two centrioles located just outside the nucleus and lie at right angle (90º) to each other. Cytoplasm which surrounded centrioles called as "Centrosphere". Centrioles and centrosphere collectively called centrosome or Microcentrum or diplosome.

Structure :

Each centriole is surrounded by peri centriolar mass, which is called as massules or crown or satellite. Centrioles are membraneless elongated structure which exhibit cart wheel structure (Just like Basal body of cilia). Basal body is also a type of centriole.



(A) (B)

(A) A pair of centrioles (Diplosome), (B) T.S. of a centriole

Centriole mainly consist of 9 triplet fibers of tubulin. (9 + 0 arrangement). Centrioles are self duplicating units, which contains DNA, RNA and protein synthesis machinery. Centriolar DNA discovered by Randall and Disprey. Centriolar DNA is probably ds circular and naked. Replication of centriole occur in s-phase.

Function :

In animal cells centroiles play important role in initiation of cell division by arranging spindle fibres between two poles of cell. The location of centrioles during cell division decides the plane of division. The plane of division is always at right angle to the long axis of spindle. Thus centrioles is also termed as "cell centers".

CILIA AND FLAGELLA :

Cilia and Flagella are hair like cellular appendages and locomotory structure. Flagellar apparatus is consist of following Parts.

Structure :- (A) Kinetosome, (B) Rootlet Rhizoplast, (C) Shaft or Ciliary part

(A) Kinetosome it is also known as basal granule or Blepheroplast or Basal body. It is membraneless structure lies immediately below the plasmamembrane. Basal body exhibit cart wheel structure similar to centriole. (9 triplet fibriles connected to a central hub in basal body.)

(i) Arrangement of microtubules is 9 + 0. In basal granule there occurs 9 microtubules on periphery and each microtubule is composed of three tubules i.e. A-tubule, B-tubule and C-tubule.

(ii) Central part of basal granule is composed of semisolid cytosol called **"Central Hub."**

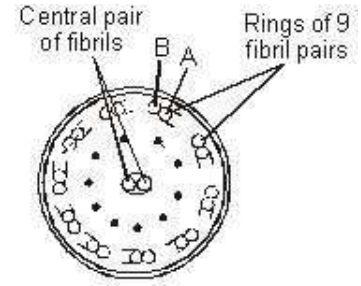
(iii) Microtubules connected to central Hub with the help of protein fibres called Primary fibres or spokes.

(iv) Secondary fibres connect microtubules with each other.

(v) Each primary fiber have a thickening called X-thickening. In between X-thickenings there occurs Y-thickenings, X and Y-thickening are inter connected.

(B) Rootlet Rhizoplast : This is a conical bundle of protein fibers which arises from basal body to different directions. Rootlet have dark bands composed of ATPase.

(C) Shaft or Ciliary part : It is projecting hair like part of ciliary apparatus. Cilium is composed of 11 microtubules. (9 doublet + 2 singlet)



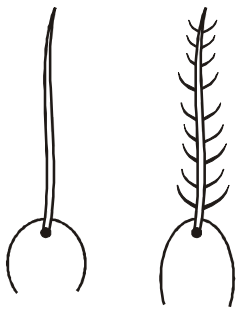
T.S. Of flagellum Showing characteristic 9+2 fibrilla organization

(i) Bundle of microtubules is called as axonema. Nine microtubules are peripheral and each composed of two small tubules i.e. A tubule with two arms and B-Tubules without arms.

(ii) Microtubules is consists of a contractile protein tubulin similar to actin of muscles.

(iii) Arms of A tubules consist of an enzymatic protein dynien similar to myosin of muscle cells. Dynien have ability of hydrolysis of ATP & liberates energy for ciliary movement.

(i) The central tubules are connected by bridges and is also enclosed by a central sheath, which is connected to one of the tubules of each peripheral doublets by radial spoke. Thus there are nine radial spokes. The peripheral doublets are also interconnected by linkers.



Flagellum and cillium

Type of Flagella :

Whiplash - When the lateral hair like structures absent.

Tinsel - When the flagella bears lateral hairs like structure (Flimmers)

Cilia and Flagella are similar in structure but some differences may observed-

S.No.	Cilia	Flagella
(i)	The cilia are small size (5-10mm)	Flagella are long (up to 150 mm)
(ii)	Number of cilia per cell is very large.	Few in number
(iii)	Cilia beat in a coordinated manner.	Flagella beats independently (Non coordinated manner)
(iv)	They take part in locomotion, attachment, feeding and sensation.	Flagella involved only in locomotion. May in sansation
(iii)	Tubulin protein	Flagellin protein

Function

(i) Both act as organs of locomotion (cilla may help aeration, feeding and circulatio of food also.)

(ii) Cilla of respiratory tract help in retaining the dust particles and prevent their entry into the lungs.

VACUOLE :

Vacuoles are discovered by Spallanzani. Vacuoles are generally absent in animal cells and meristematic cells in plants. Cell of permanent tissue in plants have well developed vacuoles. Vacuoles are surrounded by an unit membrane called tonoplast. Inside vacuole there is a nonliving fluid called cell sap. Cell sap contains water, salts, sugars, organic acids, Vitamins and waste materials of metabolism. Sometimes call sap have certain water soluble pigments like anthocyanin (blue or violot), anthoclor (yellow) etc. Beta cyanin in beet

root cells.

Functions of vacuole :

(i) Storehouse of nutrients.

(ii) Removes waste materials from cytoplasm.

(iii) Solutes is cell sap regulates osmotic relations of plant cell.

(iv) Pigments of cell sap provide different colouration to petals.

(v) Mature plant cell store water in vocuole.

MICROBODIES :

Microbodies are single membrane bound small spherical structures. Size vary from 0.3 – 1.5 μm. It includes following Peroxisome, Spherosome, Glyoxisome and Transosome.

Peroxisomes

It is also known as Uricosomes. Discovered by Rhodin and Tolbert. In animal cells, peroxisomes are concerned with Peroxide Metabolism. Peroxisomes contain several enzymes like urate oxidase, amino acid oxidase, peroxidase catalase. Catalase is the fastest acting enzyme known after corbonic anhydrase& it is a marker enzyme of peroxisomes. Peroxisomes are involved in β–oxidation of fatty acids. In plants, they occur in cells of green tissue and are concerned with photorespiration (glycolate pathway)

Spherosomes

Hanstein (1880) discovered them & named microsomes. Perner (1953) gave the name 'spherosome'. They occur in plant cells only. They are major site for lipid storage and synthesis. Cutin & Suberin are synthesized in it.

Glyoxysomes

Discovered by Beever in oil containing seeds, yeast cells, guard cells etc. Glyoxysomes occur only in plants especially in fatty seeds (castor seed), guard cells of stomata and unripe fruits. Glyoxysomes are considered as a highly specialised peroxisomes. Glyoxylic acid cycle takes place in glyoxysomes. This cycle convert fats into carbohydrates (Gluconeogenesis).

Transosome

Special microbodies in ovary cells of birds (concern with yolk formation). These covered by three unit membranes.

CYTOSKELETON :

Microtuibules, microfilaments and intermediate filaments are proteinaceous strectures to support the extensive system of membranes. They collectively form cytoskeleton of the cel. These prform a variety of functions. These are of three types :

(A) Microtubules (B) Microfilaments (C) Intermediate filaments

(A) Microtubules : The microtibules were first discovered by Robertis and Franchi.

The microtubules are found in the cytoplasmic matrix of all eukaryotic cells. They also occur in cilia, flagella, centrioles and basal bodies, mitotic apparatus etc. Prokaryotic cells lack microtubules.

The microtubules are hollow, unbramched cylinders generally about 25 nm in diameter with a hollow core of about 15 nm. The boundary of a microtubule is composed of 13 parallel protofilaments. Each protofilament is made up of α and β subunits of tubulin protein. The assembly and disassembly of microtubles requri GTP and Ca^{+2}.

Function

(i) These help in the spindle and astral ray formation during cell division.

(ii) These form the cytoskeletion of cilia and flagella.

(iii) These help in generating the shape, rigidity and form of the cell and cell mobility.

(iv) Microtubules help in the anaphasic movement of chromosomes.

(v) Microtubules help in the intracelluar transport of nutrients and inorganic ions.

(vi) Position of future cell plate is determined by microtubles.

(B) Microfilaments : (Paleviz et. al.) The microfilaments are found in eukaryotic cells. The microfilaments are solid, unbranched, rod-like fibrils of indenfinite length. They are mainly composed of a globular protein actin, but have filamentous protien myosin also. They form an ectensive network in the cytoplasm of cells and may be associated with plasme membrane.

Fuction

(i) The microfilaments provids support to PM.

(ii) These represent teh contractile system of the cell and are involved in cytoplasmic streaming and amoeboid movements.

(iii) Help in pseudopodia formation

(iv) These help in the formation of cleavage furrow during cell division.

(C) Intermediate Filaments : Non-contractile hollow filaments of acidic proteins. They are involved in formation of scaffolds for chromatin and in forming a basket around nucleus.

Function

Once intermediate filaments are formed, they are stable ans usually do not breakdown. Intermediate filaments provide mechanical strength to the cell & cell-cell junction.

CELL INCLUSIONS :

These are metabolically inctive, non-living substances present in the cell, also called **ergastic substances**. These can be organic or inorganic in nature and may get solubilized or remain unsoluble.

These include reserve materials, excretory or secretory products and minaral matter.

1. **Reserve materials :** Carboyhdrates (starch grains, glycogen granules), nitrogenous substances (aleurone grains), fats, oils are important reserve materials.
2. **Excretory products :** Several types like, alkaloids essential oils, gums, glycogen granules), nitrogenous, latex, organic acids, resins, tannins, etc., are major excretoty products occuring in the plants. Canada Balsam obtained from *Abies balsemia* is a type of Resin
3. **Mineral matter :** The crystals of silica, calcium carbonte and calcium oxalate are found in plant cells.

(a) Silica : Silica is deposited either on the wall or may remain embedded in surface of grasses (garden grass, wheat, oat, etc.).

(b) Calcium oxalate : In the leaves of Indian Rubber Plant (Ficus elastica), banyan (Ficus benghalalensis), numerous small calcium carbonate crystals are found accumulated on peg-like ingrowth of the multilayered epidermal cells, giveng an appearance of a bunch of grapes. This crytalline mass is called cystolith. Cells containing these are called lithocysts.

(c) Calcium oxalate : These are present in almost all the plant organs and are particularly common in storage organs, pith and cortical tissues. The shape of the crystals is variable. Needle-like or acicular crystals called raphildes are found in many aquatic palnts (Lemna, Eichhornia). These crystals may also group into star-like aggregates called sphaeraphides or druses e.g., Begonia, Colocasia, Chenopodium, etc.

ORGANIC EXCRETORY

(A) Nitrogenous

(i) **Alkaloids -** Nitrogenous waste materials, bitter in taste and insoluble in water. Alkaloids are of great medicinal importance.

(ii) **Glycosides** - Nitrogen containing degradation products of carbohydrates e.g. **Digitoxin** obtained from leaves of Fox glove ***(Digitalis purpurea)***. Digitoxin is used as heart stimulant.

(B) Non nitrogenous

(i) **Tannins -** Derivatives of glycosides, soluble in water. Tannins are bitter in taste. These occur more in unripe fruits. Tea leaves have 18% tannins, **kattha** obtained from **heart wood** of **Acacia catechu** have high concentration of tannins.

(ii) **Resin** - Oxidation products of essential oils. These occur as viscous water insoluble fluid inside plants. Formation of resins takes place inside special ducts called resin ducts. Resins commonly occurs in Pines.

(iii) **Gums** - Water soluble degradation products of plant cell wall.

(a) **Gum arabic** - obtained from **Acacia senegal** and **A.arabica**

(b) **Guar gum** - Obtained from pods of **Cyamopsis tetragonoloba**

(i) **Bengal Kino** - Stem of **Butea monosperma**

(iv) **Latex -** Composition of latex vary in different plants. It may contain sugars, starch gains, amino-acids, minerals, alkaloids, toxins, resins, gums, oils etc. Latex is produced in laticiferous tissue composed of either latex cells or latex vessels. Latex eg. **Heavea brasiliensis** serves the function of protection, healing wounds, nutrition etc.

(v) Plants which provide latex for **biofuel** are called **petrocrops**. (first studies by calvin) **Jatropa**, Calotropis, Euphorbia etc.

(vi) **Essential oils -** Highly aromatic water soluble volatile organic compounds. Chemically they are terpens. They perform a number of functions : attract insects, repel animals and act as antiseptic substance e.g. Rose oil, sandal wood oil, Jasmine oil, Khus-Khus oil, camphor (Cinnamomum camphora), Lemon glass oil, parasosaoil, Eucalyptus oil etc.

RESERVE MATERIALS

(A) Hemicellulose - Hemicellulose is a part of cell wall, Shining white colour of **Date** and **coconut** endosperm is due to high conc. of hemicellulose.

(i) Howerver hemicellulose occurs as stored food in **Ivory palm (Phytelophas)**.

(ii) This hemicellulose is used to manufacture **artificial ivory** and **billiard balls**.

(B) Inulin - Inulin is a soluble homopolysaccharide composed of fructose units. It occurs as stored food in roots of **Dahalia** and **Artichoke**.

SECRETORY MATERIAL

These occur in special glands and sacs. These includes enzymes, colouring materials, Nectar, etc.

NUCLEUS :

Credit of discovery goes to **Robert Brown**. Nucleus is double membrane bound dense protoplasmic body which controls all cellular metabolism and encloses the genetic information of cell. If the nucleus of a cell is, experimentally removed then unicellular organism will die after some time. Thus nucleus is very important and largest component of cells.

Generally eukaryotic cell contain at least one nucleus but nucleus is absent in mature phloem sieve tube elements and mature RBCs of mammals. (exceptionly nucleus is present in RBCs of camal & lama). Dikaryotic (Paramecium) and multikaryotic cells are also known.

Structure

(i) Nuclear membrane or nuclear envelope or karyotheca.

(ii) Nucleoplasm/Karyoplasm/Karyolymph.

(iii) Chromatin net

(iv) Nucleolus/little nucleus/Ribosome factory

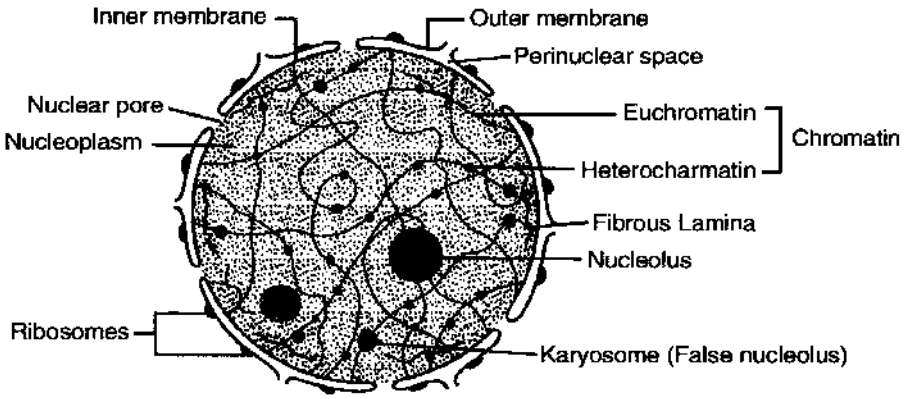


Fig. Ultrastructure of interphase nucleus

(A) Nuclear membrane :- Nucleus is surrounded by two unit membranes. Space (150 to 300Å) between two membranes is known as **perinuclear space.** Outer membrane, of nucleus may connected with **E.R.** at several places and ribosome also may found on it.

Nuclear membrane is perforated by minute **nuclear pores** of size, 300 to 1000Å diameter. Each nuclear pore is guarded by a **octagonal** discoid structure of **nucleoplasmin protein** this structure is called as **annulus** or **Bleb.** (Annulus + Pore = Nuclear Pore complex). The inner side of inner nuclear membrane is lined by **nuclear lamina**. This structure is formed by filaments of **lamin protein**.

(B) Nucleoplasm or Karyolymph :- (Term by **Strasburger** 1882)

Nucleoplasm or Nuclear sap is a ground substance of nucleus which is a complex colloidal formed of a number of chemicals like nucleotides, nucleosides, ATPs, proteins and enzymes of RNA and DNA polymerases, endonucleases, minerals, (Ca^{++}, Mg^{++}) etc. Nucleoplasm contain high concentration of Nucelotides in the form of triphosphate. Nucleoplasm also have enzymes for Glycolysis, thus nucleus may obtain energy by glycolysis. **Chromatin net** and **nucleolus** are embeded in nucleoplasm. Nucleoplasm provides site for process of transcription.

(C) Chromatin net : - (Term given by **Flemming**)

Chemically chromatin consists of DNA (31%), RNA (2-5%), Histone protein (36%) and non histone (28 %). On the basis of relative amount of arginine and lysin there are five type of Histone protein. (H_2A, H_2B, H_3,H_4, H_1)

Chromatin net has two type of chromatins (by Emil Heitz)

(a) Euchromatin (b) Heterochromatin

Type of Heterochromatin :

Constitutive heterochromatin :- Occurs in all cells in all stages e.g. centromeric region.

Facultative heterochromatin :- Occurs in some cells in some stages. e.g., Barr body.

Barr body in female cell is a facultative heterochromatic structure. (By M.Barr)

Number of Barr body in nucleus of an individual is number of (X-chromosome) minus one.

Difference between Euchromatin and Heterochromatin :

S.No.	Euchromatin	Heterochromatin
(i)	Consist of thin, extended, **light stained** part of chromatin.	Consists of thick coild, condensed part of Chromatin and **dark stained**.
(ii)	Genetically **more active** chromatin	**Less active** or inert chromatin.
(iii)	Lies at **centre of nucleus**.	Lies **near the nuclear membrane**
(iv)	Less histone protein	More histone protein
(v)	Replicate in early s-phase	Replicate in late s-phase
(iv)	DNA ⟶ mRNA	DNA ⟶ rRNA, tRNA

Note :-

(i) Heterochromatin takes light stain during cell division stages (M-phase) & takes dark stain during interphase.

(ii) At some place hetrochromatin form thick, dark dense granule called Karyosome / chromcentre / False nucleoli.

(D) Nucleolus :- Discovered by **Fontana** and Term by **Bowman**.

Nucleolus is naked or **membraneless**, attached to chromatin (or chromosomes) of specific site called **Nucleolar organiser** region/NOR. Calcium is essential for maintenance of nucleolus. Nucleolus disappears during Prophase and reappears in telophase.

Chemically nucleolus is made up of

Proteins 85%

RNA 10%

DNA 5%

(Ultrastructure of nucleolus) :

(i) Fibrillar region :- This is central fibrous part of nucleolus, which is consist of mainly rDNA and proteins. (Nucleonema)

(ii) Granular region :- This is peripheral granular part of nucleolus which is consist of rRNA and proteins.

(iii) Amorphous matrix or pars amorpha :- This is proteinaceous ground matrix, which contains both fibrous and granulus.

Functions of nucleolus

Ribosome formation is the chief role of nucleolus, thus is called as **Ribosome factory of cell**, the proteins of ribosome are synthesised in cytoplasm but it diffused in to nucleus and reach at nucleolus. Here rRNA and ribosomal proteins are assembled to form ribosomes which move to cytoplasm through nuclear pores.

Functions of Nucleus

(i) **Genetic information :-** Nucleus contains genetic information in its chromatin. (store house of genetic material)

(ii) **Transmission of genetic information :-** Nucleus takes part in transmission of genetical information from parent cell to daughter cell or the one generation to next.

(iii) **In cell-division :-** Division of nucleus is pre-requisite to cell division.

(iv) **Control of metabolism :-** Nucleus controls metabolism of cell by sending m-RNA in cytosol (Basically biomolecule DNA controls cellular activities through directing synthesis of enzyme).

(v) **Variations :-** Variation develope due to change in genetic material of nucleus. (Evolutionary role).

CHROMOSOMES :

First of all, chromosomes was observed by **Hofmeister (1818)** and Karl Nageli in pollen mother cells (PMC) of Tradescantia. Credit of discover of chromosomes goes to Strasburger. Term "Chromosome" was proposed by Waldeyer in 1889. Term 'Chromatin, was suggested by Flemming.

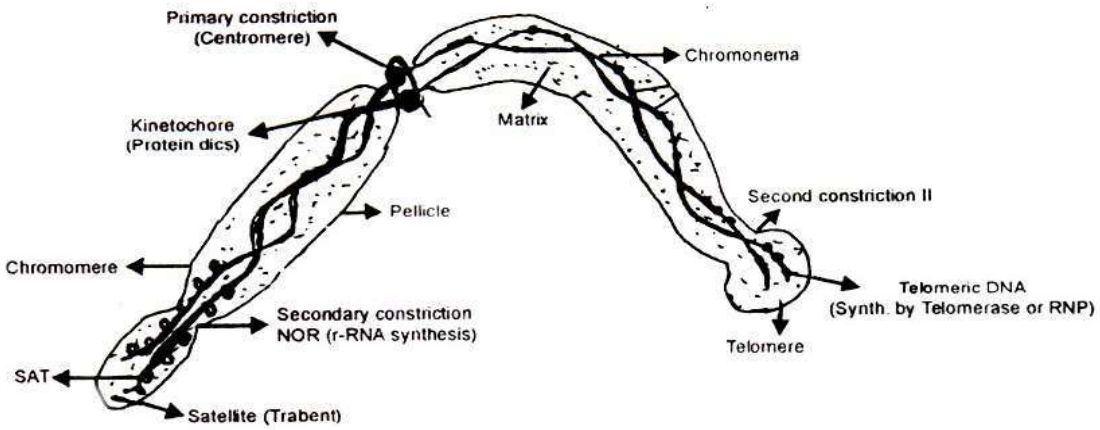
Gametes of all diploid organisms contain only one of each chromsome. The number of chromosomes in a gamete is called **"Genome"** or haploid chromosome. A complete set (n) of chromosome inherited as a unit from one parent is known as genome.

Structure of chromosome

(i) **Pellicle :-** This is outermost, thin proteinaceous covering or sheath of chromosome.

(ii) **Matrix :-** Ground substance of chromosome, which has different type of enzymes, minerals, water, proteins.

(iii) **Chromonema :-** Term given by **Vejdovsky.** This is an important, gentical, highly coiled thread, throughout the length of a chromosome or chromatid. Each chromonemata is consist of a single long thread of DNA associated with histone. Sometimes bead like structure are seen on chromonema fibres, which are called as chromomeres. Singular form of chromonema is chromonemata.

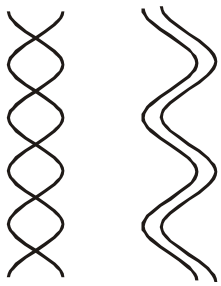


A schematic diagrammatic representation of chromosome

Coiling in chromonema

(a) **Plectonemic-coiling :-** When both the chromonema are inter twined and can not be separated easily this coiling is called Plectonemic-coiling. It apper in mitotic prophase chromosomes.

(b) **Paranemic coiling :-** When both chromonema can be easily seperable. In **meiotic** prophase.


Plectonemic Paranemic

(iv) **Centromere/Kinetochore :-** (Primary constriction)

Each chromosome (at metaphase) is consist of two half chromosome or two chromatids. Both the chromatids of a chromosome are joined or connected by a structure called Centromere. At this point or centromere two protein discs are present which is called Kinetochore. Centromeric DNA is called as alphoid DNA (Hetrochromatic).

(v) **Chromatid :-** At metaphase stage each chromosome is consist of two cylindrical structures called Chromatids. Both sister chromatids or longitudinal half chromatids (in Anaphase or Telophase) or two chromatid. (as in metaphase)

(vi) **Secondary constriction :** Besides primary constrictions one or two, other constriciton may also occurs on some chromosome, which are known as secondary constriction. Secondary constriction is also known as **NOR (Nucleolar organiser region)** (13,14,15,21,22 chromosomes in human)

(viii) **Satellite / Trabent**

(a) Found in chromosome in which secondary constriction is found.

(b) It is small spherical part of chromosome distal to secondary constriction.

(c) Chromosome with satellite is called **SAT chromosomes**.

(ix) **Telomere**

(a) Tip of chromosome is known as **telomere**. (rich in **guanine** base) show polarity.

(b) Perform two important function

It prevent ends of two chromosomes from sticking with each other. (fusing of chromosome)

Help chromosome in attachment to nuclear envelope.

(c) Enzyme **telomerase** present in Telomere which is a type of Ribozyme.

Type of Chromosome on basis of position of centromere

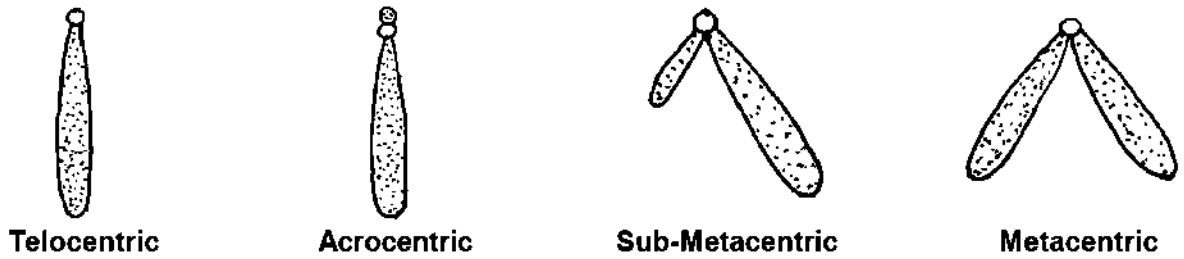
(i) **Metacentric** - Centromere in mid two arms are equal so chromosome is **v-shaped**.

(ii) **Submetacentric** - Centromere slightly away from mid so chromosome is **L-shaped**.

(iii) **Acrocentric** - Centromere occupies sub terminal position, so one arm is very long whereas other arm is extremely short. Acrocentric chromosome is **J-shaped**. [Arm ratio maximum]

(iv) **Telocentric** - Centromere occupies terminal most position so chromosome is single armed.

Telocentric is **i-shaped**.



Types of Chromosomes

Chromosome number in some organisms :

Animals	**2n**	**n**
Ascaris megalocephala (Round worm)	2	1
Drosophila melanogaster (Fruit fly)	8	4
Chimpanzee/Gorilla	48	24
Homo sapiens	46	23
Aulocantha (a protozoan)	1600	800
Plants		
Mucor hemelis (fungi)	2	1
Haplopappus gracilis (Familiy compositae) & Brachycome plant	4	2
Takakia (Bryophyta)	4	2
Pisum sativum (Pea)	14	7
Maize (Zea mays)	20	10
Wheat (Triticum)	42	21
Ophioglossum reticulatum (Pteridophyta)	1262	631

Special type of Chromosome (Giant Chromosome)

(A) Lampbrush Chromosome

(i) Lampbrush chromosome was first observed by Flemming (1882) in amphibian oocyte at Diplotene stage of cell divition.

(ii) A detail study was made by J. Ruckert (1892) in the oocyte of sharks.

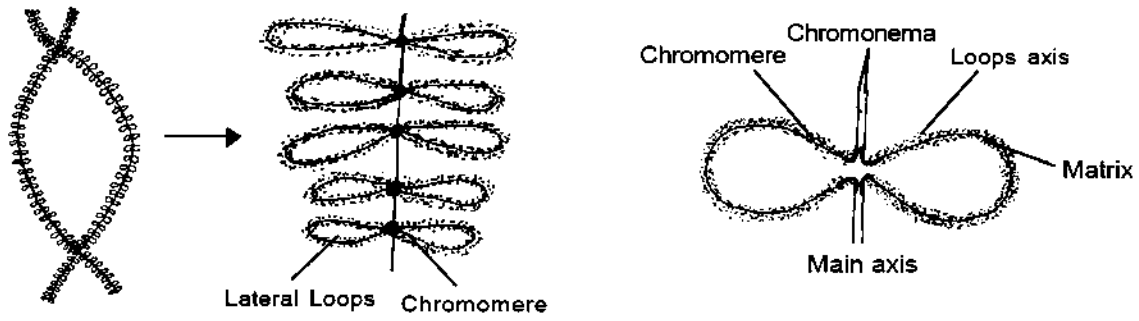
(iii) Found in the oocytes of insect, sharks, amphibian, reptiles and birds which produce yolky eggs.

(iv) Lampbrush chromosome composed of main axis which possess series of chromomere.

(v) Main axis formed of DNA and Protein.

(vi) Main axis give rise to lateral loops (composed of DNA). Lateral loops axis remain surrounded by matrix. Matrix is composed of RNA and Protein.

(vii) It is concerned with protein synthesis, yolk formation (vitellogenesis) and RNA synthesis.



Lamp brush chromosome

(B) Polytene chromosome / Salivary gland chromosome

(i) It was discovered by Balbiani in 1881.

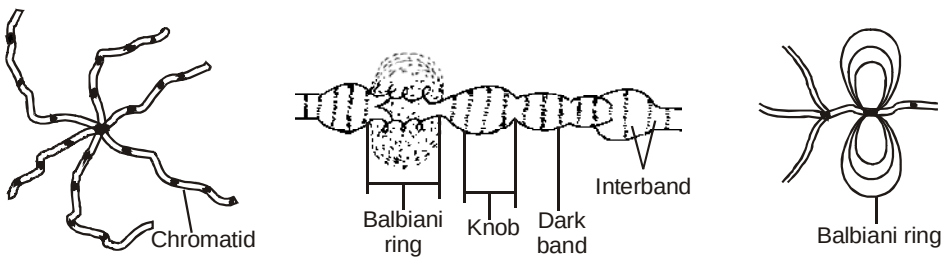
(ii) It is found in salivary gland of chironomous larva, Salivary gland, malphigian tubule, epithelial lining of drosophila, salivary glands of certain Diptera.

(iii) The larger size of chromosome is due to the presence of numerous chromatids. so called polytene (Many stranded) chromosome.

(iv) Numerous chromatids (512 to 1000) presence is because of repeted division of chromosome without cytoplasmic division such division is called endomitosis or endoreduplication [repeated replication of DNA].

(v) Possess two types of transverse bands, dark band, which is Feulgen positive and posses more DNA, Light band is Feulgen negative which posses more RNA.

(vi) **Balbiani ring / puffs :** The bands get enlarged at certain place and because of uncoiling of chromonemata and form swelling called puffs or Balbiani ring. Balbiani rings are concerned with synthesis of mRNA and protein.



Polytene chromosome

(vii) Ecdyson hormone of insect stimulates formation of balbiani ring.

(viii) Polytene chromosome is related with **metamorphosis of an insect**.

(C) Supernumerary / B-chromosome / Accessory chromosome

(i) In certain plants and animal one or more additional chromosome were observed in addition to the normal number called supranumerary chromosome (named by D.Jones).

(ii) It is genetically inert, Heterochromatic and small sized.

(iii) It is present in the nucleus.

(iv) Its presence does not effect an organism phenotypically if its number is high **they reduce the fertility and vigour**.

(v) **Wilson** in 1905 discovered it in **metapodium insect**.

(vi) Increase ecological adaptation to organism.

Karyotype Analysis

All the membrane of a species of a plant or the animal are characterised by a set of chromosomes, which have certain constant characterstics including the number of chromosomes, relative size, position of centromere, length of the arm, secondary constriction and satellites. All such features by which a particular set of chromosome can be identified is called karyotype of a species. A diagrammatic representation of karyotype (morphological) os a species is called idiogram, where the choromosome of a diplois det of an organism are ordereed in a series of decreasing size.

There are two basic types of karyotype :

1. **Symmetric Karyotype :** A karyotype showing small differences between smallest and largest chromosomes and have comparatively more metacentic chromosome is called symmetric karyotypes. This type of karyotype is considered to be relatively primitive feature.
2. **Asymmetric Karyotype :** A karyotype showing large differences between smallest and largest chromosomes and have comparatively fewer metacentic chromosome is called asymmetric karyotypes. This type of karyotype is considered to be relatively advanced feature.

Uses of Karyotyping or Karyotype Analysis

(i) After comparing the karyotypes of different froups of organisms, sometimes similarities are observed in karyotypes, which are presumed to represent evolutionary relationships.

(ii) Primitive or advanced features of an organism can also be suggested by karyotype.

(iii) Genetic disorders occurring due to chromosomal abnormalities can be detected.

Certain specific terms

(i) Idiogram : Karyotype of a species is representes with the help of a diagram called idiogram (pictorial presentation), where the chromosomes are arranged in descending order of size.

(ii) Genome : Genome is defined as a haploid set of chromosomes.

(iii) Plasmon : Hereditary factors or genus present in cytoplasm are called 'plasmon'.

Genus present in plastids are called plastogenes and genes present in mitochondria are called chondriogenes.

Banding technique

It is used to study of the specific pattern of band and interbands on chromosome. This include the use of **flurochromes** (Flurescent dyes).

1. **Q-banding :** It is obtained when chromosomes are stained with **quinacrine mustard.** It stains **A-T rich** areas (developed by **casperson** for Y chromosomes).
2. **C-banding :** It is used to stain constitutive **heterochromatin**, usually in **centromeric** region of the chromosome.
3. **G-banding :** Chromosomes are stained with ***Giemsa***. It stains **sulphur rich** protein parts.

   A variety of different bands are obtained by the modification of Q-banding and G-banding like C, T and N-bands. Q, C, G and R banding used for animal karyotypes while **C and N banding** used in plants.
4. **R-banding :** The process involved incubation of the chromosomes in a buffer at high temperature followed by use of Giemsa stain. This brings about the visualization of sulphur deficient region of chromosomes thus named as reverse giemsa.

CELL DIVISION

INTRODUCTION :

(i) **W.Flemming** at first studied mitotic division in **Salamander**.

(ii) Strasburger discovered meiosis.

(iii) Strasburger gave name prophase, metaphase, anaphase, telophase.

(iv) Meiosis name was given by **Farmer** and **Moore**.

(v) It is important for development, regeneration and reproduction.

(vi) Hormone cytokinin increases rate of cell division.

TYPES OF DIVISION :

(A) Amitosis **(B) Mitosis** **(C) Meiosis**

(A) Amitosis (No spindle, No chromosome) :

(i) It is the simplest mode of cell division at first described by **REMAK** (1841).

(ii) This type of division starts with elongation of nucleus.

(iii) Nucleus becomes dumbbell shaped, and get divided into two daughter nucleus.

(iv) Nucleur division is followed by the division of cytoplasm its results in formation of two daughter cells.

(v) In this division, **no spindle formation** and **no distinct chromosome** formation occurs. Nuclear evelope remains intact. The daughter cells are approximately the two equal halves of a parental cell. e.g. PPLO, Blue-green algae, Bacteria and Eukaryotic cells. Examples are yeast-budding occurs by amitosis.

(vi) Ameoba multiple fission occurs by amitosis.

(vii) Paramecium division of meganucleus.

(viii) Mammals-growth of foetal membranes (amnion, chorion, allantois, yolk sac)

(ix) Division of mitochondria and chloroplasts.

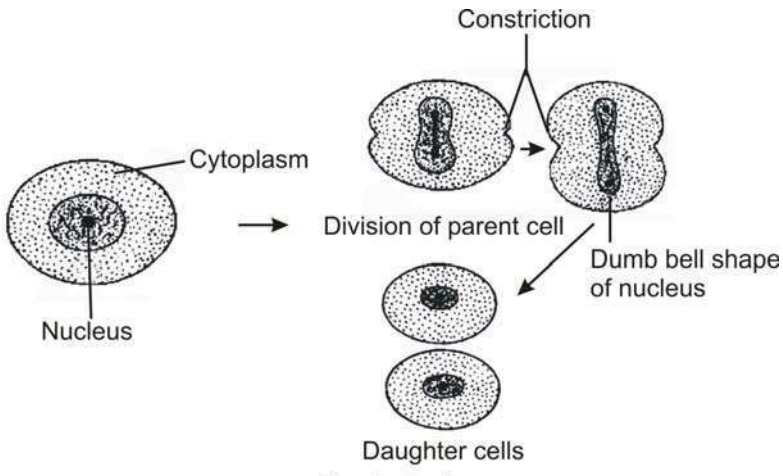


Fig. Amitosis

(B) MITOSIS :

(i) Mitosis was discovered by **Flemming** in 1879 in animal cell and in plants cells by **Strasburger** in 1875.

(ii) Mitosis is a cell division in which parent cell divide to form two daughter cell, in which **number of chromosome**, **amount of DNA**, number and types of gene are equal to parent cell.

(iii) It occurs in **somatic cell (n, 2n, polyploid any)**.

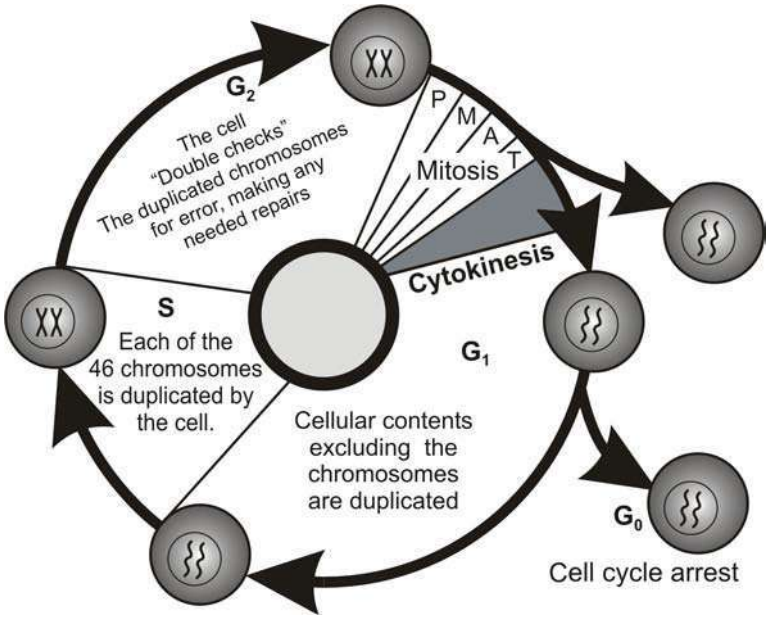
(iv) It is called **indirect division.**

(v) Mitosis results in increase in number of cells in the body.

Mitosis cell division can be divided into two phases.

1. Interphase

2. Division phase or M phase



1. Interphase / Cell cycle

(i) Interphase is phase between two cell division. group into three sub stages G_1 S and G_2.

(ii) In this phase cell prepares itself for division so, called **preparatory phase**.

(iii) It is longest phase of cell cycle. It get completed approx. in 19-22 hours.

(iv) It is also called **resting phase**. (previously)

(v) In this phase, cell remain **metabolically extremely active**.

(vi) In this phase synthesis of protein, enzyme, DNA and RNA takes place

(vii) Centriole duplicates into two. Thus two centrioles are formed.

(viii) Cell cycle can remain **arrested only G_1 phase. Then G_1 is called as G_0 phase. G_0 phase found in** cells of permanent tissue.

(ix) **Cell cycle is running** by a group of special proteins "**Cyclins and Cdks** (MPF), (Nurse, T-Hunt & Hartmann **2001** studies on sacchromyces (**Baker yeast**))

1. **Three sub stages of interphase :**
2. **G_1 phase [longest phase 12 - 15 hr]**

(i) Cell growth occurs in this phase.

(ii) Mitochondria, Chloroplasts (plants), Lysosomes, Ribosome, Endoplasmic Reticulum Golgi Complex, Vacuoles etc. are produced.

(iii) Structural and functional proteins are formed.

(iv) Nucleolus produces rRNA, mRNA and tRNA. (RNA synthesis may inhibited by **actinomycin**).

(v) **Metabolic rate** of the cell becomes **very high**.

(vi) It may be called **pre DNA synthesis phase**.

(vii) It is known as post mitotic phase.

3. **S-phase [6 - 10 hr)**

(i) **Replication of DNA takes place**. (DNA get doubled)

(ii) Protein molecules called **histones** are synthesized that cover each strand of DNA.

(iii) **Centriole** replicate is late **S-phase**

4. **G_2-phase [3 - 12 hr]**

(i) **Tubulin protein synthesis** start for spindle formation.

(ii) This phase may be called **post DNA synthesis** phase.

(iii) Cell division involves enormous expenditure of energy thus cell **stores ATP** in G_2 phase

(iv) After G_2 phase cell enters in division or M-phase

CAUSE OF MITOSIS :

(i) **Karyo plasm theory :** Hertwig, says that mitosis occurs due to disturbance in karyoplasmic index (KI) of cell.

$$KI = \frac{V_n}{V_c - V_n}$$

Here V_n = Volume of nucleus

V_c = Volume of cell

$V_c - V_n$ = Volume of cytoplasm

$$KI \propto \frac{1}{\text{Volume of cytoplasm}}$$

Small cell → less cytoplasm → High KI → No division it show nucleus control the activity of cytoplasm and no division occur.

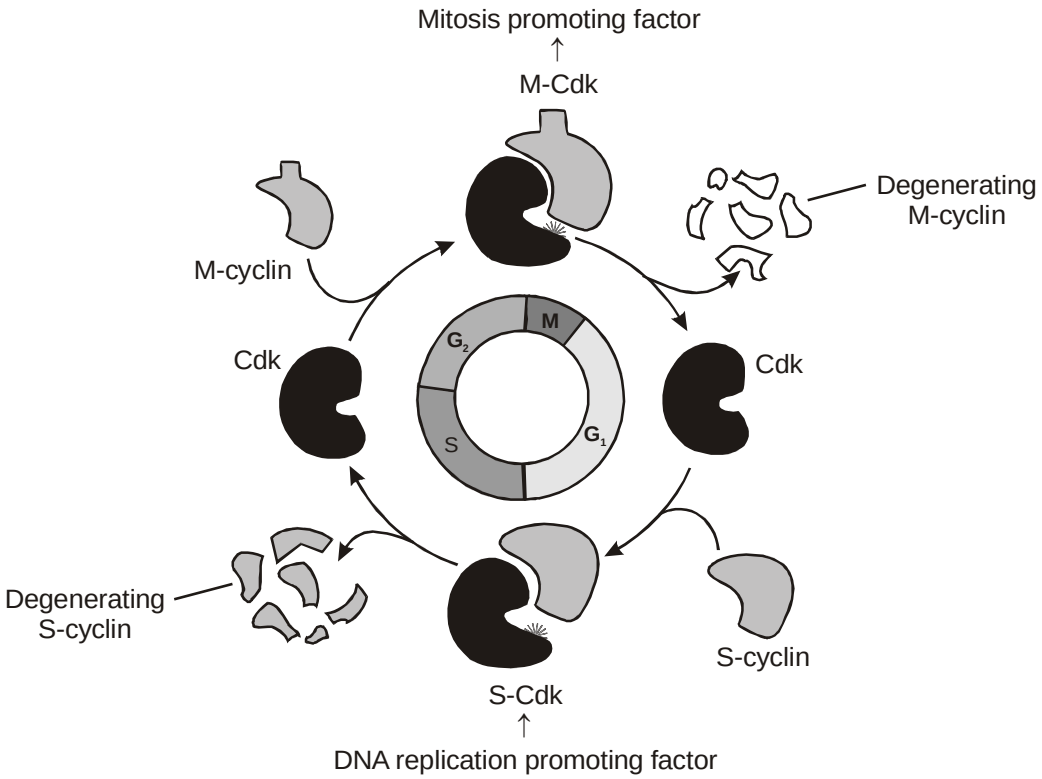
Large cell → More cytoplasm → Low KI → Division occur. It cause to loose control of nucleus on cytoplasmic metabolism so large cell divide into two

(ii) **Surface volume Ratio :** It says that when cell grows in size its volume increases but surface area remain less so it affect metabolic activity of cell which result into division of cell.

Note : Above two hypothesis regarding the division of cell are completely discarded because new concept give the genetic control of cell division.

CELL DIVISION CONTROL :

(i) A cell reproduces by performing an orderly set sequences of irreversible events, In which it duplicates It's contents & then divides into two, these events are known as cell cycle.



(ii) Molecular biologists, identifying the biomolecules, that control or drive the cell cycle, many biologists, some of whom worked with **invertebrate** or **frog egg's** others with **yeast** cell or cell culture.

(iii) Scientists concluded that the activity of enzymes, known as **cyclin dependant kinases. (Cdk's)** regulates the cell cycle.

(iv) They are activated when they combined with key protein called **cyclin**.

(v) Kinase is an **enzyme** that removes a phosphate group from ATP & add to another protein.

(vi) At some check points $\begin{pmatrix} G_1 \to S \\ G_2 \to M \end{pmatrix}$ a **kinase** enzyme combines with **cyclin** & this moves the cell cycle forwardly.

(vii) **S-kinase** is capable of starting the replication of DNA after it combined with **S-cyclin (G_1 - Cyclin)**. After some time S-cyclin is destroyed & S-kinase is no longer active.

(viii) **M-kinase** is capable of turning on mitosis after it has bind with **M-cyclin**, **(G_2-cyclin)**.

2. Division Phase

In this phase nuclear and cytoplasmic division takes place.

A. Karyokinesis- Nuclear division.

B. Cytokinesis-Cytoplasmic division.

A. **Karyokinesis**

It is divided into four phases –

(a) Prophase **(b)** Metaphase **(c)** Anaphase **(d)** Telophase

(a) Prophase

(i) It is the **longest phase** of karyokinesis.

(ii) Chromosomes appear as pairs of chromatids joined by centromere (chromatin condensation start).

(iii) The nuclear membrane disintegrate and disappear into the cytoplasm.

(iv) **Nucleolus start disappearing**.

(v) Each centrioles Separates and start to move towards the opposite pole of the cell.

(vi) Around each centriole **astral rays** are formed in the cytoplasm. due to (**gelation of protein**).

(vii) **Anastral mitosis -** In plants, centrioles are absent and no asters are formed. Mitosis without asters is known as anastral mitosis.

(viii) **Amphiastral Mitosis -** In animals, the asters are present and the mitosis is described as amphiastral, or astral mitosis.

(b) Metaphase

(i) The chromosome arrange at the **equatorial plane**.

(ii) Each centromere is joined by two **chromosomal fibre or kinetochore spindle** one from each pole.

(iii) Some other fibres of the spindle extend from one pole to the other pole. These are known as **continous fibres** or **non kinetochore spindle**

(iv) Centromere lies at equator and arms remain directed towards **poles**.

(v) Chromosomal fibre have polarity i.e. + end at equator and – end at the pole.

(vi) In metaphase each chromosome **splits lengthwise upto the centromere** (division of matrix of chromosome). Thus replicated chromatids clearly visible at metaphase stage.

(c) Anaphase (Smallest stage)

(i) The fibres which occur in between the chromosomes are called **interzonal/non kinetochore spindle fibres.**

(ii) In early anaphase interzonal fibres (small and contracted) **appears at equator** of cell.

(iii) **Centromere of each chromosome splits lengthwise** (**division of centromere**).

(iv) Number of chromosome becomes **double** in cell during mitotic anaphase.

(v) Interzonal fibres **expands** and they push chromosomes towards the oppsite poles.**(Pushing)**

(vi) Chromosomal fibres **contract** and they pull chromosome towards opposite poles. **(Pulling)**

(vii) By **pulling and pushing** mechanism chromosomes rapidily move towards the opposite poles.

(viii) Approximately 30 ATP are required to carry a chromosome to pole. Chromosomes reach at poles in late anaphase.

(ix) At this phase cytokinesis process starts.

(d) Telophase (Reverse prophase)

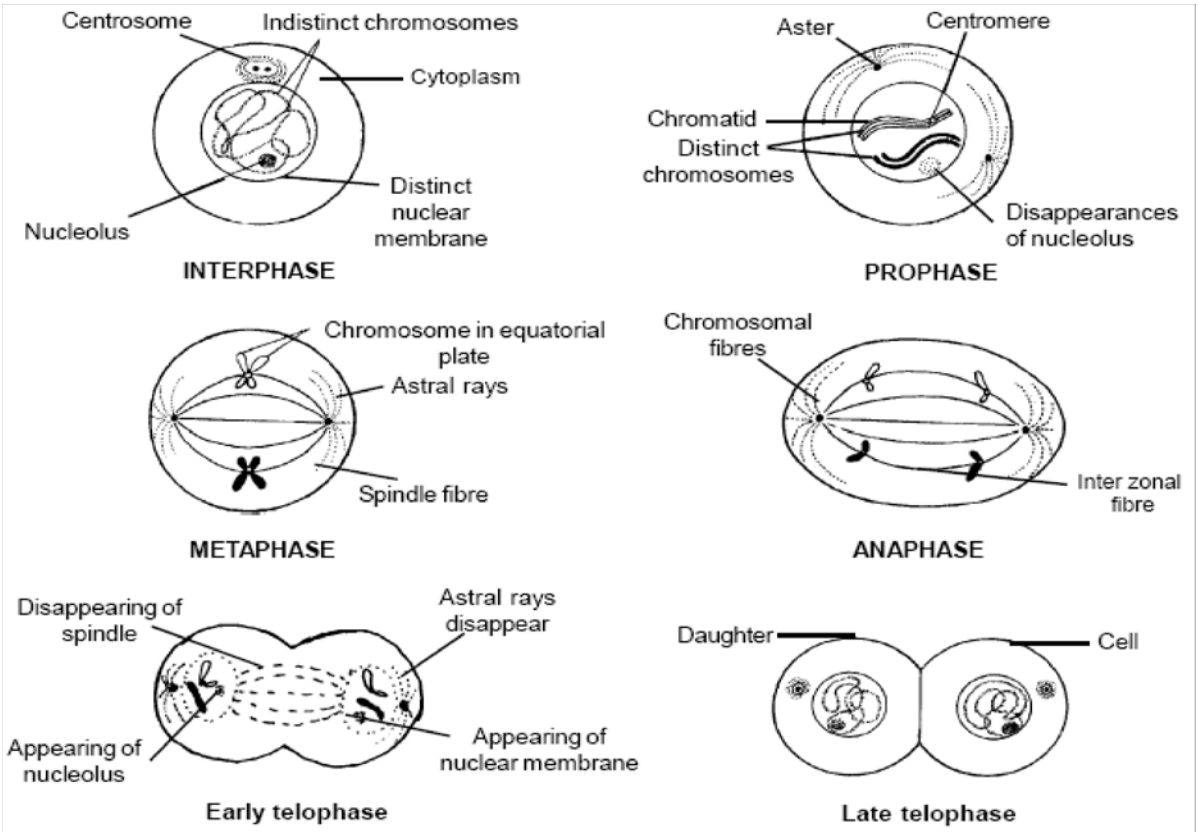
(i) The daughter chromosomes with their **centromere at the poles** begin to uncoil and lengthen. They aggregate together to form a mass at the poles.

(ii) The **nucleolus reappear**.

(iii) New nuclear membrane develops around the chromosomes from the elements of the **E.R.**

(iv) Spindle and astral fibre are absorbed in the cytoplasm.

(v) Thus two daughter nuclei are formed and they have the appearance of the interphase nuclei.



B. **Cytokinesis**

(i) After nuclear division (Karyokinesis) cytoplasm get divided into two (more or less) equal parts, this results in formation of two daughter cells from a single parent cell.

(ii) The cytoplasmic division differs in animal and plant cells.

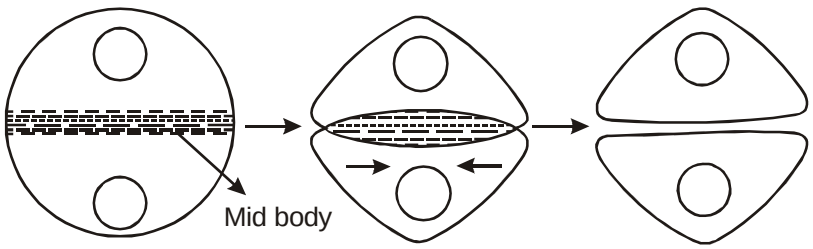
(iii) Cytokinesis starts in **late anaphase**.

(iv) In **animals** cytokinesis occurs by **constriction & furrow formation**. Microtubules and microfilaments arrange on equator to form midbody.

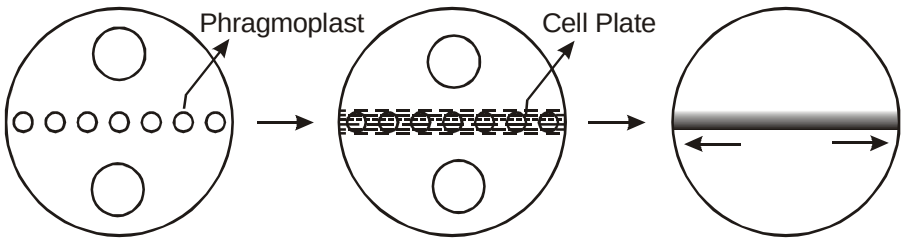
(v) Contraction occurs in midbody and Plasma membrane starts constricting to form **contratile** ring.

(vi) Thus a furrow forms form the out side to inside in cell. Furrow deepens continuosly and ultimately a cell divides into two doughter cells.

(vii) In animals cytokinesis occurs in **centripetal order**.



(viii) **Cytokinesis in plants :** Takes place by **cell plate formation** because constriction is not possible due to presence of the rigid cell wall.



(ix) Many golgi vesicles arrange themselves on equator to form **phragmoplast**. ER and Fragmets of spindle fibres also collect on equator. Collectively this structure is known as **Cell plate**.

(x) Golgi vesicles secrete calcium and magnesium pectate. Further cell plate is modified into middle lamella.

(xi) In plants, cytokinesis occurs in centrifugal order (cell plate formation is form centre to periphery).

SIGNIFICANCE OF MITOSIS :

(A) Identical gene composition

(i) **In mitotic cell division daughter cell contain the same number of chromosomes as the parent cell**.

(ii) The daughter cells carry the same hereditary information as is in the parental cells.

(iii) There is no variation in genetic information.

(iv) It gives a genetic stability within a population.

(B) Growth

Mitotic cells division is responsible for growth in an organism.

(C) Cell Replacement

Mitotic cell division is responsible for the replacement of lost cells , healing of wound.

(D) Regeneration and Asexual reproduction

In many lower animals mitotic cell division is responsible for regeneration and asexual reproduction.

MODIFICATION OF MITOSIS :

(i) **Cryptomitosis of Promitosis :-** It is a primitive type of mitosis. In this type of divsion, nuclear membrane **does not disappear** but remain intact throughout the division.

All the changes of karyokinesis

Occurs inside nucleus even the formation of spindle **(Called as intranuclear spindle)**. eg. some protozoans (Amoeba) during Binary fission.

(ii) **Dinomitosis :-** Dinomitosis founds in **dinofilagellates**, which are **mesokaryotes**. In mesokaryotic cells histones are absent. Because of this, the **chromosomes fail to condense properly** and hence are not distinctly visible during cell division.

Nuclear membrane persists throughout the cell division and so spindle formed is intranuclear type.

(iii) **Free nuclear division :-** Karyokinesis is not followed by cytokinesis so such divisions lead to **coenocytic** condition. eg. endosperm, fungi of phycomycetes group.

(iv) **Endomitosis :-** This is **duplication of chromosomes** without division of nucleus. Endomitosis leads to **polyploidy**. i.e. Increase in number of sets of chromosome.

(v) Colchicine induces polyploidy in plants. Colchicine is a mitotic poison as it arrest the formation and arrangement of spindle fibres.

(vi) **Endoreduplication :-** Endoreduplication is a modification of endomitosis. The **polytene** chromosomes form by process of **endorduplication**. In endoreduplication, the **chromatids (DNA) replicate** but do not get seprated. This process is also known as **polyteny**.

(vii) **Mustard gas and Ribonucleases** are also mitotic poisons.

MEIOSIS (TERM BY FARMER & MOORE) :

(i) It occurs in **male and female germ cells**, such cells are called **meiocytes**.

(ii) In this type of division parent cell **divides to produce four daughter cell (genetically different)**.

(iii) It is a reduction division in which the number of chromosomes (genetic matter) is reduced to half i.e. diploid number (2n) becomes haploid (n).

(iv) It is responsible for transmission of hereditary information from generation to generation.

It is divided into two main phases.

(a) **Meiosis I :** Heterotypic division or reduction division. It leads to reduction in chromosome numbers. Division of chromosome does not occurs in meiosis-I and only segregation of homologus chromosomes takes place.

(b) **Meiosis II :** Homotypic division or equational division. It does not leads to any change in chromosome number. Meiosis II is just like mitosis. Division of centromere occur in meiosis II. In Meiosis, division of nucleus takes place twice but division of chromosome occurs only once.

(A) Prophase - I (Longest and complex step of meiosis)

It is divided in five sub - stages :

(a) Leptotene **(b)** Zygotene **(c)** Pachytene

(d) Diplotene **(e)** Diakinesis

(a) Leptotene

(i) The volume of the nucleus is increased and chromatin condense to from chromosome.

(ii) Chromosomes becomes distinct, long and uncoiled. (**Longest and Thinest**)

(iii) On chromosomes contain a series of beaded structure appear called **chromomere**.

(iv) The centriole divides into two.

(v) The ends of all chromosomes are directed **towards cetriole** on one side of nucleus forming **bouquet**.

(vi) At this stage orgamism shows a peculiar type of orientation of chrmosomes - **animals** show **bouquet** type while **plants synizesis** type.

(b) Zygotenes

(i) Two **homologous chromosomes** approach each other and being to pair, this pairing is called **synapsis**. Each pair consists of a maternal chromosomes (the chromosomes of the mother) and a paternal chromosomes (the chromosomes of the father). The pair so formed are known as **bivalents**.

(ii) The chromosomes become thicker and shorter.

(iii) There develops a structure in between homologous chromosomes, Which is termed as ***synaptonemal complex***. Synaptonemal complex is composed of three thick lines of, DNA and proteins.

(iv) According to **Mosses (1956)** synaptonemal complex helps in pairing and chiasmata formation.

(v) About **0.3% DNA** is synthesized in Zygotene substage.This DNA is used in chromosome pairing or synapsis. (Zyg. DNA)

(vi) The centrioles move to the opposite poless.

(c) Pachytene

(i) Each individual chromosome of each **bivalent** begins to **split longitudinally** into two similar chromatids. As a result, each bivalent now contains **four chromatids**. This stage is called **tetrad stage**.

(ii) Due to increased attraction, homologous chromosomes tightly coil around each other.

(iii) Both the chromatids of a chromosome are called **sister chromatids** and each chromosome is called **Dyad.**

(iv) **Nonsister chromatids** of homologous pair develops ***recombination nudules*** and exchange their parts i.e. **crossing over**. Crossing over was discovered by **Morgan** and **Castle** in **Drosophila**.

(v) **Endonuclease** first breaks the nonsister chromatids at the place of recombination nodule.

(vi) Nonsister chromatids reunite after exchanging their parts (by **Ligase**) As the result of crossing over cross like structures - **chiasmata** (discovered by Janseen) form in bivalent.

(d) Diplotene

(i) In this stage, the homologous chromosomes repel (**desynapsis**) each other. The two homologous chromosomes thus separate from each other. So **chiasmata become visible**.

(ii) By the end of this stage, the chiasmata begin to move alone the length of the chromosomes from the centromere towards the end. This displacement of chiasmata is termed as **terminalization**.

(iii) **Diplotene** (Dictyotene) may last long up to month or year (12 to 15 years in Human Female)

(e) Diakinesis

(i) Terminalization is completed in this stage.

(ii) The bivalents tend to repel each other and migrate to the periphery of the nucleus just inside the nuclear membrane.

(iii) The **nucleolus disappears**.

(iv) The **nucleus membrane** also begins disintegrate and disappear.

(i) Spindle fibres make their appearance in the cytoplasm.

(B) Metaphase-I

(i) The spindle fibres get well developed are of three types

(a) Chromosomal / Kinetochore microtubules

(b) Continous / non kinetochore microtubules (pole to pole)

(c) Interzonal / non kinetochore microtubules (between the chromosomes)

(ii) The chromosomes move towards the equator and finally they orient themselves on the equator.

(iii) The centromeres lies towards the poles and the arms towards the equator.

(iv) At this stage each chromosome have two chromatids.

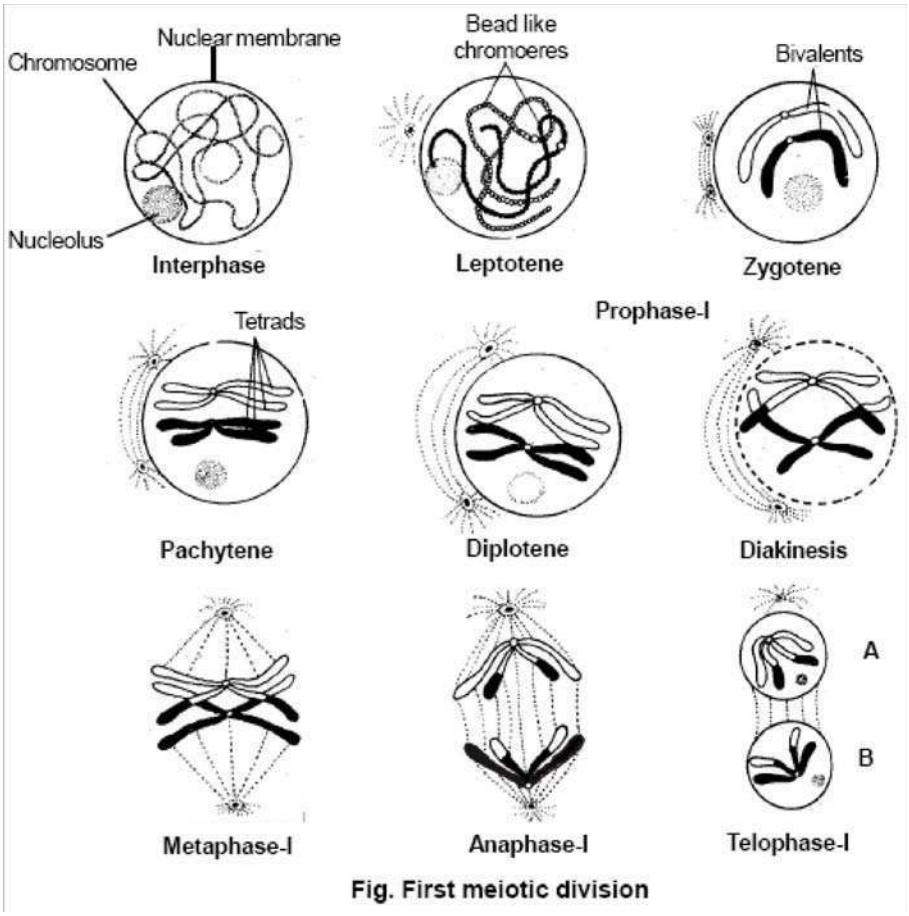


Fig. First meiotic division

(C) Anaphase-I

(i) Chromosomal fibre contracts and interzonal fibre **expands**. So homologous chromsomes segregate from each other and move towards the opposite poles.

(ii) Anaphase-I is characterised by **segregation** or **disjunction** of homologous chromosomes. **Division of centromere** is absent.

(iii) Unlike the condition in mitosis, the two chromatids of each chromosomes do not separated in meiosis-I because centromere does not splited.

(iv) Anaphase-I is responsible for reduction in chromosome number in daughter cells.

(D) Telophase-I

(i) The haploid number of chromosomes after reaching their respective poles, become very long and uncoil.

(ii) The nuclear membrane and the nucleolus reappear and thus two daughter nuclei formed are haploids.

(E) Cytokinesis-I

(i) In animals - by constriction and furrow (successive type)

(ii) In plants mostly cytokinesis absent.

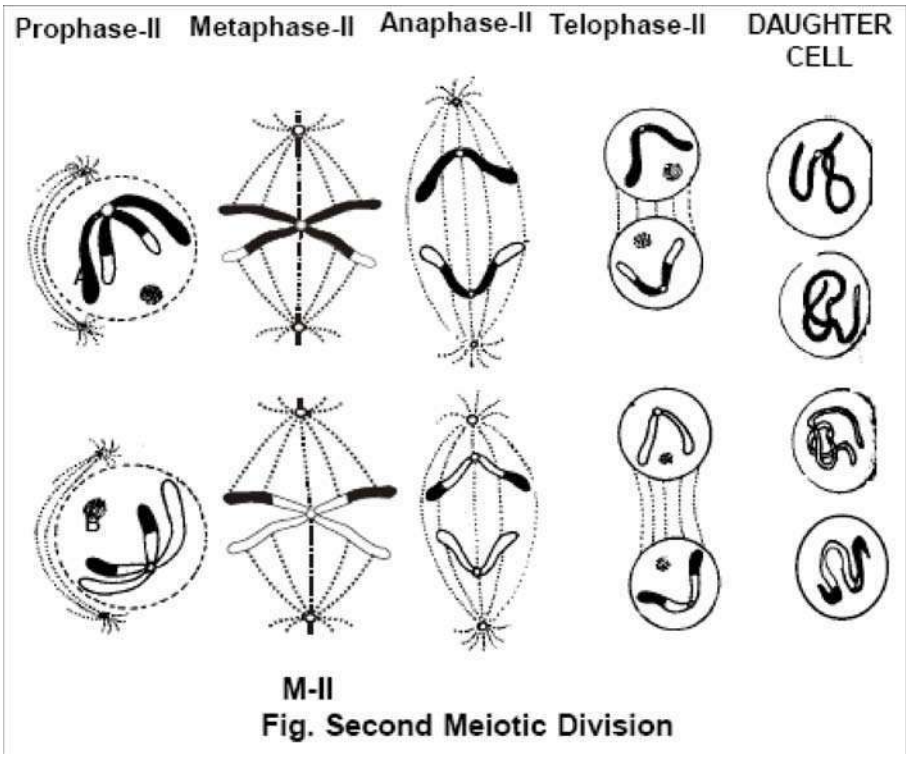
(iii) In plants, all the four daughter cells are produced **simultaneously**. Group of four cells produced simultaneously is called **tetrad**. (Tetrad of pollen grains).

Interphase-II

It is period in between meiosis-I and Meiosis-II. It may or may not be present. It is generally present in animal cell. There is **no s-phase** and **no DNA synthesis**. So called **Interkinesis**.

MEIOSIS-II

In this division no change in number of chromosome takes place (**Haploid to haploid**).



M-II

Fig. Second Meiotic Division

(A) Karyokinesis

Like meiotic-I, it is divided into four phases.

(B) Prophase - II

(i) The chromosomes appear distinct with two chromatids.

(ii) Each centriole divides into two resulting in the formation of two centrioles. Then each moves to opposite pole. They produce **asters**. Spindle fibres are formed between the asters.

(iii) The nucleus membrane and nucleolus disappear.

(C) Metaphase - II

(i) The chromosomes get arranged on the equator similar to mitosis.

(D) Anaphase II

(i) The two chromatids of each chromosomes are separated by the **divisions of centromere** and are attached to the spindle fibres.

(ii) The separated chromatids becomes daughter chromosomes and move the opposite poles due to the contraction of the spindle fibres.

(C) Telophase II

(i) During this stage, the daughter chromosomes again form chromatin thread.

(ii) The nuclear membrane surrounds each group. The nucleolus reappears.

(iii) Spindle fibre disappears.

(D) Cytokinesis-II

(i) After this there is cleavage of cell membrane in animal cells or cell wall formation in plant cells.

(ii) Each daughter cell of meiosis-I produces two haploid cells at the end of meiotic II

(iii) Hence this leads to the formation of **four daughter cells** (gametes). genetically different from eachother.

SIGNIFICANCE OF MEIOSIS :

Gametes are produced by meiosis. In meiotic cell division number of chromosome get reduced to half. When male and female gametes fuse, it again leads to (2n) number of chromosomes in the zygote. In this way by meiotic cell division number of chromosome is maintained constant in a sexually reproducing organism. During crossing over exchange of genes takes place in between maternal and paternal (two) chromosomes, this exchange of genes leads to **variation**. Variation is the raw material for evolution.

TYPE OF MEIOSIS :

(i) **Zygotic or Initial meiosis :** When the meosis in life cycle of an organism occurs in **zygote cell**. eg. in Thallophyta.

(ii) **Sporic meiosis or Intermediate Meiosis :** Meiosis takes place during **spore** formation eg. all the plants except thalophyta.

(iii) **Gametic or Terminal Meiosis :** Meiosis during the **gamete** formation. Eg. Animals.

(G) Differences between Mitosis and Meiosis Division

S.No.	Contents	Mitosis	Meiosis
(i)	Occurence	May occur in haploid, diploid or polyploid cells.	Occurs only in diploid or polyploid cells.
(ii)	Kind of cell	Somatic cells and some spores	Only Germ cells
(iii)	Number of cells	Two daughter cells	Four daughter cells
(iv)	General process	Whole process completes in one sequence with DNA replication only one time in interphase.	Process completes in two successive divisions which occur one after the other with DNA replication only once during interphase -I.
(v)	Prophase	(i) Shorter duration without substages. (ii) Homologous chromosomes remain separate. (iii) No crossing over and chiasmata formation.	(i) Longer duration with five substages. (ii) Homologous chromosomes pair up to **form bivalents**. (iii) Presence of **Crossing over** and chiasmata formation.
(vi)	Metaphase	(i) Centromeres are directed towards the equator and arms are directed towards the poles.	(i) Centromeres are directed towards the poles and arms are directed towards the centre.
(vii)	Anaphase	(i) Centromeres divide (ii) Chromatids separate. (iii) Chromatids are identical.	(i) Centromeres divide during meiotic -II Only. (ii) Chromatids separate during meiotic -II Only. (Chromosomes separate in meiotic-I) (iii) Separated chromosomes may not be identical due to **crossing over**.
(viii)	Telophase	(i) Same number of chromosomes as in parent cell. (ii) Both the homologous chromosomes present.	(i) Chromosome number is half than the parent cell. (ii) Only one of each pair of homologous chromosomes present.

TOOL & TECHNIQUE

UNIT OF MEASURMENT :

1 Millimeter (mm) = 1/10 cm.

1 Micron (μ) or Micrometer (μm) = 1/1000 mm.

1 Millimicron (mμ) or nanometer (nm) = 1/1000 m.

1 Angstrom (Å) = 1/10 mμ.

STAINING :

As most of cell components are transparent, to make these visible, different dyes are used to stain them. The cellular components take-up these dyes according to their chemical nature.

Stain	Final colour	Suitable for
Janus green	Greenish blue	Mitochondria
Brazlin	Red	DNA
Aurantia	Yellow	Mitochondria
Toludin-Blue / Azure-B	Sky blue	RNA
Para Rosailin	Purple	DNA
Feulgen stain	Red/Purple	DNA
Methylene	Blue	Nucleus
Sudan black and red	Black/Red	Lipid
Iodine solution	Blue/Red	Starch /Glycogen
Eosine	Red/Pink	Cytoplasm /Cellulose
Basic fuschin	Magenta red	Nucleus, Yeast, Golgi complex
Acid fuschin	Magenta	Cortex, Cell wall, mitochondria
Hematoxylin	Violet	Nucleus, cell wall & cellulose
Safranin	Red	Nucleus, Lignified tissue
Aniline blue	Blue	Fungal hyphae
Crystal violet	Violet	Bacteria
Phloroglucinol + HCl	Red	Lignin
Ruthenium red	Red	Pectin
Sudan III or IV	Red	Suberin, cutin, oil

TOOLS IN CYTOLOGY :

(A) Microscopy :

The study of fine structure of an object under a microscope is called **Microscopy**. The term, 'Microscope', was given **Faber**. **De-Vinci** was first person to use lens.

(B) Types of Microscope :–

(i) **Simple Microscope :**

The microscope used by Robert Hooke is considered as **simple microscope**. Its magnification power was 14–42 times only.

(ii) **Compound or Light Microscope :**

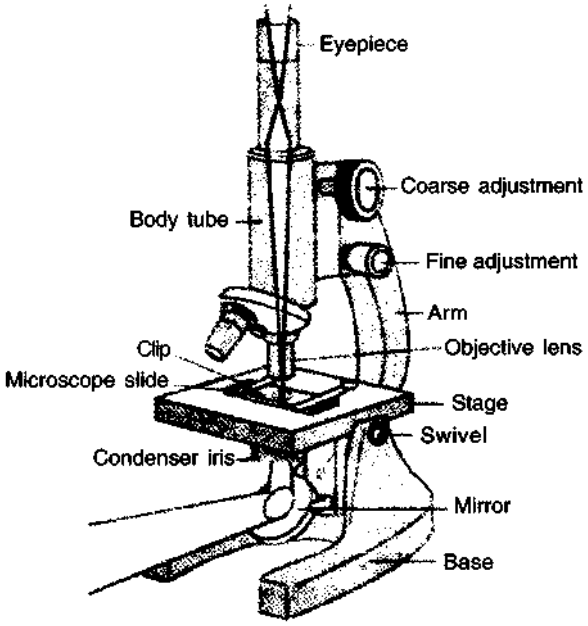


Fig : Compound Microscope

(iii) Compound microscope was first assembled by Z. Janssen and J.Janssen in 1590.

(iv) It is one of the oldest and most commonly used microscope to study the structure of cells and organisms.

(D) Special Note :

(i) Light microscope can magnify an object to about 1000 times the actual size of the specimen.

(ii) Light microscope is used to study the live unstained materials as well as the preserved and stained specimens.

(iii) This type of microscope is also called **Bright Field Microscope.** In this image is formed when the light is transmitted through the specimen.. The specimen is denser and more opaque than its surroundings. The image produced by the specimen will be darker than the surrounding brightly illuminated field. It is used to study live, unstained materials as well as preserved and stained materials.

(E) Dark Field Microscope :

(i) It was invented by **Z singmondy** in 1905.

(ii) In this, the image of specimen is illuminated bright against dark background.

(iii) The dark background, is achieved by keeping special disc called ‘stop’ on the condenser which blocks all the light from the centre and now only oblique beam of light reaches object or specimen. This type of microscope is used to see nuclei, mitochondria and vacuoles of cells.

(F) Phase contrast Microscope :

(i) It was invented by **F. Zernicke** in 1935.

(ii) It is used to study **living cells and tissues without staining**. Also used to study **chromosomes in mitosis & meiosis**.

(iii) As composition and densities of various cell organelles are different, their refractive indexes are also different.

(iv) This microscope converts the differences in refractive in dexes into relative darkness and brightness. It alters the light that passes through the specimen into different light intensity.

(G) Fluorescence Microscope :

(i) It was invented by **Coones** in 1945.

(ii) It uses **ultraviolet light** instead of visible light.

(iii) The fluorescent compounds like collagen, chlorophyll, riboflavin, vitamin A absorb UV light and then emit light of longer wavelength (Fluorescence).

(iv) Certain fluorescent dyes are also used like acridine orange and coriphosphine.

(v) This is used to **study the chromosome behavior** and **to identify pathogenic microorganism**.

(H) Differential or Interference Contrast Microscope :

(i) This is based on the principle of phase contrast but it gives quantitative data also.

(ii) It is used **to measure thickness of cell**, to determine protein lipids and nucleic acids in the cell parts to measure dry weight and water contents of the specimen etc.

(iii) In these microscopes the light rays are split into two beams before passing through specimen by the help of 2 prisms that creates contrasting colour in a image and two sources of light.

(iv) One beam passes thought the object and undergoes a phase change (diffracted wave). The second beam does not pass through the object and remains unchanged (undeviated wave).

(v) Since the two beams of light interfere with each other and also in combined state, it is called as interference contrast microscope.

(I) Electron Microscope :

(i) The electron microscope was invented by **Knoll** & **Rusk**a in 1931.

(ii) In E.M. the image is formed by a **beam of electrons rather than by visible light**. The image is formed by differential scattering of electrons from specimen.

Various parts of EM –

(i) **Filament –** It is made up of **tungsten**.
It is heated in vacuum tube to emit a beam of electrons for illumination **(source of light is electron beam)**.
Vacuum is kept in the tube so that the electrons may not collide with oxygen or nitrogen atoms of air.

(ii) **Electromagnetic condenser Lens –** It collects and focuses the beam of electrons on the object.

(iii) **Electromagnetic objective lens –** It produces an enlarged image of the object.

(iv) **Electromagnetic projector lens –** It further magnifies the image and projects it on to a **fluorescent viewing screen** or **photographic plate**.

(v) **Specimen used –**

(a) The specimen used is treated with chemicals and dyes to enhance the contrast and as such the live objects cannot be observed.

(b) Since images produced by electrons do not have the colour, the electron micrographs always have shades of black, grey and white.

(c) The colour enhanced micrographs are produced by computer.

There are two types of E. M. →

1. Transmission Electron Microscope (TEM) :

(i) TEM was developed by **Knoll** & **Ruska**.

(ii) It is used for the **study of ultrastructure of cell organelles**.

(iii) Magnification **power 1,00,000 to 3,00,000 times**.

(iv) In TEM the electrons pass through the object & produce an image.

(v) In order to increase the contrast & to prevent damage of tissue by electron bombardment the **specimen is fixed, coated or stained by the salts of various heavy metals (e.g. – Lead, Tungsten, Uranium) Usually Osmium tetroxide & formaldehyde are used**. After fixation the specimen embedded in plastic material & ultrathin sections are cut on a specially designed ultramicrotome using glass or diamond knife. After this the sections are placed on a thin membrane which is kept on a copper grid in the EM for observations.

2. Scanning Electron Microscope (SEM) :

(i) It was invented by **Knoll** in 1935.

(ii) It is used for **detailed study of surface of specimens**.

(iii) It gives **3D image**.

(iv) Magnification power **upto 2,00,000**.

(v) In SEM the image is formed due to reflection of electrons from the surface of the specimen.

(vi) A shower of electrons are strike on the surface of specimen in SEM.

Magnification (M) of a Microscope :

It is ratio of the visible size of an object to its actual size.

$$M = \frac{\text{Size of image seen with microscope}}{\text{Size of image seen with naked eye}}$$

For laboratory microscope it is calculated by multiplying the magnification of the objective lens by that of the ocular lens.

Resolving Power of a Microscope :

The ability to see two close points as separate and distinct points is called **resolving power**.

(i) Resolving power of a microscope is given by the **Abbe equation**.

$$L_m = \frac{0.61\lambda}{N.A.}$$

Where,

L_m = limit of resolution or resolving power.

0.61 = Constant

λ = wavelength of light

N.A. = n sin α (n = refractive index of medium)

(sin α = sine of half angle of light entering the objective lens from the specimen)

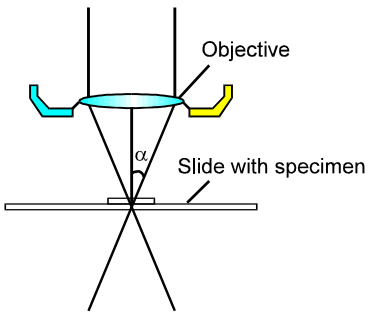


Fig : Semiangle of aperture

(ii) If L_m becomes small the resolution increases. Limit of resolution is inversely proportional to resolving power.

(iii) As limit of resolution is inversely proportional to wavelength of light, the highest resolution is obtained with

the light of shortest wavelength i.e. (450–500nm). Therefore, blue filter is used in a microscope.

(iv) The function of condenser in microscope is to produce a cone of light striking on it. This cone has a narrow angle, it does not spread out much after leaving the slide and does not form separate images causing low resolution.

(v) Most oil immersion objectives have a maximum numerical aperture of 1.4, with the numerical apertures commonly ranging from 1.0 to 1.35.

(vi) The maximum resolution of light microscope that can be achieved is 200nm. (at 426nm which is shortest visible wavelength).

(vii) Another important thing for a microscope is in choosing good microscopic objective lens having short **working distance**. Working distance of an object can be defined as the distance between the surface of objective lens and the object or coverslip.

TECHNIQUES IN CYTOLOGY :

(A) X-ray diffraction :

(i) This technique is based on the **diffraction of radiations** when they fall on small obstacles.

(ii) X-rays diffraction is one of the most important tools in **molecular biology and ultrastructure**.

(iii) It permits biologists to determine the orientation of molecules and to recognize atomic organization.

(iv) X-ray diffraction is a good technique to determine the three dimensional positions of the atoms in the molecules like nucleic acid and protein.

(B) Autoradiography :

(i) It is **direct use of radiations** in the study of biological molecules.

(ii) One of the important techniques used to study the synthesis of molecules and to trace the metabolic pathways or events in the cells is autoradiography.

(iii) **Autoradiographic techniques can be used to trace the path of carbon in photosynthesis**.

(iv) Autoradiography involves the incorporation or radioactive substances into the molecules and the detection of their presence by photographic technique.

(v) The most useful **radioactive isotopes employed in autoradiography are beta emitters including ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{45}Ca, ^{59}Fe and ^{131}I**.

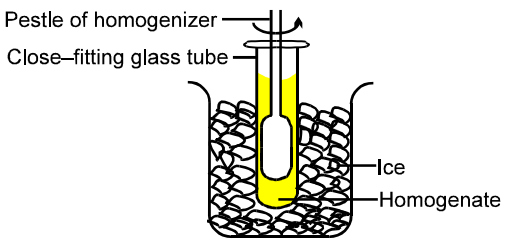
(C) Cell Fractionation :

It is a technique **to separate the various cell component into fractions**. Fractionation involves two methods.

(a) Homogenization **(b)** Centrifugation

(a) Homogenization –

(i) This method involves the homogenization or destruction of cell boundaries by different mechanical or chemical procedures followed by the separation of the subcellular fractions according to mass, surface tension and specific gravity.



(ii) Homogenization of cell can be brought by simple grinding of cells with glass beads (warning blender) breaking cell by pressure, by osmotic shock, by ultrasound waves etc. The resultant slurry obtained is called **cell homogenate**.

(iii) The important thing, which is considered in cell homogenization is the **temperature**, **pH** and **isolation medium**. Normally **homogenization is done at 0-4°C to prevent enzymatic breakdown of cell**. The commonly used isolation mediums are ice cold 0.25M sucrose solution, sorbitol, mannitol.

(iv) For biochemical analysis of mitochondria, the cells must be subjected to cell fractionation.

(b) Centrifugation –

(i) It is a process of separation of various components of a cell under the influence of Centrifugal Force. And the instruments in which this force develops is called Centrifuge. Due to centrifugal force the various components move outward in the medium with different speeds depending upon their size & density.

A centrifuge is a motor driven machine. Centrifuge can be of several types – Normal clinical centrifuge which can rotate upto 5000 rpm (revolutions per minute). The high speed centrifuge (Ultracentrifuge) has speed from 50,000 to 1,00,000 rpm & may be refrigerated.

(ii) Depending upon the specific requirement, different kinds of rotors are used to hold the cell homogenate/ solutions to be fractionated during centrifugation.

(iii) In most of the clinical centrifuges there are only swing out rotors having suspended test tubes.

(iv) Homogenate contains other debris also. These impurities can be removed by low speed centrifugation. The resultant supernatant is called **cell free extract**. From this cell free extract the various cell organelles can be isolated.

(D) Types of Centrifugation :

Density Gradient Centrifugation : for subcellular component

(i) This involves centrifugation through a **gradient of increasing sucrose density**.

(ii) The denser solution is at the bottom and its density gradually decreases towards the top.

(iii) After formation of gradient the homogenate is layered at the top and centrifuged. After centrifugation, components from the homogenate with different moving speeds reach equilibrium with the gradient or may form bands at different position. Hence this type of separation is also called **isopycnic (equal density) centrifugation.**

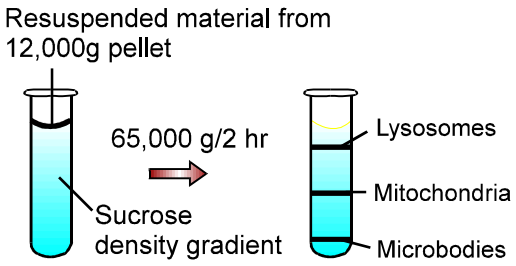


Fig : Sucrose-density Equilibrium Centrifugation

(iv) Sedimentation of the components depends on **sedimentation coefficient** or **svedberg units (S)** which is **proportional to molecular weight of sediments particles**.

Special Points :

(i) **T. Svedberg** won the **nobel prize** for chemistry for the development of **analytical ultracentrifugation**.

(ii) On the basis of the knowledge of the sedimentation coefficient, **the size and composition of the cell, and types of components can be determined**.

(iii) The force exerted on the homogenate is expressed in terms of gravitational force (g). This force is related to the speed of rotations per min.

(A) Molecular Fractionation :

In this technique molecules present in the cell cytosol can be seperated. The two important techniques are:

(a) Chromatography **(b)** Electrophoresis

(a) Chromatography :

(i) It was proposed by **Michael Tswett** - 1906. This technique is based on the **principle of differential migration of components of a mixture** resulting in their separation.

(ii) It is a technique of separation of components of biochemical mixture by partitioning between two solvent systems. One of them is held immobile (stationary phase) and the other mobile (liquid phase). The original experiments were concerned with the separation of **coloured substances** (**plant segments**) and, therefore, this method was called **chromatography**.

(iii) In biology this technique is used in isolating and **purifying materials ranging from plant pigments to amino acids**.

(iv) This technique is useful for preparative as well as analytical purposes.

(v) Depending on the types of solid phase used, the chromatography is of five types. These are–

(a) **Adsorption or column chromatography** commonly used for separation of **mixture of tissue lipids**.

(b) **Thin layer and paper chromatography** (used for **separation of amino acids, nucleotides** and **low** molecular weight products).

(c) **Ion exchange chromatography** (used for **insulin purification** and **plasma fractionation**).

(d) **Gel filtration chromatography** (used for **determination of molecular weight of proteins**).

(e) **Affinity chromatography** (used for separation of immunoglobulins, cellular enzymes and mRNA).

(b) Electrophoresis :

(i) Electrophoresis is a technique in which **charged molecules are placed in a medium and exposed to an electric fiel**d.

(ii) The charged molecules migrate through the medium at different rates, according to **charge, mass length size, shape and other properties**.

(iii) A spot or band of sample to be detected is applied to a solid support, than electric field is applied. The sample molecules moves through the support towards the positive or negative electrodes depending on the net charge of molecule.

(iv) Support media includes paper and cellulose acetate, starch, agarose, polyacryl amide (PAGE) and silica gels.

(v) The voltage used depends upon the nature of the sample & type of support medium. Higher voltage is used for paper supports than for gels because of higher resistance of paper.

(vi) Electrophoresis is useful for the **analysis of numbers and types of components in a mixture** as well as for isolating and purifying molecules.

(vii) Protein electrophoresis is used to detect amino acid variations in hundreds of human proteins.

(viii) Proteins with slight variations in their amino acid sequence will migrate at different rates through electrically charged gels.

EXERCISE - 1

Q.1 The heterochromatin is condensed in the following region of the chromosome -
(1) Secondary construction - I
(2) Secondary constriction - II
(3) Both the above
(4) Telomere

Q.2 One solenoid composed of -
(1) 8-nucleosome (2) 6-nucleosome
(3) 10-nucleosome (4) 16-nucleosome

Q.3 The chromosomes appear as beaded structures at -
(1) Leptotene (2) Pachytene
(3) Diakinesis (4) Telophase - I

Q.4 Histone which links the nucleosomes together is called -
(1) H_1 (2) H_2A
(3) H_2B (4) H_4

Q.5 The protein nucleoplasmin occurs in -
(1) Nuclear pore complex
(2) Sieve cells
(3) Nucleolus
(4) Heterochromatin

Q.6 Nucleus stores energy in the form of -
(1) ATP (2) GTP
(3) TTP
(4) CTP and all the above

Q.7 Ribounucleic acid occurs in -
(1) Nucleus
(2) Cytoplasm
(3) Nucleus and cytoplasm
(4) Mitochondria and chloroplast

Q.8 The chromatin material which takes darker stain in interphase is called-
(1) Euchromatin
(2) Heterochromatin
(3) Primary constriction
(4) Satellite body

Q.9 In human being secondary constriction II found on -
(1) X - chromosome
(2) Y - chromosome
(3) 13, 14, 15, 21, 22 chromosome
(4) 1, 10, 13, 16 & y-chromosome

Q.10 Nucleosome is made up of -
(1) Nonhistone protein + RNA
(2) Histone protein and DNA
(3) Non-histone and histone protein
(4) Phospholipid and protein

Q.11 Structure which provide shape to chrosome is called -
(1) Telomere (2) Satellite
(3) Centromere (4) Chromomere

Q.12 Who first Synthesized artificial Gene in laboratory -
(1) Mandle (2) Khorana
(3) Sutton (4) Kornberg

Q.13 Feulgen reaction is used to stain :-
(1) DNA
(2) RNA-polymerase
(3) DNA-polymerase
(4) (1) and (3) both

Q.14 Indicate the increasing order of size -
(1) Lysosome, ribosome, mitochondria, choroplast
(2) Ribosome, lysosome, chloroplast, mitochondria
(3) Ribosome, lysosome, mitochondria, chloroplast
(4) Chloroplast, mitocondria, lysosome, ribosome

Q.15 Microsomes are obtained by -
(1) Vital staining
(2) Sonography
(3) Fractionation of cell by ultrasonic sound wave
(4) X-ray crystallography

Q.16 Longest plant cells are :-
(1) Vessels (2) Trachieds
(3) Cotton fiber (4) Fibers of Ramian

Q.17 Cell organells can be separated by method of-
(1) Autoradiography
(2) Microtomy
(3) Differential centrifugation
(4) X-ray differaction

Q.18 Calvin isolated the different chemical of calvin cycle by -
(1) Autoradiography (2) Chromatography
(3) Cell fractionation (4) x-ray diffraction

Q.19 The biggest cell is : -
(1) Hen egg (2) Human egg
(3) Kidney cell (4) Ostrich egg

Q.20 Cell Lineage theory proposed by :-
(1) Schieiden (2) Schwann
(3) Rudolph (4) Hooke

Q.21 Which of the following is absent in an intact cell :-
(1) Microsomes (2) Golgibody
(3) Glyoxysomes (4) Microtubules

Q.22 Animal and plant cells differ in their :-
(1) Movement (2) Growth
(3) Nutrition (4) Respiration

Q.23 Which microscope is best study cell division in function state -
(1) EM (2) SEM
(3) Phase contrast microscope
(4) Simple microscope

Q.24 Protoplasm of a single cell without cell wall is called -
(1) Plasmodium (2) Trophoplasm
(3) Hyaloplasm (4) Protoplast

Q.25 An exception to cell theory is -
(1) Erythrocytes (2) Bacteria
(3) Fungi (4) Virus

Q.26 Cell theory states that -
(1) All cells have Nucleus
(2) Cell are the functional and structural units of Plants and animals
(3) All cells are living
(4) Cells reproduce by Mitosis & Meiosis

Q.27 The stem and leaves of grasses are rough due to :-
(1) Calcium carbonates
(2) Resins
(3) Silica
(4) Calcium oxalate

Q.28 Resin canals abundantly occur in :-
(1) Conifers (2) Cycads
(3) Gnetales (4) Dicots

Q.29 Deposition of lignin mainly occurs in -
(1) Primary cell wall
(2) Secondary cell wall
(3) Tertiary cell wall
(4) Middle lamella

Q.30 Euglena stores food in the form of paramylum (β 1 $\rightarrow$ 3 glucan) which is conversion product of :-
(1) Starch (2) Fructose
(3) Hyaluronic acid (4) Pectin

Q.31 Suberisation mainly occurs in :-
(1) Middle lamella (2) Primary cell wall
(3) Sec. cell wall (4) Cytoplasm

Q.32 Tonoplast, the membrane of vacuole is :-
(1) Living membrane
(2) Non living membrane
(3) Impermeable
(4) Permeable

Q.33 Stored food in onion leaves :-
(1) Starch (2) Sugars
(3) Inulin (4) Glycogen

Q.34 Ripening fruits softene due to -
(1) Conversion of starch into sugars
(2) Solubilisation of pectates in middle lamella
(3) Formation of organic acids
(4) Conversion of fats into carbohydrates

Q.35 Resins are :-
(1) Cell wall degradation products
(2) Alkaloids
(3) Glycosidic derivative
(4) Oxidation products of essential oils

Q.36 ''Drus'' are :-
(1) Crystals of calcium carbonate
(2) Crystals of calcium oxalate
(3) Alkaloids
(4) Crystals of silica

Q.37 Mineral Crystal Raphides found in :-
(1) Rubber plant (2) Papaver
(3) Sunflower (4) Brinjal

Q.38 Electron microscope was invented by-
(1) Knoll and Ruska
(2) Rudolph and Kolliker
(3) C.P. Swanson
(4) None of the above

Q.39 Phase contrast microscope is -

(1) based on the scattering of light and using a dark field condenser

(2) used for the study of living cells

(3) related to retardation and thickness of object

(4) the best method for studying non-living ultra structure

Q.40 A fluorescent microscpe is used -

(1) for increasing resolving power

(2) for obtaining X-ray diffraction pattern of DNA

(3) to study cell and their components in a living state

(4) To localise cell structure stained with fluorochome dyes

Q.41 Fuelgen reaction of DNA is due to -

(1) aldehyde produced by acid hydrolysis

(2) removal of RNA but not DNA

(3) phosphoric acid carbohydrated and nitrogen based

(4) phosporic acid

Q.42 Magnification power of a light compound microscope depends on :-

(1) Power of eye piece lens

(2) Power of objective lens

(3) Source of light

(4) (1) and (2) both

Q.43 Which dye is used to stain chromosomes:-

(1) Acetocarmine

(2) Haematoxylin

(3) Feulgen

(4) All the above

Q.44 Toludene blue specifically stains :-

(1) DNA (2) RNA

(3) Chitin (4) Lignin

Q.45 Which stain is used for electron microscopy-

(1) PAS

(2) Aurantia

(3) Para Rosailin

(4) Osmium tetraoxide

Q.46 Which one is a vital stain :-

(1) Janus green (2) Methylene blue

(3) Neutral red (4) All the above

Q.47 Cell organelles can be separated by method of :-

(1) Autoradiogrphy (2) Microtomy

(3) Differential centrifugation

(4) X-ray differaction

Q.48 Structure of RNA can be studied by :-

(1) Feulgen (2) Toludene blue

(3) X-ray crystallography

(4) Chromatography

Q.49 In electron microscope source of light is :-

(1) White light (2) U.V ray

(3) Electron beam (4) Green light

Q.50 The best microscope to study ultra structure of cell is :-

(1) Phase contrast microscope

(2) Electron microscope (EM)

(3) Scanning electron microscope (SEM)

(4) Flourescent mcroscope

Q.51 Chromosome number in gynoecium is 12, then in endosperm it will be -

(1) 18 (2) 36

(3) 12 (4) 6

CELL DIVISION

Q.52 The main difference between a dividing animals and plant cell lies in-

(1) Cell plate formation

(2) Coiling of chromosome

(3) Chromosome movement

(4) Types of spindle fibres

Q.53 Cytoplasmic structures involved in cell division are-

(1) Mitochondria (2) Ribosomes

(3) Lysosomes (4) Centrioles

Q.54 Cell division is not present in the cells of-

(1) Skin (2) Gonads

(3) Brain (4) Bone marrow

Q.55 Before cell division, the entire DNA content of the cell gets doubled during interphase. This doubling takes place-

(1) At the beginning of the interphase

(2) At the end of the interphase

(3) Throughout the interphase

(4) Somewhere during the middle of the interphase

Q.56 Where can we study mitosis-

(1) Brain (2) Nail base

(3) Legs (4) Kidneys

Q.57 Tetrad is made of-

(1) Four non homologous chromatids

(2) Four homologous chromosomes with four chromatids

(3) Four non homologous chromosomes

(4) Two homologous chromosomes each with two chromatids

Q.58 During meiotic cells division, genetic recombinations between two homologous chromosomes are facilitate by-

(1) Movement of centromeres

(2) Extrusion of polar bodies

(3) Movement of centrioles

(4) Formation of synaptonemal complex

Q.59 Meiosis I is reductional division. Meiosis II is equational division due to-

(1) Pairing of homologous chromosomes

(2) Separation of chromatids

(3) Disjunction of homologous chromosomes

(4) Crossing over

Q.60 In the somatic cell cycle–

(1) In G_1 phase DNA content is double the amount of DNA present in the original cell

(2) DNA replication takes place in S-phase

(3) A short interphase is followed by a long mitotic phase

(4) G_2 phase is followed by mitotic phase

Q.61 What is true about cell cycle–

a. During G_1 phase there is active synthesis of RNA and proteins but no change in its DNA content

b. In synthesis or S phase each chromosome carries a duplicate set of genes

c. During G_2 phase a cell contains double the amount of DNA present in the original diploid cell (2n)

d. In S-phase a cell doubles the original diploid (2n) chromosome number

(1) c and d (2) a, b and c

(3) all (4) b, c and d

Q.62 Mitosis is not found in -

(1) Cartilage cells (2) Bone cells

(3) Nerve cells (4) All of the above

Q.63 If the cells in the root of an angiosperm have 12 chromosomes, 6 chromosomes will be present in -

(1) Synergid (2) Endosperm cell

(3) Leaf cell (4) Cotyledonary cell

Q.64 The number of chromosomes present in the leaf tip cells of a plant species, having six chromosomes in each of the four cells of its pollen tetrad, would be -

(1) Three (2) Six

(3) Twelve (4) Twenty four

Q.65 At which stage during meiotic prophase I the synaptic forces, between homologous chromosomes, are the maximum ?

(1) Leptotene (2) Zygotene

(3) Pachytene (4) Diplotene

Q.66 The number of chromatids in a chromosome at metaphase is -

(1) Two each in meiosis and mitosis

(2) Two in mitosis and one in meiosis

(3) Two in mitosis and four in meiosis

(4) One in mitosis and two in meiosis

Q.67 Find out the incorrect statement -

(1) Balbiani rings (puffs) are the sites of RNA synthesis

(2) Cytokinesis refers to the division of cytoplasm

(3) Tetrad is made of two homologous chromosomes each with two chromatids

(4) The chromosome end is called nucleolus

Q.68 Decondensation of chromosome occurs in-

(1) Prophase (2) Metaphase

(3) Anaphase (4) Telophase

Q.69 The quantity of DNA in a chromosome at metaphase is -

(1) Two each in meiosis and mitosis

(2) Two in mitosis and one in meiosis

(3) Two in mitosis and four in meiosis

(4) One in mitosis and two in meiosis

Q.70 A red blood cell was kept in a solution for a few minutes, where it got burst. The solution taken was–

(1) Hypotonic

(2) Concentrated sugar solution

(3) Isotonic

(4) Hypertonic

Q.71 Function of telomeres in nucleus is –

(1) Poleward movement

(2) To initiate the RNA synthesis

(3) To seal the ends of chromosome

(4) To recognise the homologous chromosome

Q.72 The salivary gland chromosomes in the dipteran larvae, are useful in gene mapping because

(1) these are fused

(2) these are much longer in size

(3) These are easy to stain

(4) They have endoreduplicated chromosomes

Q.73 DNA synthesis takes place in -

(1) S phase (2) G_1 phase

(3) G_2 phase (3) None

Q.74 When pairing occurs in chromosomes (meiosis) -

(1) Leptotene (2) Zygotene

(3) Pachytene (4) Diakinesis

Q.75 Most active stage of cell cycle is -

(1) Prophase (2) Metaphase

(3) Telophase (4) Interphase

Q.76 Which of the following is the method of cytokinesis in plant cell -

(1) By cell plate formation

(2) By constriction

(3) By phragmoplast

(4) (1) and (3) both

Q.77 In which stage of cell cycle nucleus becomes bigger -

(1) G_1 (2) G_2

(3) S (4) M

Q.78 What happens in interkinesis -

(1) DNA - replication

(2) Chromosome duplication

(3) Preparation of second meiotic div.

(4) Resting stage

Q.79 Which can be observed in an interphase nucleus under the light microscope -

(1) Chromosomes (2) Nucleosomes

(3) Centromere (4) Heterochromatin

Q.80 Angular divergence of spindle decreases at-

(1) Metaphase (2) Early anaphase

(3) Late anaphase (4) Telophase

Q.81 Minimum number of meiotic div. required to produce 62 pollengrains -

(1) 15 (2) 31

(3) 62 (4) 16

Q.82 In cell cycle, changes of which stage are not visible under microscope -

(1) Interphase (2) Prophase

(3) Metaphase (4) Anaphase

Q.83 Which type of division leads to polyploidy-

(1) Cryptomitosis (2) Meiosis

(3) Endomitosis (4) Amitosis

Q.84 Which of the following not ocurs in Anaphase-I but occurs in Anaphase-II -

(1) Condensation of chromosomes

(2) Poleward movement of chromosome

(3) Contraction of spindle fibers

(4) Splitting of centromere

Q.85 In which stage of cell division, division of matrix of chromosome occurs -

(1) Late prophase (2) Early metaphase

(3) Late metaphase (4) Anaphase

Q.86 During G_2 - phase a diploid cell contains the amount of DNA equal to a -

(1) Diploid cell (2) Tetraploid cell

(3) Haploid cell

(4) Nothing can be said

Q.87 Crossing over takes place in -

(1) Zygotene (2) Pachytene

(3) Diplotene (4) Diakinesis

Q.88 A contractile mid body forms during cytokinesis in -

(1) Animals (2) Higher plants

(3) Fungi (4) Algae

Q.89 In which order, cytokinesis occurs in plants -

(1) Centripetal (2) Centrifugal

(3) Oblique (4) Equatorial

Q.90 Meiosis not occurs in -
(1) Ovule (2) Anther
(3) Microsporangia (4) Shoot tip

Q.91 Which of the two events restore the normal number of chromosomes in life cycle -
(1) Mitosis and Meiosis
(2) Meiosis and fertilisation
(3) Fertlisation and mitosis
(4) Only meiosis

Q.92 Number of meiosis required to produce 100 ovules in angiosperms -
(1) 125 (2) 100
(3) 25 (4) 75

Q.93 Constancy of the chromosome number in sexually producing generation is brought by the process of -
(1) Meiosis (2) Mitosis
(3) Amitosis (4) None

Q.94 Amitosis is characteristic of -
(1) Higher plants (2) Higher animals
(3) Bryophyta (4) Lower organisms

Q.95 Slipping of chiasmata towards the ends of bivalent is called -
(1) Terminalisation (2) Diakinesis
(3) Interkinesis (4) Heteropycnosis

Q.96 Which does not occurs in prophase -
(1) Hydration of chromatin
(2) Dehydration of chromatin
(3) Appearance of chromosome
(4) Disappearance of nuclear memb. and nucleolus

Q.97 During cell cycle, RNA and protein synthesis takes place during -
(1) G_1 and G_2 phase (2) S - Phase
(3) M - phase (4) Cytokinesis

Q.98 In which stage of cell division, number of chromosomes best counted -
(1) Prophase (2) Metaphase
(3) Telophase (4) Interphase

Q.99 Cell division in blue green algae similar to that in -
(A) Bacteria (B) Brown algae
(C) Green algae (D) Higher plants

Q.100 The synaptonemal complex was first observed by -
(1) Moore (1905)
(2) Farmer and moore (1905)
(3) Mosses (1956)
(4) Flemming (1882)

Q.101 A cell is bound to divide, if it has entered-
(1) G_2 : phase (2) G_1 - phase
(3) Prophase (4) S - phase

Q.102 How many Chromosome shall be present in a diploid cell at mitotic anaphase if its egg cell has ten chromosome -
(1) 10 (Ten) (2) 20 (Twenty)
(3) 30 (Thirty) (4) 40 (Forty)

Q.103 If crossing-over occur at two strand stage then percentage of crossing over is -
(1) 50% (2) 60%
(4) 70% (4) 100%

Q.104 Meiosis which occur at the time of spore formation is called -
(1) Zygotic meiosis (2) Haplontic meiosis
(3) Terminal meiosis (4) Intermediate meiosis

Q.105 Chromosome exhibit high level of coiling at which phase of karyokinesis -
(1) Prophase (2) Metaphase
(3) Telophase (4) Interphase

Q.106 The synaptonemal complex appears -
(1) Between homologous chromosomes
(2) In zygotene stage
(3) Composed of DNA + protein
(4) All the above

Q.107 At anaphase - II of meiosis each chromosome contains -
(1) 4 DNA (2) 3 - DNA
(3) 2 - DNA (4) 1 - DNA

Q.108 During cell division chromosome move towards different poles due to -
(1) Centriole (2) Vacuole formation
(3) Microtubules (4) Cytokinesis

Q.109 For studying meiosis the relevant plant material usually fixed around -
(1) 9-10 AM (2) 4.5 AM
(3) 3.5 PM (4) 12 PM

Q.110 Tetrad formation in meiosis occur is -
(1) Leptotene (2) Zygotene
(3) Pachytene (4) Diplotene

Q.111 In Anaphase - I each chromosome composed of -

(1) One chromatid (2) Two chromatid

(3) Four chromatid (4) Many chromatid

Q.112 In meiosis, division of centromere occurs during -

(A) Interphase (B) Anaphase - I

(C) Anaphase - II (D) Metaphase - I

Q.113 In meiosis, nuclear membrane and nucleolus disappear during -

(1) Zygotene (2) Pachytene

(3) Diakinesis (4) Metaphase - I

Q.114 Cell cycle can remain arrested at -

(1) G_1 (2) S

(3) G_2 (4) M

Q.115 Which of the following are mitotic poisons-

(1) Colchicine

(2) Mustard gas and Azides

(3) Cyanides

(4) All the above

Q.116 In cell cycle, which stage is misnomerly called resting phase -

(1) S-phase (2) Telophase

(3) Cytokinesis (4) Interphase

Q.117 Separation of homologous chromosomes during Anaphase - I is called -

(1) Synapsis (2) Disjunction

(3) Nondisjunction (4) Crossing over

Q.118 In tetrad, the number of non cross over chromatids is normally -

(1) Four (2) Two

(3) One (4) None

Q.119 Sporic meiosis occurs in -

(1) Animals (2) Thallophyta

(3) Bryophyta

(4) All plants except thallophyta

Q.120 If a meristematic cell is placed in a medium containing radio active thymidine, radioactivity will be first observed in -

(1) Euchromatin

(2) Hetero chromatin

(3) Both simultaneously

(4) None of the above

Q.121 The metabolism of a cell which decreases during prophase again starts increasing during-

(1) Telophase (2) Anaphase

(3) Metaphase (4) G_1 - phase

Q.122 Synthesis of cycline protein occurs in -

(1) Permanent tissue (2) Meristem

(3) Lignified cells (4) All the types of cell

Q.123 During which stage a diploid cell becomes tetraploid in mitosis -

(1) G_2 (2) Prophase

(3) Metaphase (4) Anaphase

Q.124 If the number of bivalents are 8 in metaphase - I, what shall be the number of chromosomes in daughter cells after meiosis - I and meiosis - II respectively -

(1) 8 and 4 (2) 4 and 4

(3) 8 and 8 (4) 16 and 8

Q.125 Homologous chromosomes shows maximum attraction during -

(1) Leptotene (2) Zygotene

(3) Pachytene (4) Diplotene

Q.126 Ribonuclease, a mitotic poison, inhibits cell cycle in -

(1) Interphase (2) Prophase

(3) Metaphase (4) Anaphase

Q.127 Dinomitosis occurs in -

(1) Procaryotes (2) Mesokaryotes

(3) Eucaryotes (4) Akaryotes

Q.128 Stain for cell division -

(1) Saffranin (2) Aniline blue

(3) PAS (4) Acetocarmine

Q.129 Terminal meiosis occurs in -

(1) Sporocyte (2) Gametocyte

(3) Zygote (4) Gamete

Q.130 How many microspore mother cells are required to produce 80 male gametes in angiosperms -

(1) 10 (2) 20

(3) 40 (4) 80

Q.131 Coiling of chromonema in prophase of mitosis is -

(1) Plectonemic (2) Paranemic

(3) Helical (4) Irregular

Q.132 Chiasmata appears during -
(1) Diakinesis (2) Synaptotene
(3) Diplotene (4) Leptotene

Q.133 In mitosis, the spindle is -
(1) Bipolar (2) Multipolar
(3) Apolar (4) Random

Q.134 Synthesis and storage of ATP molecules required for cell div. takes place in -
(1) Prophase (2) G_1 - Phase
(3) Anaphase (4) G_2 - Phase

Q.135 Each daughter chromosome in anaphase moves towards opposite poles at the speed of 1 μm per minute with the expenditure of energy -
(1) 5 ATP (2) 30 ATP
(3) 38 ATP (4) 200 ATP

Q.136 Cell plate which appears during cytokinesis, ultimately transforms in -
(1) Middle lamella (2) Primary wall
(3) Sec. wall (4) Plasma membrane

Q.137 Chromosomal morphology (Structure) is best observed at -
(1) Prophase (2) Metaphase
(3) Interphase (4) Anaphase

Q.138 In which stage the centromere lie at equator and arms are directed towards poles -
(1) Metaphase of mitosis
(2) Metaphase - I
(3) Metaphase - II
(4) I and 3 both

Q.139 What type of division lead to coenocytic condition -
(1) Cryptomitosis (2) Endomitosis
(3) Free nuclear div. (4) Dino-mitosis

Q.140 Pairing of homologous chromosomes is called -
(1) Disjunction (2) Synapsis
(3) Segregation (4) Polyteny

Q.141 During cytokinesis in plants, which o the following secretes the middle lamella -
(1) Golgibody (2) SER
(3) RER (4) Lysosomes

Q.142 Synapsis found in between -
(1) Nonhomologous chromosome
(2) Homologous chromosome
(3) Nonhomologous and homologous chromosome
(4) Chromatids

Q.143 Longest phase of mitosis is -
(1) Prophase (2) Metaphase
(3) Anaphase (4) Telophase

Q.144 When the prophase chromosome are stained with acetocarmine they take differential staining. This phenomenon is called -
(1) Idiogram (2) Karyotype
(3) Heteropycnosis (4) Satellite

Q.145 Crossing over takes place on -
(1) Two stranded stage
(2) Three stranded stage
(3) One stranded stage
(4) Four stranded state

Q.146 Decision of cell division occurs at -
(1) Starting of G_1 (2) End of G_1
(3) Initial stage of prophase
(4) End of telophase

Q.147 Smallest phase of mitosis is -
(1) Prophase (2) Metaphase
(3) Anaphase (4) Telophase

Q.148 Synthesis of proteins for formation of spindle fibres takes place in -
(1) G_1-phase (2) S-phase
(3) G_2-phase (4) M-phase

Q.149 How many divisions will occur in an isolated tip cell to form 128 cells -
(1) 128 (2) 127
(3) 32 (4) 7

Q.150 Causes of Cancer is -
(1) Fast and uncontrolled cell division by Meiosis
(2) Stop the process which controls cell division in Mitosis
(3) Over growth of daughter cells in telophase and due to failure of cleavage furrows and non separation of cells
(4) Unequal amount of DNA in daughter cells formed by Mitosis

Q.151 The part of a cell that can be seen with and electron microscope, but can't with a light microscope is/are the -
(1) nucleus (2) Golgi bodies
(3) chloroplasts
(4) membrane separating the nucleus from the cytoplasm

Q.152 The organic compound present in traces in living cells can be dectected and isolated by-

(1) centrifugation (2) tracer tecnique

(3) chromatography (4) microscopy

Q.153 Which techique used for separation of immunoglobulins, cellular enzymes and m-RNA-

(1) Ion exchange chromatography

(2) Affinity chromatography

(3) Paper chromatography

(4) None of these

Q.154 1 A° is equal to

(1) 10^{-8} cm (2) 10^{-4} cm

(3) 10^{-6} cm (4) 10^{-3} cm

Q.155 Electron microscope was invented by-

(1) Knoll and Ruska

(2) Rudolph and Kolliker

(3) C.P. Swanson

(4) None of the above

Q.156 Phase contrast microscope is -

(1) based on the scattering of light and using a dark field condenser

(2) used for the study of living cells

(3) related to retardation and thickness of object

(4) the best method for studying non-living ultra structure.

Q.157 The smallest size of a cell which can be seen with unaided eye is -

(1) 1 micron (2) 10 micron

(3) 100 micron (4) 1000 micron

Q.158 A fluorescent microscpe is used -

(1) for increasing resolving power

(2) for obtaining X-ray diffraction pattern of DNA

(3) to study cell and their components in a living state

(4) To localise cell structure stained with fluorochome dyes

Q.159 Fuelgen reaction of DNA is due to -

(1) aldehyde produced by acid hydrolysis

(2) removal of RNA but not DNA

(3) phosphoric acid carbohydrated and nitrogen based

(4) phosporic acid

Q.160 The resolving power of an electron microscope is -

(1) 0.000005 nm (2) 0.0000005 um

(3) 2 μn (4) 0.025 Å

Q.161 Which cell organelle is detected with the help of sudan black :-

(1) Peroxisome (2) Glyoxysome

(3) Sphaerosome (4) Rough E.R.

Q.162 Magnification power of a light compound microscope depends on :-

(1) Power of eye piece lens

(2) Power of objective lens

(3) Source of light

(4) (1) and (2) both

Q.163 Feulgen reaction is used to stain :-

(1) DNA (2) RNA-polymerase

(3) DNA-polymerase (4) (1) and (3) both

Q.164 Microsomes are obtained by -

(1) Vital staining

(2) Sonography

(3) Fractionation of cell by ultrasonic sound waves

(4) X-ray crystallography

Q.165 Which dye is used to stain chromosomes:-

(1) Acetocarmine (2) Haematoxylin

(3) Feulgen (4) All the above

ANSWER KEY

EXERCISE - 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	2	1	1	1	4	3	2	3	2	3	2	1	3	3	4	3	1	4	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	3	3	4	4	2	3	1	2	1	1	1	2	2	4	2	1	1	2	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	4	4	2	4	4	3	3	3	2	1	1	4	3	4	2	4	4	2	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	3	1	3	2	1	4	4	1	1	3	3	1	2	4	4	3	3	4	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	1	3	4	3	2	2	1	2	4	2	2	1	4	1	1	1	2	1	3
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	4	4	4	2	4	4	3	2	3	2	3	3	1	4	4	2	2	4	1
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	2	4	3	3	1	2	4	2	1	1	3	1	4	2	1	2	4	3	2
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	1	2	1	3	4	2	3	3	4	2	4	3	2	1	1	2	3	4	1	4
Ques.	161	162	163	164	165															
Ans.	3	4	1	3	4															

EXERCISE - 2

Q.1 Which of the following is the smallest cell-
(1) Human nerve cells (2) Chlamydomonas
(3) Virus (4) PPLO

Q.2 Which of the following statements is not true-
(1) Animal cells contain ultrascopic chloroplast while plant cells contain microscopic chloroplasts
(2) Animal cells never contain chloroplasts unlike many plant cells
(3) Plant cells have central vacuoles while animal cell do not
(4) Plant cells have cellulosic cell wall while animal cell do not

Q.3 All cells are derived from pre-existing cells" is the famous generalization of-
(1) Schultz (2) Schleiden
(3) Lamarck (4) Virchow

Q.4 Which of the following is true of the carbohydrate portion of the cell membrane-
(1) It contributes to the polycationic charge on the extracellular surface
(2) It is 1% of plasma membrane
(3) It is found primarily in the form of free saccharide groups
(4) It has a symmetric distributions

Q.5 Plasmalemma of animal cells is elastic due to the presence of-
(1) Proteins (2) Lipids
(3) Carbohydrates (4) Microfilaments

Q.6 Movement of solutes across a membrane from a region of higher to a region of lower concentrations is called-
(1) Diffusion (2) Active transport
(3) Osmosis (4) Lysis

Q.7 The most abundant substance of middle lamella is-
(1) Lignin (2) Suberin
(3) Pectin (4) Cutin

Q.8 Cell wall is the secretory product of-
(1) Lysosomes (2) Cytoplasm
(3) Plasmodesmata (4) Middle lamella

Q.9 Nucleoplasm is continuous with cytoplasm through-
(1) Centriole
(2) Endoplasmic reticulum
(3) Golgi apparatus (4) Nuclear pores

Q.10 Role of nucleus in morphological differentiation was discovered in-
(1) Neurospora by Beadle and Tatum
(2) Garden pea by Mendel
(3) Drosophila by Morgan
(4) Acetabularia by Hammerling

Q.11 Which one is not a part of nucleus-
(1) Chromatin (2) Nucleoplasm
(3) Karyosome (4) Centrosome

Q.12 The size of the nucleolus is large where-
(1) Protein synthesis is active
(2) Protein synthesis is less
(3) No protein synthesis occurs
(4) None of the above

Q.13 Aerobic respiration is performed by-
(1) Iysosomes (2) Chloroplast
(3) Mitochondria (4) Glyoxysomes

Q.14 Mitochondria are most abundant in-
(1) Heart muscle (2) Muscles of thigh
(3) Wings of birds (4) None

Q.15 Cytochrome oxidases are found-
(1) On outer wall of mitochondria
(2) In the matrix of mitochondria
(3) In the lysosomes
(4) On cristae of mitochondria

Q.16 Small particles present on inner mitochondrial membrane are called-
(1) Cristae (2) Ergatosomes
(3) Elementary particles
(4) Quantasome

Q.17 Lysosomes containing inactive enzymes are called-
(1) Primary lysosomes
(2) Secondary lysosomes
(3) Residual bodies (4) Autophagosomes

Q.18 Which of the following statements best describes the functional characteristics of lysosomes-

(1) They contain enzymes that lack macromolecular specificity

(2) They function at alkaline pH

(3) Help in dissolving membrane of ovum during fertilization

(4) They function only within the intracellular compartment

Q.19 Lysosomes are called "suicide bags" because they have-

(1) Catabolic enzymes

(2) Food vacuole

(3) Hydrolytic enzymes

(4) Parasitic activity

Q.20 In which of the following cells the endoplasmic reticulum is absent-

(1) Kidney cells (2) Liver cells

(3) Mammalian mature erythrocytes

(4) Mammalian eye cells

Q.21 If cells are broken up and sedimented by centrifugation, the new structures formed in one of the fraction is-

(1) Centrosomes (2) Microsomes

(3) Peroxisomes (4) Lysosomes

Q.22 Which of the following enzyme is characteristic of Golgi complex-

(1) Cytochrome oxidase

(2) Glycosyl transferase

(3) Acid phosphatase (4) Malate synthetase

Q.23 The endoskeleton of the cell is made up of -

(1) Cell wall (2) Cytoplasm

(3) E.R. (4) Mitochondria

Q.24 Match the following

(A) Microtubules - Structural component of cilia

(B) Centrioles - Store hydrolases

(C) Peroxisomes - Stores carbohydrate, fats and proteins in plants

(1) A correct, B and C false

(2) A and C correct, B false

(3) A and B correct, C false

(4) All are false

Q.25 Genome is-

(1) Diploid set of chromosomes

(2) Haploid set of chromosomes

(3) A single chromosome

(4) None of the above

Q.26 The carbohydrates which project out of the lipid bilayer in animal cell membrane are linked to -

(1) Lipids only (2) Proteins only

(3) Peptidoglycan (4) Both lipid & protein

Q.27 In living cells mitochondria can be stained with-

(1) Neutral red (2) Janus green

(3) Crystal violet (4) Aceto-orcein

Q.28 The outer membrane of mitochondria is -

(1) Less permeable (2)Less proteinaceous

(3) Heavier (4) Larger

Q.29 Mitochondrial outputs are -

(1) ADP, CO_2 (2) ATP, O_2

(3) ATP, CO_2, H_2O (4) ATP, CO_2

Q.30 The overcoat of the plasma membrane is the handiwork of -

(1) Golgi complex (2) Lysosomes

(3) Nucleolus (4) Mitochondria

Q.31 Find out the incorrect statement -

(1) The inner mitochondrial membrane possesses succinic dehydrogenase and cytochrome oxidase.

(2) The membrane bound Krebs cycle enzyme is succinic dehydrogenase

(3) Both mitochondrial membrane are ultrastructurally similar

(4) Mitochondrial cristae are sites of oxidation-reduction reaction.

Q.32 Which is an incorrect statement -

(1) Microtubules take part in cell division

(2) Detoxification site in liver cells is in SER

(3) The nucleolus contains DNA homologous to ribosomal RNA

(4) Centrioles are located on the chromosomes

Q.33 Which of the following statements regarding cilia is not correct–

(1) Cilia contain an outer ring of nine microtubules surrounding two microtubules

(2) The organized beating of cilia is controlled by fluxes of Ca^{2+} across the membrane

(3) Cilia are hair-like cellular appendages

(4) Microtubules of cilia are composed of tubulin

Q.34 Selecting the wrong statement from the following–

(1) Both chloroplasts and mitochondria have an internal compartment, the thylakoid space bounded by the thylakoid membrane

(2) Both chloroplasts and mitochondria contain DNA

(3) The chloroplasts are generally much larger than mitochondria

(4) Both chloroplasts and mitochondria contain an inner and an outer membrane

Q.35 All the following statement are correct except–

(1) Peroxisomes are quite common in the photosynthetic cells. Their number can be 70–100 per mesophyll cell wherein they interact with mitochondria and chloroplasts to take part in photorespiration

(2) Glyoxysomes are numerous in the endosperm of wheat

(3) The ER-bound ribosomes synthesise secretory membrane and lysosomal protein

(4) Ribosomes when associated with ER are attached with their 60S sub-unit

Q.36 Why the material should be dry, thin and kept in vacuum in electron microscope–

(1) To get straight beam of electrons

(2) To avoid collision of electrons with atoms of O_2 and N_2

(3) To avoid multiple scattering of electrons

(4) All correct.

Q.37 Electron microscope is better than light microscope because–

(1) It has high magnification

(2) It has high resolution

(3) It gives 2D/3D images

(4) all are correct

Q.38 O^{18} was used in H_2O to prove that O_2 comes from H_2O in photosynthesis by Rube and Kamen. C^{14} was used by Calvin to discover dark reaction. N^{15} is used in the study of–

(1) Chromosome replication

(2) DNA replication

(3) Protein synthesis

(4) C_4 Cycle.

Q.39 A student wants to study metaphasic behaviour of chromosomes. The most suitable tool is–

(1) Phase contrast microscope

(2) X-ray microscope

(3) Cell fractionation

(4) Scanning electron microscope

Q.40 Which of the following is the better explanation of earlier discovery of the "Nucleus" than the "Cell Theory"–

(1) Nucleus is a more important structure than cytoplasm.

(2) Robert Brown had a better microscope.

(3) Nuclei take a darker stain than other parts of a cell.

(4) Nucleus is a visible body while cell theory is an abstract generalization.

Q.41 Choose the correct statement–

(1) Ribosomal subunits are united during protein synthesis.

(2) Ribosomal subuits always remain united.

(3) Ribosomal subunits are united in nucleus during r-RNA synthesis.

(4) All are correct statements.

Q.42 Which of the following observations most strongly support the view that mitochondria have elctron transport system/enzymes–

(1) Mitochondria have a property to concentrate in cells which form locomotory structures.

(2) Disruption of mitochondria yields membrane fragments which are able to synthesize ATP.

(3) Mitochondria have a folded inner membrane.

(4) Acontractile protein capable of utilizing ATP is obtained from mitochondria.

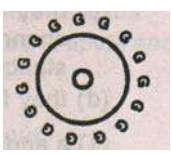
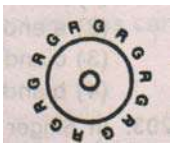
Q.43 What is correct ?
(1) Nucleosomal organisation provides a chromatin fibre about 10 nm in thickness and chromatin fibres further condensed to produce a solenoid of 30 nm diameter.
(2) The solenoid structure further coils to produce a chromatin fibre of 200 nm and then a chromatid of 700 nm diameter.
(3) All the folded loops of chromatin are held to gether
(4) All of the above.

Q.44 The eukaryotic cells are essentially two envelope system because they contain–
(1) Cell wall and plasmamembrane
(2) Plasmamembrane and Nuclear membrane
(3) Plasmamembrane and Tonoplast
(4) Double membrane bound cell organelles

Q.45 Which of the following statement justifies that "the cell is a self-contained unit"–
(1) It independently carries out all fundamental biological processes.
(2) It oxidises food molecules to produce energy and utilises this energy to synthesise complex molecules.
(3) Reproduces with similar hereditary properties.
(4) All of the above.

Q.46 The significance of phospholipid bilayer in plasma membrane is to form–
(1) Water resistant barrier
(2) To allow only carbohydrate substances to pass
(3) Passage for free flow of ions
(4) To allow easy passage of proteins

Q.47 Man and mouse cells are treated with red rhodamine and Green fluorescent dyes separately and then are made to fuse. The resultant cells when kept at 37ºC, the distribution of dye on the surface of cell will be like–

(1)
(2) 
(3)
(4) 

Q.48 Muramic acid is present in cell walls of -
(1) Bacteria and blue-green algae
(2) Green algae
(3) Yeast (4) All fungi

Q.49 Growth of cell wall during cell elongation takes place by -
(1) Apposition (2) Intussuseption
(3) Both A and B (4) Super position

Q.50 Plasmodesmata are -
(1) Pores in cell wall
(2) Pores in cell membrane
(3) Protoplasmic connections
(4) A and B both

Q.51 Which element mainly occurs in middle lamella-
(1) Ca (2) Mg
(3) Na (4) K

Q.52 Cell membrane is composed of -
(1) Proteins and cellulose
(2) Proteins and phospholipids
(3) Proteins and carbohydrates
(4) Proteins, phospholipids and some carbohydrates

Q.53 Which of the following is main enzyme of plasma membrane -
(1) TPP ase (2) ATP ase
(3) Peptidyl transferase (4) Catalases

Q.54 Percentage of intrinsic proteins in the total proteins of plasma membrane -
(1) 70% (2) 20% (3) 10%
(4) 90%

Q.55 Cell wall was discovered by -
(1) Robert brown (2) Malpighi
(3) Robert Hooke (4) Nageli

Q.56 Cell wall is -
(1) Dead and impermeable
(2) Dead and permeable
(3) Living and impermeable
(4) Living and selective

Q.57 Tonofibrils are characteristic of which junction-
(1) Desmosomes (2) Plasmodesmata
(3) Gap junction (4) Tight junction

Q.58 Torus is composed of -

(1) Suberin (2) Chitin

(3) Cutin (4) Lignin

Q.59 Carbohydrates which present in the cell membrane take part in -

(1) Transport of substance

(2) Cell recognition

(3) Attachement to microfilament

(4) Attachement to microtubules

Q.60 Plasma membrane is fluid structure due to presence of -

(1) Carbohydrate (2) Lipid

(3) Glyco protein (4) Poly saccharide

Q.61 In which cell-surface junction fused membrane reveals five-layered structure -

(1) Pemosomes (2) Zona occludence

(3) Gap-junction (4) Plasmodesmata

Q.62 Which type of cell surface junctions abundantly occur in epithelial tissues -

(1) Nexus (2) Desmosomes

(3) Zona occludence (4) Plasmodesmata

Q.63 Amphipathic molecule in pasma membrane is -

(1) Protein (2) Carbohydrates

(3) Phospholipids (4) All the above

Q.64 The average thickenss of plasma membrane is-

(1) 70 Å (2) 75 – 100 Å

(3) 100 – 150 Å (4) 200 Å

Q.65 Unit membrane model of plasma membrane was proposed by -

(1) Robertson (2) Singer

(3) Denielli (4) Robert Hook

Q.66 Pit membrane of simple pit is formed by -

(1) Secondary cell wall

(2) Middle lamella

(3) Primary cell wall

(4) plasma membrane

Q.67 Term plasmodesmeta was first used by -

(1) Leuwenhock (2) De duve

(3) Strasburger (4) Porter

Q.68 Primary cell wall formed by -

(1) Intussuception

(2) Apposition

(3) Intussusception & lignification

(4) Mineralization

Q.69 Cell wall of prokaryotes is made up of -

(1) Chitin (2) Cellulose

(3) Glucose amine (4) Mucopepitde

Q.70 Butter Sandwich model of plasma membrane was proposed by -

(1) Davson and Danielli

(2) Robertson

(3) Singer and Nicolson

(4) Benson

Q.71 The Singer's Model of Plasma membrane differs from the Robertson's model in the -

(1) Number of lipid layers

(2) Arrangement of proteins

(3) Arrangement of lipid layers

(4) Absence of protein layers

Q.72 Ingestion of solid food by plasma membranes is called -

(1) Endosmosis (2) Pinocytosis

(3) Cytokinesis (4) Phagocytosis

Q.73 In order to find out quickly whether the cells are living one must observe -

(1) Cell sap

(2) Tonoplast

(3) Movement of Cytoplasm

(4) Starch ganules

Q.74 Which one is widely distributed in a cell -

(1) DNA (2) RNA

(3) Plastids (4) Golgi

Q.75 Maximum enzymes are found in -

(1) Lysosomes (2) Mitochondria

(3) Nucleus (4) E.R.

Q.76 Rough E.R. mainly responsible for -

(1) Protein synthesis

(2) Cell wall formation

(3) Lipid synthesis

(4) Cholesterol synthesis

Q.77 Besides producing secretory vescles, the function of golgibody is -
(1) Lysosome formation
(2) Formation of spindle fibers
(3) Formation of E.R.
(4) All the above

Q.78 Mitochondria supply most of the necessary biological energy through -
(1) Breaking down sugars
(2) Reducing NADP
(3) Oxidising substrates of TCA cycle
(4) Breaking down proteins

Q.79 Enzymes for ETS occurs in (mitochondria)-
(1) Matrix
(2) Outer wall
(3) Inner membrane
(4) Between inner & outer wall

Q.80 Which cell organelle secretes zymogen granules-
(1) Lysosomes (2) Golgibody
(3) Smooth E.R. (4) Sphaerosomes

Q.81 Mitochondrial DNA is -
(1) Naked (2) Circular
(3) Double stranded (4) All the above

Q.82 Which structures are responsible for lipid synthisis repectively in plants and animal cells-
(1) Smooth E.R.
(2) Smooth and rough E.R.
(3) Smooth E.R. and peroxisomes
(4) Sphaerosomes and smooth E.R.

Q.83 Lysosomes are not helpful in -
(1) Osteogenesis
(2) Cellular digestion
(3) Metamorphosis in frog
(4) Lipogenesis

Q.84 Digestion of hormonal vesicle by lysosome is called -
(1) Crinophagy (2) Heterophagy
(3) Autophagy (4) Autolysis

Q.85 In mammals, the mitochondrial ribsosomes are-
(1) 55 s (2) 70 s
(3) 80 s (4) 100 s

Q.86 Which of the following provides mechanical support and shape to the cell -
(1) Golgi complex (2) Centrioles
(3) Lomasomes (4) E.R.

Q.87 Mitochondria are site of respiration first reported by Kingsbury and supported by Hogeboom. Mitochondira are related with the oxidation of-
(1) Carbohydrates (2) Fats
(3) Proteins (4) All the above

Q.88 Peptidyl tranferase enzyme found on -
(1) Cytoplasm (2) E.R.
(3) Golgibody (4) Ribosomes

Q.89 Which of the following transport the cell well material from dictyosome -
(1) Microtubles (2) Microfilament
(3) E.R. (4) Microbodies

Q.90 Golgibody is absent in -
(1) Prokaryotes
(2) Mature mammalian R.B.C.
(3) Akaryotes (4) All the above

Q.91 Which cell organelles release oxygen -
(1) Mitochondria (2) Golgi body
(3) Chloroplast (4) Ribosome

Q.92 One of the following is present outside the plasma membrane but inside the cell-wall-
(1) Sphaerosome (2) Peroxisome
(3) Lomasome (4) Golgi body

Q.93 Lysosome containing bone cells are called-
(1) **Osteo blast** (2) Fibro blast
(3) Osteoclast (4) Condrioblast

Q.94 Chemical modification of substance like glycosidation of protein and lipid occur in-
(1) Endoplasmic reticulum
(2) Golgi body
(3) Lysosome (4) Ribosome

Q.95 Most of the cell-organelles are derived from which structure of cell -
(1) Nucleus
(2) Endoplasmic reticulum
(3) Mitochondria
(4) Chloroplast

Q.96 Ribophorin-I and II occur on the surface of-
(1) Rough E.R. (2) Smooth E.R.
(3) Golgi body (4) None

Q.97 At which pH lysosomal enzymes remain active-
(1) pH -5 (2) pH - 7
(3) pH - 8 (4) pH - 10

Q.98 Synthesis of cellulose and hemicellulose take place in -
(1) Micro bodies (2) Smooth E.R.
(3) golgi complex (4) Lysosome

Q.99 Main function of golgi-complex is -
(1) Fermentation
(2) Phosphorylation
(3) Respiration
(4) Packaging of materials for secretion

Q.100 Functional unit of protein synthesis is -
(1) Dictysome (2) Polysome
(3) Peroxisome (4) Lysosome

Q.101 Which of the following is a main source of cellular membranes -
(1) Endoplasmic reticulum
(2) Golgi body
(3) Mitochondria (4) Nucleus

Q.102 Mark the lysosomal stabilizer-
(1) Vitamin -K (2) Vitamin-A
(3) Cortisone (4) Progesterone

Q.103 The nuclear membrane originate from -
(1) E.R. (2) Golgi cisternae
(3) Golgi vesicle (4) Lysosome

Q.104 Which of the following prevents the rupturing of lysosomal membrane -
(1) Cholesterol (2) Vit. A
(3) Testosterone (4) UV - rays

Q.105 Ground substance present inside the mitochondria is called -
(1) Stroma (2) Matrix
(3) Cell sap (4) Cytoplasm

Q.106 The stored food and secretory substances found in the cytoplasm makes -
(1) Cytoplasm (2) Hyaloplasm
(3) Protoplasm (4) Deutoplasm

Q.107 During germination which cell organelle converts fatty acid into soluble carbohydrate-
(1) Peroxisome (2) Glyoxysome
(3) Sphaerosomes (4) Lysosome

Q.108 A single unit membrane organelle is -
(1) Ribosomes (2) Mitochondria
(3) Chloroplast (4) Lysosomes

Q.109 Double layered organelle are -
(1) Ribosomes (2) Mitochondria
(3) Lysosomes (4) Centriole

Q.110 Substance which is synthesized in golgi body is-
(1) Protein (2) Polysaccharides
(3) Fats (4) ATP

Q.111 True Statement about Mitochondria is -
(1) Change in shape and size and division both occur
(2) Do not change shape but division occurs
(3) Do not change shape and size and division not occurs
(4) Change shape but division does not occur

Q.112 E.R. is not related with -
(1) Plasmalemma (2) Golgibody
(3) Mitochondria (4) Nucleus

Q.113 The chlorophyll pigment is readly soluble in-
(1) Water (2) Acids
(3) Alkalies (4) Acetone

Q.114 Enzymes are synthesized on -
(1) Dictyosomes (2) Ribosome
(3) Mitochondria (4) None of the above

Q.115 Which is not true about sphaerosomes -
(1) Involved in photorespiration
(2) Arise from E.R.
(3) Related to fat metbolism
(4) Single membane bound

Q.116 Elaiplasts absent in -
(1) **Potato** (2) **Cocus nucifera**
(3) **Arachis hypogea** (4) **Helianthus**

Q.117 Which ion holds the ribosomal subunits toghether-
(1) Ca^{+2} (2) Mn^{+2}
(3) Mg^{+2} (4) Na^{+}

Q.118 Mitochondria and chloroplast are considered to be endosymbionts of cell because they -

(1) Possess their own nucleic acid

(2) Have capacity of ATP synthesis

(3) Do not reproduce

(4) All the above

Q.119 Peroxysomes contain -

(1) Hydrolytic enzyme

(2) Transferase

(3) Isomerase

(4) Oxidising enzyme (Oxidase)

Q.120 What is the angle between two centriole of a centrosome -

(1) 30º (2) 45º

(3) 60º (4) 90º

Q.121 In which of the following cell centriole is absent-

(1) Epithelial cell (2) Gland cell

(3) Liver cells (4) Nerve cell

Q.122 Ribosomes are -

(1) Positively charged

(2) Negatively charged

(3) Amphoteric (4) Neutral

Q.123 On which concentration of Mg^{+2} ions units of ribosome is combined -

(1) 0.0001 M (2) 0.001 M

(3) 0.01 M (4) 0.10 M

Q.124 Plastids which store fats and oils are called-

(1) Aleuroplast (2) Amyloplast

(3) Etioplast (4) Elaioplast

Q.125 Biogenesis of eucaryotic Ribosomes takes place in -

(1) Mitochondria (2) Chloroplast

(3) Both (1) and(2) (4) Nucleolus

Q.126 Red colour of tomato and chilly is due to-

(1) Lycopene in chloroplast

(2) Xanthophylls in chromoplast

(3) Lycopene in chromoplast

(4) Anthocyanin in leucoplast

Q.127 Anthocyanin pigment occurs in -

(1) Chromoplasts (2) Amyloplasts

(3) Cytoplasm (4) Cell sap

Q.128 Which of the cilia protein is analogous to myosin of muscles -

(1) Tubulin (2) Dynien

(3) Flagellin (4) None of these

Q.129 Blepheroplast is a type of -

(1) Centriole (2) Plastid

(3) Cilia (4) Mitochondria

Q.130 Pericarp and petals contain -

(1) Chloroplast (2) Chromoplast

(3) Leucoplast (4) Etioplast

Q.131 Arrangement of microtubules in centriole is-

(1) 9 + 2 (2) 2 + 9

(3) 11 + 0 (4) 9 + 0

Q.132 Which of the following plastids are helpful in starch formation and storage -

(1) Chromoplast (2) Leucoplasts

(3) Chloroplast (4) Lycopene

Q.133 Which of the following enzymes are found in matrix of peroxisomes -

(1) NADH cytochrome reductase

(2) Glyoxidases and malate dehydrogenase

(3) Acid phosphatases and isocitirc lysase

(4) Catalases and oxidases

Q.134 Sedimentation coefficient of mitoribosomes of higher plants is -

(1) 80s (2) 70s

(3) 65s (4) 55s

Q.135 The Ribosomes are made up of

(1) DNA + Protein (2) RNA + Protein

(3) DNA + RNA (4) None of these

Q.136 Functional unit of Chloroplast is -

(1) Stroma (2) Quantasome

(3) Oxysomes (4) Peroxysomes

Q.137 Nuclear pores are guarded by -

(1) DNA (2) Annulus

(3) Protein (4) None

Q.138 Lampbrush chromosomes are observed in-

(1) insect larva (2) Oocytes

(3) Sperms (4) Sallvary glands

Q.139 Which of the following stimulates balbiani ring formation in polytene chromosomes -

(1) Dynien (2) Juvenile harmone

(3) Ecdyson (4) Histone

Q.140 Small chromosomes which do not produce any detectable phenotypic expression are termed -

(1) Heterochromatic chromosomes

(2) Supernumerary chromosomes

(3) Nonsence chromosomes

(4) Nucleoids

Q.141 Genome is -

(1) Part of chromosome

(2) Half chromosome

(3) Total DNA in cell

(4) A complete set of chromosomes

Q.142 True chromosomes absent in prokaryotes due to the absence of -

(1) Nucleus (2) Nucleolus

(3) Histone (4) All the above

Q.143 A complete set of chromosomes inherited as an unit from one parent is known as -

(1) Karytype (2) Gene pool

(3) Genotype (4) Genome

Q.144 Nucleolus in Eukaryotic cell is -

(1) Nonliving

(2) Visible at metaphase

(3) Bounded by a membrane

(4) The site of packaging of r-RNA with proteins

Q.145 Site of m-RNA syntesis in lampbrush chromosomes is -

(1) Balbiani ring (2) Lateral loops

(3) Dark bands (4) Light bands

Q.146 Which of the following character is not taken into consideration while preparing a karyotype-

(1) Chromosomal length

(2) Arm ratio

(3) Position of sec. constriction

(4) Length of chromonemata

Q.147 The non-sticky chromosomal ends are knwon as-

(1) Chromatids (2) Centromere

(3) Chromomere (4) Telomere

Q.148 Lambrush chromosome contain -

(1) One chromatid (2) Two chromatid

(3) Three chromatid (4) Several chromatid

Q.149 Highest arm ratio occur in which chromosome-

(1) Telocentric (2) Metacentric

(3) Submetacentric (4) Acrocentric

Q.150 Toludene blue specifically stains :-

(1) DNA (2) RNA

(3) Chitin (4) Lignin

Q.151 Which stain is used for electron microscopy-

(1) PAS

(2) Aurantia

(3) Para Rosailin

(4) Osmium tetraoxide

Q.152 Which stain is commonly used in study of cell division :-

(1) Feulgen reaction (2) Acetocarmine

(3) Eosine (4) Saffranine

Q.153 Which one is a vital stain :-

(1) Janus green (2) Methylene blue

(3) Neutral red (4) All the above

Q.154 Which of the following are nuclear stains :-

(1) Aceto Carmine (2) Haematoxylene

(3) Saffranine (4) (1) and (2) both

Q.155 Cell organelles can be separated by method of:-

(1) Autoradiogrphy

(2) Microtomy

(3) Differential centrifugation

(4) X-ray differaction

Q.156 Structure of RNA can be studied by :-

(1) Feulgen

(2) Toludene blue

(3) X-ray crystallography

(4) Chromatography

Q.157 Chlor-zinc iodide (schultz solution) stains:-

(1) Cellulose (2) Protein

(3) Chitin (4) Lipid

Q.158 Light compound microscope with 15 x eye piece lense and 45 x objective lense will have a magnification of -

(1) 2000 (2) 675

(3) 1000 (4) 500

Q.159 Calvin isolated the different chemicals of calvin cycle by :-

(1) Autoradiography (2) Chormatography

(3) Cell fractionation (4) x-ray diffraction

Q.160 In feulgen technique, schiff reagent reacts with -

(1) Phosphate group

(2) CHO group of deoxyribose

(3) Nitrogen bases

(4) Only purine nitrogen base

Q.161 In electron microscope source of light is :-

(1) White light

(2) U.V ray

(3) Electron beam

(4) Green light

Q.162 Ultra sonic sound waves are used in which tecnique of cytology :-

(1) X-ray diffraction

(2) Chromatograpgy

(3) Cell fractionation

(4) Autroradiography

Q.163 In light compound microscope the power of oil immersion lens is :-

(1) 10 X (2) 20 X

(3) 45 X (4) 100 X

Q.164 The best microscope to study ultra structure of cell is :-

(1) Phase contrast microscope

(2) Electron microscope (EM)

(3) Scanning electron microscope (SEM)

(4) Flourescent mcroscope

ANSWER KEY

EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	4	2	2	1	3	2	4	4	4	1	3	1	4	3	1	3	3	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	2	3	1	2	4	2	2	3	1	3	4	2	1	2	4	4	2	1	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	4	2	4	1	4	1	2	3	1	4	2	1	3	2	1	1	2	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	2	3	2	1	2	3	1	4	1	2	4	3	2	2	1	1	3	3	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	4	4	1	1	4	4	4	1	4	3	3	3	2	2	1	1	3	4	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	3	1	1	2	4	2	4	2	2	1	3	4	2	1	1	3	1	4	4
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	4	2	3	4	4	3	4	2	1	2	4	2	4	2	2	2	2	2	3	2
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	4	3	4	4	2	4	4	2	4	2	4	2	4	4	3	3	1	2	1	2
Ques.	161	162	163	164																
Ans.	3	3	4	2																

EXERCISE -3 PREVIOUS YEAR'S QUESTIONS

Q.1 Hydrolytic enzymes are abundantly found in which cell organelles - **[RPMT 2004]**

(1) Ribosome

(2) Lysosome

(3) Oxysome

(4) Endoplasmic reticulum

Q.2 Which of the following is the site of lipid syntesis - **[RPMT 2002]**

(1) Rough ER (2) Smooth ER

(3) Golgi bodies (4) Ribosome

Q.3 Ribosomes are produced in -**[CPMT 2002]**

(1) Nucleolus (2) Cytoplasm

(3) Mitochondria (4) Golgibody

Q.4 Which of the following pair lack the unit membrane - **[RPMT 2002]**

(1) Nucleus & E.R.

(2) Mitochondria & Chloroplast

(3) Ribosome & nucleolus

(4) Golgi body & lysosome

Q.5 Golgybody is concerned with -

(1) Respiration (2) Secretion

(3) Excertion (4) Degradation

Q.6 Which of the following occurs more than one and less than five in achromosome - **[CPMT 2002]**

(1) Chromatid (2) Chromomere

(3) Centromere (4) Telomere

Q.7 The cells without nuclei are present in - **[RPMT 2002]**

(1) Vascular cambium (2) Root hair

(3) Companion cell

(4) Members of seive tube

Q.8 Plant with minimum number of chromosomes is - **[RPMT 2004]**

(1) Haplopappus gracilis

(2) Salix tetrasperma

(3) Poa (4) Cynodon

Q.9 Heteropycnosis is exhibited by -

(1) Autosome **[RPMT 2004]**

(2) Chromatoid body

(3) Nucleolus (4) Sex-chromosome

Q.10 Best material for the study of mitosis in laboratory - **[CPMT 2002]**

(1) Anther (2) Root tip

(3) Leaf tip (4) Ovary

Q.11 Mitosis occurs in - **[RPMT 2002]**

(1) Haploid individuals (2) Diploid individuals

(3) Both (1) & (2) (4) IN bacterial only

Q.12 The number of DNA in chromosome at G_2 state of cell cycle - **[RPMT 2002]**

(1) One (2) Two

(3) Four (4) Eight

Q.13 Which is correct for meiotic metaphase-I **[RPMT 2002]**

(1) Bivalents are arranged at equator

(2) Univalents are arranged at equator

(3) Non-homologus chromosomes forms pair

(4) Spindle fibers are attached at chromomere

Q.14 In which stage of meiosis the chromosome number reduces to half - **[RPMT 2004]**

(1) Anaphase-I (2) Anaphase-II

(3) Telophase-I (4) Telophase-II

Q.15 Chiasmata are formed as a result of - **[RPMT 2004]**

(1) Exchange of parts of paired homologus chromosome

(2) Exchange to part of unpaired non-homologus chromosome

(3) Duplication of parts of paired homologus chromosome

(4) Loss of parts of unpaired non-homologus chromosome

Q.16 If the n = 16 in plant cell then how many possible bivalent in metaphase - I of meiosis- **[RPMT 2007]**

(1) 32 Bivalents (2) 16 Tetravalents

(3) 16 Bivalents (4) 32 Bivalents

Q.17 The main function of lysosome is - **[UTTARANCHAL PMT 2004]**

(1) Sexual reproduction

(2) Extracellular digestion

(2) Intracellular digestion

(4) Both (2) and (3)

Q.18 Which of the following maintains continuity between the water and lipid phases inside and outside the cells -

[UTTARANCHAL PMT 2004]

(1) Cell wall

(2) Lecithin

(3) Cell vacuole

(4) Cell membrane of woody plants

Q.19 The membrane surrounding cell vacuole is called - **[UTTARANCHAL PMT 2004]**

(1) Tonoplast (2) Cell wall

(3) plasma membrane (4) cell membrane

Q.20 The diagrammatic representation of chromosomes is known as - **[UTTARANCHAL PMT 2006]**

(1) idiogram (2) karyotype

(3) holotype (4) homotype

Q.21 Thread like structures that are composed of the nuclear DNA of eukaryotic cells and are the carrier of genetic information. These structures were known as chromosomes. The term "chromosome" was given -

[UTTARANCHAL PMT 2006]

(1) Waldeyer (2) Balbiani

(3) Purkinje (4) Sutton

Q.22 Chromosomes, present in prolonged prophase in the salivary glands of Drosophila are -

[UTTARANCHAL PMT 2006]

(1) Polytene chromosome

(2) B-Chromosomes

(3) Lampbrush chromosome

(4) supenumerary chromosomes

Q.23 Chromosomes at anaphase are of various shapes due to position of -

[UTTARANCHAL PMT 2006]

(1) Setellite (2) Chromonema

(3) Centromere (4) DNA

Q.24 The term 'nucleosome' was given by oudet olins' and olins called these particle as "nu" particles which histone is absent in nucleosome-

[UTTARANCHAL PMT 2006]

(1) H_1 (2) H_2

(3) H_3a (4) H_4

Q.25 Nucleosome given beaded appearance to chromosome. They help in packing of DNA in the chromosomes. A nucleosome has -

[UTTARANCHAL PMT 2006]

(1) about 2 turns of DNA

(2) 8 histone molecules of 4 types (2 mols each of H_2 a, H_2b, H_3 and H_4)

(3) 200 nitrogen base pairs

(4) all of the above

Q.26 Salivary glands chromosome were discovered by Balbiani (1881) from salivary glands of larva of - **[UTTARANCHAL PMT 2006]**

(1) Chironomous (2) Drosophila

(3) Silk worm (4) Lac worm

Q.27 In SAT chromosome, SAT (Satellite) is terminal part of chromosome beyond secondary contriction. It contains -**[UTTARANCHAL PMT 2006]**

(1) DNA (2) RNA

(3) repetitive DNA (4) None of these

Q.28 Material exchange through nucleopores is faciliate by- **[UTTARANCHAL PMT 2006]**

(1) Lamina propria (2) lipid layer

(3) Nucleoplasmin (4) Nucleoles

Q.29 Centriole is -

[UTTARANCHAL PMT 2006]

(1) Microtubuler and membraneless

(2) Absent in Amoeba, red algae, blue-green algae conifers and angiosperm and made up of peripheral Trilet microtubuls

(3) Basically locomotary and their role in spindle formation is secondary

(4) All of the above

Q.30 Association of m-RNA with several ribosomes is called - **[West Bengal 2007]**

(1) Polysome (2) Informosome

(3) Both (1) and (2) (4) None of these

Q.31 G_2 phase comes between -

[West Bengal 2007]

(1) S and M phase (2) G_1 and S phase

(3) S and D phase (4) G_1 and M phase

Q.32 Lampbrush chromosome is found in -

[Wes Bengal 2007]

(1) Oocyte of amphibians

(2) Salivary gland of mosquito

(3) Silk gland of silkworm

(4) None of the above

Q.33 Prokaryotic ribosomes are - **[West Bengal 2007]**

(1) 50s (2) 60s

(3) 70s (4) 80s

Q.34 Mesosomes of prokaryotes perform function similar to - **[West Bengal 2007]**

(1) Mitochondria (2) Peroxysomes

(3) Lysosomes (4) Ribosomes

Q.35 RER is rough bucause of the presence of- **[West Bengal 2007]**

(1) Volutin granules on its

(2) Ribosomes on its surface

(3) Lysosomes on its surface

(4) Mitochondria on its surface

Q.36 Crossing over takes place between - **[West Bengal 2007]**

(1) 2 sister chromatids

(2) 2 non-sister chromatids

(3) 3 homologous chromosomes

(4) 4 non-homologous chromosomes

Q.37 Cellular recognition is fasciliated by components of plasmamembrane. These components are generally - **[West Bengal 2007]**

(1) Protein molecules alone

(2) Lipid molecules alone

(3) Both lipid and protein molecules

(4) Gloycolipids and glycoproteins

Q.38 The significance of meiosis lies in - **[C.G. PMT 2004]**

(1) Maintaining constancy in the number of chromosomes in an organism

(2) Production of genetic variability in the population of species

(3) Reduction of the diploid number of chromosomes to haploid

(4) All of the above

Q.39 Which among the following can be seen only under the electron microscope - **[C.G. PMT 2004]**

(1) Chloroplast (2) Ribosome

(3) Leucoplast (4) Nucleus

Q.40 A mature plant cell has - **[C.G. PMT 2004]**

(1) Cell wall and protoplasm

(2) Protoplasm and vacuole

(3) Vacuole and cell wall

(4) Protoplasm cell wall and vacuole

Q.41 The larger sub-unit in 80 s ribosome is - **[C.G. PMT 2004]**

(1) 50 s (2) 60 s

(3) 40 s (4) zero s

Q.42 Golgi bodies are absent in - **[C.G. PMT 2004]**

(1) Plants (2) Bacteria

(3) Animals (4) Eukaryotic cells

Q.43 Endoplasmic reticulum is more developed in- **[C.G. PMT 2004]**

(1) Green cells (2) Young cells

(3) Mature cells (4) Bacteriophage

Q.44 Mitochondria are related to - **[C.G. PMT 2004]**

(1) Prokaryotic cell (2) Plasmids

(3) Prion (4) Virus

Q.45 The main function of lysosomes is - **[C.G. PMT 2004]**

(1) Digestion (2) Replication

(3) Translation (4) Translocation

Q.46 Which of the following has a single membrane - **[C.G. PMT 2004]**

(1) Ribosome (2) Peroxisome

(3) Nucleus (4) Centrosome

Q.47 L-shaped chromosomes are called - **[C.G. PMT 2004]**

(1) Sex-chromosome (2) Acrocentric

(3) Telocentric (4) Sub-metacentric

Q.48 Pairing of homologous chromosomes takes place in - **[C.G. PMT 2004]**

(1) Pachytene (2) Zygotene

(3) Diplotene (4) None of these

Q.49 How many meiotic divisions will be necessary to produce two hundred pollen grain - **[C.G. PMT 2004]**

(1) 100 (2) 99

(3) 50 (4) 200

Q.50 Who coined the term chromosome - **[C.G. PMT 2004]**

(1) Balbiani (2) Waldeyer

(3) Sutton (4) Purkinje

Q.51 A chromosome having sub-terminal centromere is called - **[C.G. PMT 2004]**

(1) Telocentric (2) Acrocentric

(3) Metacentric (4) Sub-metacentric

Q.52 Which is the character of mitosis - **[C.G. PMT 2005]**

(1) Leptotene (2) Zygotene

(3) Pachytene (4) None of the above

Q.53 How many types of cells are known - **[C.G. PMT 2005]**

(1) One (2) Two

(3) Three (4) Four

Q.54 In which mitosis does-not occur - **[C.G. PMT 2005]**

(1) Green algae (2) Fungi

(3) Bacteria (4) Higher plants

Q.55 A mature plant cell has - **[C.G. PMT 2005]**

(1) Cell wall (2) Vacuole

(3) Protoplasm (4) All of the above

Q.56 Repulsion of homologous chromosomes takes place in - **[C.G. PMT 2005]**

(1) Zygotene (2) Leptotene

(3) Diakinesis (4) Pachytene

Q.57 In eukaryotic cell the type of ribosome is- **[C.G. PMT 2005]**

(1) Only 70 s (2) Only 80 s

(3) 70 s and 80 s both

(4) Only 50 s

Q.58 Synthesis of DNA takes place in - **[C.G. PMT 2005]**

(1) G_1 (2) G_2

(3) S (4) None of these

Q.59 The genetic material of procaryotic cells is called- **[C.G. PMT 2005]**

(1) Nucleus (2) Nucleolus

(3) Nucleoid (4) Centrosome

Q.60 Which organelle of plant cells secrets polysaccharide to make cell walls - **[C.G. PMT 2005]**

(1) Golgi-bodies (2) Lysosome

(3) Mitochondria (4) Chloroplast

Q.61 RNA contains which of the following base, in place of Thymine of DNA - **[C.G. PMT 2005]**

(1) Thymine (2) Uracil

(3) Adenine (4) None of these

Q.62 The main function of lysosomes is in - **[C.G. PMT 2005]**

(1) Only intracellular digestion

(2) Only Extracellular digestion

(3) Both intracellular and extracellular digestion

(4) None

Q.63 Eukaryotic cell has - **[C.G. PMT 2005]**

(1) One chromatin fiber

(2) Definite nucleus

(3) Incipient nucleus

(4) None of these

Q.64 Four daughter cells formed after meiosis are - **[C.G. PMT 2005]**

(1) Genetically similar

(2) Genetically different

(3) Anucleate

(4) Multinucleate

Q.65 The synthesis of lipids and proteins is associated with - **[C.G. PMT 2005]**

(1) Endoplasmic reticulum

(2) Miochondria

(3) Chloroplast

(4) Lysosomes

Q.66 Cell theory was proposed by - **[C.G. PMT 2005]**

(1) Schleiden and Schwann

(2) Watson and Crick

(3) Drawin and Wallace

(4) Mendel and Morgan

Q.67 During meiosis the division of centromere takes place in - **[C.G. PMT 2005]**

(1) First prophase (2) First anaphase

(3) Second metaphase (4) Second anaphase

Q.68 Which one of the following is not found in animal cell - **[C.G. PMT 2005]**

(1) Nucleus (2) Golgi bodies

(3) Chloroplast (4) Mitochondria

Q.69 Unit membrane consists of - **[C.G. PMT 2005]**

(1) Lipid + Sugar + Lipid

(2) Protein + Lipid + Protein

(3) Lipid + Protein + Lipid

(4) Protein

Q.70 Principal constituents of chromosomes are- **[C.G. PMT 2005]**

(1) DNA + Protein (2) DNA

(3) RNA (4) tRNA

Q.71 Shape of chromosome is determined by - **[C.G. PMT 2005]**

(1) Telomere (2) Centromere

(3) Chromomere (4) Centrosome

Q.72 In a bacterial cell the respiratory enzymes are found in - **[C.G. PMT 2005]**

(1) Mitochondria (2) Chondrisome

(3) Mesosome (4) Centrosome

Q.73 The cell wall of Spirogyra is made up of - **[C.G. PMT 2005]**

(1) Cellulose (2) Suberin

(3) Lignin (4) Chitin

Q.74 The main function of Golgi complex is - **[C.G. PMT 2005]**

(1) Translocation (2) Phosphorylation

(3) Glyco-oxidation (4) Fermentation

Q.75 In cell division, spindle fibres are made up of protein - **[Jharkhand 2006]**

(1) Myoglobin (2) Tubulin

(3) Albumin (4) Myosin

Q.76 Bulk of histone proteins synthesized in - **[Jharkhand 2006]**

(1) G_1-phase (2) G_2-phase

(3) S-phase (4) G_0-phase

Q.77 Choose the incorrect match - **[Jharkhand 2006]**

(1) Nucleus : RNA

(2) Lysosome : protein synthesis

(3) Mitochondria : respiration

(4) Cytoskeleton : microtubules

Q.78 Rough endoplasic reticulum is associated with- **[Jharkhand 2006]**

(1) fat synthesis (2) steroid synthesis

(3) protein synthesis (4) all of these

Q.79 Resolving power of electron microscope is- **[Jharkhand 2006]**

(1) 1 μ (2) 10 Å

(3) 100 Å (4) 1000 Å

Q.80 Number of Barr bodies in XXXXY is - **[Jharkhand 2006]**

(1) 1 (2) 2

(3) 3 (4) 4

Q.81 The study related to the structure and function of a cell is called as - **[Jharkhand 2005]**

(1) Physiology (2) Cell biology

(3) Histology (4) Cytology

Q.82 The longest phase of meiosis (I) is - **[Jharkhand 2005]**

(1) metaphse I (2) prophase I

(3) anaphase I (4) telophase I

Q.83 Fluid mosaic model was given by - **[Jharkhand 2006]**

(1) Knoll and Ruska (2) Singer and Ruska

(3) Singer and Nicolson

(4) Bateson and Punnet

Q.84 Colchicine prevents the mitosis of cell at - **[Jharkhand 2006]**

(1) Prophase stage (2) Anaphase stage

(3) Telophase stage (4) Metaphase stage

Q.85 The number of DNA in chromosome at G_2 stage - **[Jharkhand 2006]**

(1) One (2) Two

(3) Four (4) Eight

Q.86 The characteristic of blue-green algae is - **[Jharkhand 2006]**

(1) DNA without histone

(2) Nucleus absent

(3) Nuclear membrane absent

(4) All of the above

Q.87 Cell wall of a cell is removed, the remaining is called - **[Bihar 2005]**

(1) Etioplast (2) Aleuroplast

(3) Amyloplast (4) Protoplast

Q.88 Movement against concentration gradient is called- **[Bihar 2005]**

(1) Osmosis (2) Active transport

(3) Diffusion (4) Passive transport

Q.89 Synapsis occurs in ..... phase of meiosis - **[Bihar 2005]**

(1) Zygotene (2) Diplotene

(3) Pachytene (4) Leptotene

Q.90 Which one is present in both prokaryotic and eukaryotic cell - **[Bihar 2004]**
(1) Ribosome (2) Mitochondria
(3) ER (4) Nucleus

Q.91 Centromere is also called - **[Bihar 2003]**
(1) Chromomere
(2) Secondary constriction
(3) Primary constriction
(4) Chromonema

Q.92 In "singer and Nicolson" model of plasma membrane, the extrinsic proteins are - **[Bihar 2002]**
(1) Tightly associated with intrinsic protein and can be easily separated
(2) Loosely associated with intrinsic protein
(3) Loosely associated with intrinsic protein and can be easily separated
(4) Loosely associated with intrinsic protein and can't be easily separated

Q.93 Ribosomes are associated with -**[Bihar 2002]**
(1) RNA synthesis (2) Protein synthesis
(3) Enzyme mobilisation
(4) DNA synthesis

Q.94 Which organelle is not found in an animal cell - **[Bihar 2001]**
(1) Peroxysome (2) Ribosome
(3) Lysosome (4) None of these

Q.95 Actin fibre is present in - **[Bihar 2001]**
(1) Cilia (2) Flagella
(3) Carbohydrates (4) Microfilaments

Q.96 Meiosis can be observed in - **[Bihar 2006]**
(1) Tapetal cells (2) Megaspores
(3) Micropores (4) Spore mother cells

Q.97 Carrier proteins are involoved in -**[Bihar 2006]**
(1) Transport of enzymes
(2) Water transport
(3) Active transport of ions
(4) Passive transport of gases

Q.98 The recent model for plasma membrane proposed by Singer and Nicolson is - **[Bihar 2005]**
(1) Molecular-lipid model
(2) Lamellar model
(3) Unit membrane model
(4) Fluid mosaic model

Q.99 Significance of meiosis lies in -**[Bihar 2006]**
(1) Reduction of chromosome number to one half
(2) Maintaning constancy of chromosome number during sexual reproduction
(3) Production of genetic variability
(4) All of the above

Q.100 Function of mitochondria is - **[UP CPMT 2002]**
(1) Excretion
(2) Respiration
(3) Digestion
(4) Excretion and respiration

Q.101 Term basal body is associated with development of - **[UP CPMT 2003]**
(1) cilia and flagella (2) cell plate
(3) phragmoplast (4) kinetochore

Q.102 Golgi body originates form - **[UP CPMT 2003]**
(1) lysosome
(2) Endoplasmic reticulum
(3) mitochondria
(4) cell memrane

Q.103 Lipid molecules in plasma membrane are arranged in which manner - **[UP CPMT 2003]**
(1) scattered (2) series
(3) alternate (4) head parallel

Q.104 Structure of nuclear membrane helps in - **[UP CPMT 2003]**
(1) organisation of the spindle
(2) synapsis of homologous chromosome
(3) Nucleo-cytoplasmic exchange of material
(4) anaphasic separation of daughter chromosome

Q.105 Hydrolytic enzymes are stored in - **[UP CPMT 2003]**
(1) Golgi bodies (2) Lysosomes
(3) Endoplasmic reticulum
(4) Mitochondria

Q.106 Ribosome may also called - **[UP CPMT 2002]**
(1) Microsome (2) Dictyosome
(3) Ribonucleoprotein (4) Oxysomes

Q.107 Genes are present in - **[UP CPMT 2003]**
(1) Chromosomes (2) Lamellae
(3) Plasma membrane (4) Mesosomes

Q.108 The cromosome showing L-shaped structure by the presence of centromere is termed as- **[MP PMT 2003]**

(1) Acentric (2) Metacentric

(3) Sub-metacentric (4) Telocentric

Q.109 Chromosomes can be seen best during - **[MP PMT 2003]**

(1) Prophase (2) Metaphse

(3) Anaphase (4) Telophase

Q.110 What will be the gametic chromosome number of a cell, if somatic cell have 40 chromosome - **[MP PMT 2003]**

(1) 10 (2) 20

(3) 30 (4) 40

Q.111 Who coined the term 'cell' - **[MP PMT 2003]**

(1) Purkinje (2) Robert Brown

(3) Robert Hooke (4) Hugo von Mohl

Q.112 In which of the following stage chromosomes are arranged at equatorial plate - **[MP PMT 2003]**

(1) Anaphase (2) Metaphase

(3) Prophase (4) Telophase

Q.113 During mitosis number of chromosomes gets - **[MP PMT 2003]**

(1) Change

(2) No change

(3) May be change if cell is mature

(4) May be change if cell is immature

Q.114 Chromosome having centromere in its middle is- **[MP PMT 2005]**

(1) Acrocentric (2) Telocentric

(3) Metacentric (4) Submetacentric

Q.115 Single membrance bound is -**[MP PMT 2005]**

(1) Lysosome (2) Plastid

(3) Nucleus (4) Mitochondria

Q.116 Which of the following do not possess lipoproteinaceous membrane - **[MP PMT 2006]**

(1) Lysosomes (2) Lomasomes

(3) Ribosomes (4) Sphaerosomes

Q.117 In meiosis chromosome number becomes - **[MP PMT 2006]**

(1) Half of its parent chromosome

(2) Same as that of parent chromosome

(3) One fourth of its parent chromosome

(4) None of the above

Q.118 Centrosome is not present in - **[MP PMT 2003]**

(1) Cells of higher plants

(2) Cells of lower plants

(3) Cells of higher animals

(4) Cells of lower animals

Q.119 Site of protein synthesis is - **[MP PMT 2005]**

(1) Ribosome (2) SER

(3) Golgi bodies (4) Lysosome

Q.120 To study the living cells without staining, which of the following microscopes can be used ? **[PB PMT 2002]**

(1) SEM (2) Flourescent

(3) Phase contrast (4) TEM

Q.121 Molecular biology is the study of :- **[CET Chd. 2002]**

(1) Structure, function and cell reproduction

(2)physio-biochemiccal studies of biomolecules

(3) studying tissues under microscope

(4) metabolic activitity of life

Q.122 The subcelluar components can be separated by - **[CMC Ludhiyann 2002,2003]**

(1) Paper chormatography

(2) autoradiography

(3) gel electrophoresis

(4) differential and density gradient centrifugation

Q.123 The choromosome separation during metaphase can be best studies by - **[CET Chd. 2002,2003]**

(1) phase contrast microscope

(2) TEM

(3) X-ray technique

(4) Scannning electron microscope

Q.124 The techniqe chromatohraphy was developed by - **[BVP Pune 2002]**

(1) Wilkins (2) Georgy Gey

(3) Tswett (4) Zernicks

Q.125 Which of the following dye is used for staining cell organalle, mitochondria ? **[PB PMT 2003]**

(1) Janus Green (2) Saffranin

(3) Azure B (4) Crystal violet

Q.126 In fluid mosaic model of plasma membrane- **[CBSE - 2002]**

(1) Upper layer is non-polar and hydrophilic

(2) Polar layer is hydrophobic

(3) Phospholipids form a bimolecular layer in middle part

(4) Proteins form a middle layer

Q.127 According to widely accepted ''fluid mosaic model'' cell membranes are semi-fluid, where lipids and integral proteins can diffuse randomly. In recent years, this model has been modified in several respects. In this regard, which of the following statements is incorrect- **[CBSE - 2005]**

(1) Proteins can also undergo flip-flop movements in the lipid bilayer

(2) Many proteins remain completely embeded within the lipid bilayer

(3) Proteins in cell membranes can travel within the lipid bilayer

(4) Proteins can remain confined within certain domains of the membranes

Q.128 Which one of the following is not a constituents of cell membrane - **[CBSE 2007]**

(1) Cholesterol (2) Glycolipids

(3) Proline (4) Phospholipids

Q.129 The main organelle involved in modification and routing of newly synthesized proteins to their destinations is - **[CBSE 2005]**

(1) Endoplasmic Reticulum

(2) Lysosome

(3) Mitochondria (4) Chloroplast

Q.130 Chlorophyll in chloroplasts is located in - **[CBSE 2005]**

(1) Grana (2) Pyrenoid

(3) Stroma

(4) Both grana and stroma

Q.131 Which of the following statements regarding mitochondrial membrane is **not** correct ? **[CBSE 2006]**

(1) The outer membrane resembles a sieve

(2) The outer membrane is permeable to all kinds of molecules.

(3) The enzymes of the electron transfer chain are embedded in the outer membrane.

(4) The inner membrane is highly convoluted forming a series of infoldings

Q.132 Polysome is formed by - **[CBSE 2008]**

(1) A ribsome with several subunits

(2) Ribosomes attached to each other in a linear arangement

(3) Several ribsomes attached to a single mRNA

(4) Many ribsonmes attached to a strand of endoplasmic reticulum

Q.133 Vacuole in a plant cell - **[CBSE 2008]**

(1) Lack membrane and contains air

(2) Lacks membrane and contains water and excretory substances

(3) Is membrane-bound and contains stroage protein and lipids

(4) Is membrane-bound and contains water and excretory substances

Q.134 In germinating seeds fatty acids are degraded exclusively in the - **[CBSE - 2008]**

(1) Peroxisomes (2) Mitochondria

(3) Proplastids (4) Glyoxysomes

Q.135 Keeping in viewthe fluid mosaic model for the structure of cell membrane, which one of the following statements is correct with respect to the movment of lipids and proteins from one lipid monolayer to the other (described as flipflop movement) ? **[CBSE - 2008]**

(1) While proteins can flip-flop, lipids can not

(2) Neither lipids, nor proteins can flip-flop

(3) Both lipids and proteins can flip-flop

(4) While lipids can rarely flip-flop, proteins can not

Q.136 Three of the following satements regarding cell organelles are correct while one is wrong. Which one is wrong - **[AIMS 2005]**

(1) Lysomes are double membraned vesicles budded off form golgi appratus and contain digestive enzymes

(2) Endoplasmic reticulum consists of a network of membranous tubules and helps in transport, sytehsis and secretion

(3) Leucoplasts are bound by two membranes lack pigment but contain their own DNA and protein synthesizing machinery

(4) Spharosomes are single membrane bonds and are associated with synthesis and storage of lipids

Q.137 In which one of the following would you expect to find glyoxysomes - **[AIMS 2005]**

(1) Endosperm of wheat

(2) Endosperm of castor

(3) Palisade cells in leaf

(4) Root hairs

Q.138 Which of the following statements regarding cilia is **not** correct - **[CBSE 2006]**

(1) Cilia contain an outer of nine doublet microtubules surrounding two single microtubules

(2) The organized beating of cilia is controlled by fluxes of Ca^{2+} across the membrane

(3) Cilia are hair-like cellular appendages.

(4) Microtubules of cilia are composed of tubulin

Q.139 The contractile protein of skeletal muscle involving ATPase activity is - **[CBSE- 2006]**

(1) α-Actinin (2) Troponin

(3) Tropomyosin (4) Myosin

Q.140 Select the wrong statement from the following- **[CBSE- 2007]**

(1) Both chloroplasts and mitochondria contain an inner and outer membrane

(2) Both chloroplast and mitochondria have an internal compartment, the thylakoid space bounded by the thylakoid membrane.

(3) Both chloroplasts and mitochondria contain DNA

(4) The chloroplasts are generally much larger than mitochondria

Q.141 The telomeres of euaryotic chromosomes consists of short sequences of - **[CBSE 2004]**

(1) Cytosine rich repeats

(2) Adenine rich repeats

(3) Guanine rich repeats

(4) Thymine rich repeats

Q.142 If you are provided with root-tips of onion in your class and are asked to count the chromosomes which of the following stages can your most convnintly look into - **[CBSE 2004]**

(1) Telophase (2) Anaphase

(3) Prophase (4) Metaphase

Q.143 **Protein synthesis in an animal** cell occurs- **[CBSE- 2005]**

(1) On ribosomes present in cytoplasm as well as in mitochondria

(2) On ribosomes present in the nucleolus as well as in cytoplasm

(3) Only on ribosomes attached to the nulecar envelope and endoplasmic reticulum

(4) Only on the ribosomes present in cytosol

Q.144 Telomerase is an enzyme which is a - **[CBSE 2005]**

(1) RNA (2) Ribonucleoprotein

(3) Repetitive DNA (4) Simple protein

Q.145 The length of DNA moelcule greatly exceeds the dimensions of the nucleus in eukaryotic cells. How is the DNA accomodated ? **[CBSE 2007]**

(1) Deletion of non-essential genes

(2) Supper-coiling in nucleosomes

(3) DNase digestion

(4) Through elimination of repetitive DNA

Q.146 Which one of the following preceeds re-formation of the nuclear envelope during M phase of the cell cycle - **[CBSE 2004]**

(1) Transcription from chromosomes and reassembly of the of the nuclear lamina

(2) Formation of the contractile ring and formation of the phragmoplast

(3) Formation of the contractile ring and transcription from chromosome

(4) Decondensation from chromosomes and reassembly of the nuclear lamina

Q.147 Crossing over that results in genetic recombination in higher organisms occurs between - **[CBSE 2004]**

(1) Non-sister chromatids of a bivalent
(2) Two daughter nuclei
(3) Two different bivalents
(4) Sister chromatids of a bivalents

Q.148 In the somatic cell cycle - **[CBSE 2004]**

(1) DNA replication takes place in S-phase
(2) A short interphase is followed by a long mitotic phase
(3) G_2 phase follows mitotic phase
(4) In G_1 phase DNA content is double the amount of DNA present in the orginal cell

Q.149 When synapsis is complete all along the chromosome, the cell is said to have entered a stage called - **[CBSE 2004]**

(1) Zygotene (2) Pachytene
(3) Diplotene (4) Diakinesis

Q.150 Many cells function properly and divide mitotically though they do not have - **[AIIMS 2005]**

(1) Plasma membrane (2) Cytoskeleton
(3) Mitochondria (4) Plastids

Q.151 Centromere is required for - **[AIIMS 2005]**

(1) Movement of chromosomes towards poles
(2) Cytoplasmic cleavage
(3) Crossing over (4) Transcription

Q.152 At what stage of the cell cycle are histone proteins synthesized in a eukaryotic cell - **[CBSE 2005]**

(1) During telophase (2) During S-phase
(3) During G_2-stage of prophase
(4) During entire prophase

Q.153 Plasmodesmata are - **[CBSE 2009]**

(1) Connections between adjacent cells
(2) Lignified cemented layers between cells
(3) Locomotary structures
(4) Membranes connecting the nucleus with plasmalemma

Q.154 Synapsis occurs between - **[CBSE 2009]**

(1) Two homologous chromosomes
(2) A male and a female gamete
(3) mRNA and ribosomes
(4) Spindle fibres and centromere

Q.155 Middle lamella is composed mainly of - **[CBSE 2009]**

(1) Phosphoglycerides
(2) Hemicellulose
(3) Muramic acid
(4) Calcium pectate

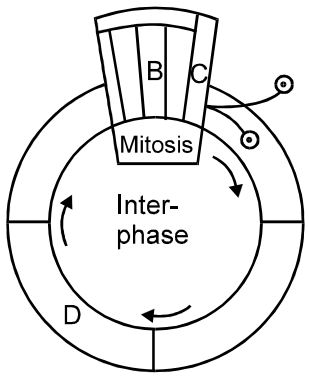
Q.156 Cytoskeleton is made up of - **[CBSE 2009]**

(1) Proteinaceous filaments
(2) Calcium carbonate granules
(3) Callose deposits
(4) Cellulosic microfibrils

Q.157 The cell junctions called tight, adhering and gap junctions are found in - **[CBSE 2009]**

(1) Neural tissue (2) Muscular tissue
(3) Connective tissue (4) Epithelial tissue

Q.158 Given below is a schematic break-up of the phases/stages of cell cycle - **[CBSE 2009]**



Which one of the following is the correct indication of the state/phase in the cell cycle-

(1) A - Cytokinesis (2) B - Metaphse
(3) C - Karyokinesis (4) D-Synthetic phase

Q.159 There is no DNA in - **[CBSE 2009]**

(1) Hair root
(2) An enucleated ovum
(3) Mature RBCs
(4) A mature spermatozoan

Q.160 A student wishes to study the cell structure under a light microscope having **10X** eye piece and **45X** objective. He should illuminate the object by which one of the follwoing colours of light so as to get the best possible resolution? **[CBSE 2005]**

(1) Yellow (2) Grren
(3) Red (4) Blue

Q.161 A major breakthrough in the studies of cell came with the development of electron microscope. This is because **[CBSE 2006]**

(1) electron beam can pass through thick mater als, whereas light microscopy requires thin section.

(2) the electron microscope is more powerful than the light microscope as it uses a beam of electrons which has wavelength much loger than that of photons

(3) the resolution power of the electron microscope is much higher than that of the light microscope

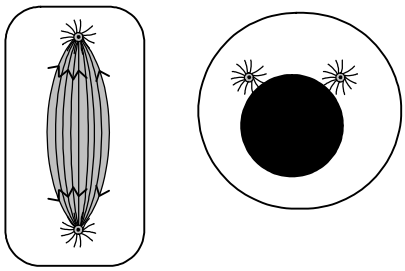
(4) the resolving power of the electron microscope is 200-350 nm as compared to 0.1-0.2 nm for the light microscope

Q.162 During mitosis ER and nucleolus begin to disappear at – **[CBSE 2010]**

(1) Late prophase (2) Early metaphase

(3) Late metaphase (4) Early prophase

Q.163 Which stages of cell division do the following figures A and B represent respectively ? **[CBSE 2010]**



(1) Metaphse - Telophase

(2) Telophase - Metaphse

(3) Late Anaphase - Prophase

(4) Prophase - Anaphase

Q.164 The main area of variuos types of activites of a cell is – **[CBSE 2010]**

(1) Plasma membrane (2) Mitochondrian

(3) Cytoplasm (4) Nucleus

Q.165 Carrier ions like Na^+ facilitate the absorption of substances like – **[CBSE 2010]**

(1) amino acids and glucose

(2) glucose and fatty acids

(3) fatty acids and glycerol

(4) fructose and some amino acids

Q.166 The plasma membrane consists mainly of – **[CBSE 2010]**

(1) phospholipids embedded in a protein bilayer

(2) proteins embedded in a phospholipid bilayer

(3) proteins embedded in a polymer of glucose molecules

(4) proteins embedded in a carbohydrate bilayer

Q.167 An elaborate network of filamentous proteinaceous structures present in the cytoplasm which helps in the maintenance of cell shape is called - **[AIPMT MAINS 2010]**

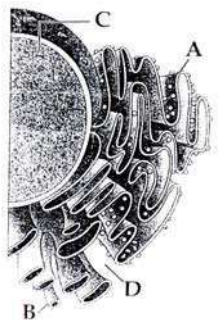
(1) Endosplasmic Reticulum

(2) Plasmalemma

(3) Cytoskeleton

(4) Thylakoid

Q.168 Identify the components labelled A, B, C and D in the diagram below from the list (i) to (viii) given along with – **[AIPMT 2010]**



Components :

(i) Cristae of mitochondria

(ii) Inner membrane of mitochondria

(iii) Cytoplasm

(iv) Smooth endoplasmic reticulum

(v) Rough endoplasmic reticulum

(vi) Mitochondrial matrix

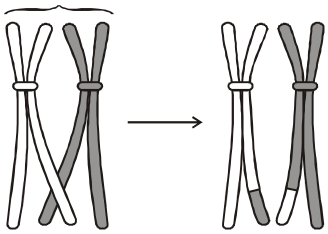
(vii) Cell vacuole

(viii) Nucleus

The correct components are :

	A	B	C	D
(1)	(i)	(iv)	(viii)	(vi)
(2)	(vi)	(v)	(iv)	(vii)
(3)	(v)	(i)	(iii)	(ii)
(4)	(v)	(iv)	(viii)	(iii)

Q.169 Given below is the representation of a certain event at a particular stage of a type of cell division. Which is this stage? **[AIPMT PRE 2012]**



(1) Prophase II during meiosis

(2) Prophase of Mitosis

(3) Both prophase and metaphase of mitosis

(4) Prophase I during meionsis

Q.170 During gamete formation, the enzyme recombinase participates during : **[AIPMT PRE 2012]**

(1) Anaphase - II (2) Prophase - I

(3) Prophase - II (4) Metaphase - I

Q.171 What is true about ribosomes **[AIPMT PRE 2012]**

(1) These are composed of ribonucleic acid and proteins.

(2) These are found only in eukaryotic cells.

(3) These are self-splicing introns of some RNAs.

(4) The prokaryotic ribosomes are 80 S, where "S" stands for sedimentation coefficient.

Q.172 Select the correct statement from the following regarding cell membrane. **[AIPMT PRE 2012]**

(1) Proteins make up 60 to 70% of the cell membrane.

(2) Lipids are arrange in a bilayer with polar heads towards the inner part.

(3) Fluid mosaic model of cell membrane was proposed by Singer and Nicolson

(4) Na + and K^+ ions move across cell membrane by passive transport

Q.173 The correct sequence of cell organelles during photorespiration is : **[AIPMT PRE 2012]**

(1) Chloroplast - Rough Endoplasmic reticulum - Dictyosomes

(2) Chloroplast - mitochondria - peroxisome

(3) Chloroplast - vacuole - peroxisome

(4) Chloroplast - Golgibodies - mitochondria

ANSWER KEY

EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	2	1	3	2	4	4	1	4	2	3	2	1	1	1	3	4	2	1	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	3	3	4	1	3	3	4	1	1	1	3	1	2	2	4	4	2	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	2	2	1	1	2	4	2	3	2	2	4	2	3	4	3	3	3	3	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	3	2	2	1	1	4	3	2	1	2	3	1	1	2	3	2	3	2	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	2	3	4	2	4	4	2	1	1	3	3	2	4	4	4	3	4	4	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	2	4	3	2	3	1	3	2	2	3	2	2	3	1	3	1	1	1	3
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	4	1	3	1	3	1	3	1	1	3	3	4	4	4	1	2	2	4	2
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	3	4	1	1	2	2	1	1	2	4	1	2	1	1	4	1	4	4	3	3
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173							
Ans.	3	1	3	3	4	2	3	4	4	2	1	3	2							

Following question given below consist of Statement-I and Statement-II. Use the following Key to choose the appropriate answer.

(A) **If both Statement-I and Statement-II are true, and Statement-II is the correct explanation of Statement-I.**

(B) **If both Statement - I and Statement-II are true but Statement-II is not the correct explanation of Statement-I.**

(C) **If Statement-I is true but Statement-II is false.**

(D) **If Statement-I is false but Statement-II is true.**

Q.1 **Statement-I :** RBC membrane is highly flexible.

Statement-II : Amount of external protein in cytoplasmic face of membrane is more.

Q.2 **Statement-I :** Lampbrush chromosomes shows transcripitionally active loops.

Statement-II : Informosomes can be used in future for embryo development.

Q.3 **Statement-I :** Centriole does not form any compartment in a cell.

Statement-II : Centriole is a non-membranous cell organelle.

Q.4 **Statement-I :** Janus green B is a vital stain for locating mitochondria.

Statement-II : Janus green is oxidised by cytochrome a2 present in mitochondria.

Q.5 **Statement-I :** Lysosomes help in digestion of foreign particles in the animal cells.

Statement-II : They have respiratory enzymes.

Q.6 **Statement-I :** Endomitosis does not cause karyokinesis or cytokinesis.

Statement-II : In endomitosis, mitosis occurs within nucleus.

Q.7 **Statement-I :** Synaptonemal complex develops between two synapsed homologous chromosomes.

Statement-II : Mitosis cannot be completed without the synaptonemal complex.

Q.8 **Statement-I :** During anaphase-II, chormatids of a chromosomes separate.

Statement-II : Centromere of a mitotic chromosome divides during anaphase.

Q.9 **Statement-I :** Dictyotene stage occurs in female only.

Statement-II : Gemetogenesis rests for a long period at diplotene stage in female.

ANSWER KEY

EXERCISE - 4

Ques.	1	2	3	4	5	6	7	8	9
Ans.	1	2	1	1	3	1	3	2	1

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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PLANT WATER RELATIONS

INTRODUCTION

- The study of various vital activities and metabolism of plants is know as **Plant physiology.**
- **Stephan Hales** is known as father of plant physiology.
- **J.C. Bose** is known as **Father of Indian Plant physiology.**
- Plants grow in soil and absorb water and minerals, which are available in soil. So that water has great importance for plant. Water forms 80-90% of fresh weight of plant body. The method or technique, in which plant cells obtain water, comes under the heading of **Water relation**.
- To understand the plant water relations, we should know the following process-

DIFFUSION

"The movement of molecules or atoms or ions of a materials from an area of higher concentration to an area of their lower concentration is called diffusion.

- The diffusion is continue till the dynamic equilibrium is established. At this stage the net movement of molecule is equal in both direction.
- The kinetic energy, which is present in the molecules of material is distributed equally in their available space by their nature.

Diffusion rate $\rightarrow$ **Gas > Liquid > Solid**

Diffusion pressure :

"The diffused molecules or ions exert a pressure on the substance or medium in which diffusion take place, known as Diffusion pressure."

- This is developed due to difference in the concentration of molecules of the material. **Diffusion pressure of a pure solvent (1236 atm) is always higher than its solution.**
- Water molecules moves from their higher concentration to the their lower concentration in plants.
- The rate of diffusion decrease with increasing size of molecules.
- The speed and direction of movement of molecules of substances depends upon the concentration of the molecules.
- Due to the difference in the concentration of molecules, diffusion pressure results.
- The potential ability of a substance to diffuse from an area of its greater concentration to an area of less concentration, is called **diffusion pressure**.
- D.P. $\propto$ concentration of substance.

Significance of diffusion :

- Exchange of gases like CO_2, O_2 take place through the diffusion.
- The distribution of hormones in the plants takes place through the diffusion.
- The process of transpiration is a diffusion process. The evaporation of water from the intecellular spaces is linked with diffusion during the transpiration.
- The ions of the minerals may diffused into the plant body.
- The process of **osmosis is a special type of diffusion** of solvent molecules through semi-permeable membrane.

OSMOSIS

"Osmosis is defined as the special diffusion of solvent (water in this context) from the solution of lower concentration to the solution of higher concentration when both the solutions are separated by a semipermeable membrane."

- Osmosis was discovered by **Abbe Nollet.**
- The detailed explanation of osmosis was given by **Traube** and **Duterochat.**
- Passing of **solvent** through the semipermeable membrane is the example of osmosis.
- The water moves into the cell during the osmosis is called **endosmosis.**

  Ex.: Grapes placed in water.
- When the water starts moving out of the cell then it is called **exosmosis.**

  Ex.: Grapes kept in salt solution.

Types of membrane :

The exchange of materials in and out through the membrane is called permeability.

- The membranes are divided in the following types on the basis of permeability :-

(i) Permeable membrane :

Such membranes are **permeable for both - solutes and solvent.** e.g. **cell wall, filter paper.**

(ii) Semipermeable membrane :

Such membranes **allow diffusion of solvent molecules, but do not allow the solutes.** e.g., artificial membrane like **Cellophane** and **Copper ferrocyanide membranes, parchment paper, goat bladder.**

(iii) Selective permeable membrane OR differentially permeable membrane :

Such membranes allow some selective solutes to pass through them along with the solvent molecules. e.g., **Cell membrane, Tonoplast, Organelles membrane.**

- These membranes are permeable for CO_2, N_2 O_2 gases, alcohol, ether and water, but impermeable for polysaccharides and proteins.

(iv) Impermeable membrane : Rubber membrane, Al-foil, Suberised cell wall, cork wall.

Types of Solution :

(i) Isotonic solution :

If solution in which a cell is placed, has equal osmotic concentration to that of cell sap, the outer solution is called **isotonic solution.**

(ii) Hypotonic solution :

If the osmotic concentration of outer solution is lesser than that of the cell sap, the outer solution is called **hypotonic solution.** If a cell is placed in such solution **endosmosis** takes place, results, cell swells up.

(iii) Hypertonic solution :

If the osmotic concentration of a solution is higher than that of the other (cell sap), solution is known as **hypertonic solution.**

- If a cell placed in this type of solution, **exosmosis** takes place. It means water of the cell sap diffused out into the outer solution, resulting cell become flaccid.

  e.g., Grapes placed in higher concentration of sugar solution becomes flaccid (contracts).

Osmotic pressure or O.P. :

- **Osmotic pressure is the pressure developed in a solution when solution and water are separated by semipermeable membrane (given by Pfeffer)**

  or "O.P. of solution is equal to pressure, which required to be applied on a solution in order

to prevent an increase in it's volume due to tendency of solvent to enter in when the two are separated by a semipermeable membrane."

- The osmotic pressure of **pure water is zero. O.P. is due to presence of solute** into the solution.
- The osmotic pressure of solution is directly proportional to the **concentration of solute in** it.
- The osmotic pressure shows maximum variation in the plants cells.
- According to **Hariss** the osmotic pressure is **highest in leaves** and **lowest in roots.**
- The **highest osmotic pressure** is found in the **halophyte** group. **Atriplex confortifolia (202 atm).**
- The **lowest osmotic pressure** is found in aquatic plants or **hydrophytes.**
- **Hydrophytes < Mesophytes < Xerophytes < Halophytes.**
- Generally osmotic pressure is lesser during the night and higher at noon.
- Osmotic pressure of a solution is measured by **osmometer.** O.P. of cell is measured by **incipient plasmolysis.** First osmometer was made by Pfeffer.
- The osmotic pressure can be measured by various methods.

The formula of Vont Hoff for measuring O.P. :

OP = mRT

Here m = Molar concentration

R = Gas constant [0.082 mole/molecules]

T = Absolute temperature

the osmotic pressure of 1 mole. glucose solution at 0ºC-

OP $\Rightarrow$ $1 \times 0.085 \times 273$ $\Rightarrow$ 22.4 atm., for non electrolytes.

The **O.P. of electrolytes** is find out by the following formula-

OP = MRT I

Where I is the constant of ionisation of electrolytes.

- The **osmotic pressure of electrolytes is h**igher than that of non electrolytes.
- For example - solution of 1 M NaCl and 1 M glucose. The molar concentration of both solutions are equal but **O.P. of 1 M NaCl is higher than solution of 1 M glucose.**
- **Water moves from lower O.P. towards the higher O.P.**

Significance of Osmosis / Osmotic Pressure :

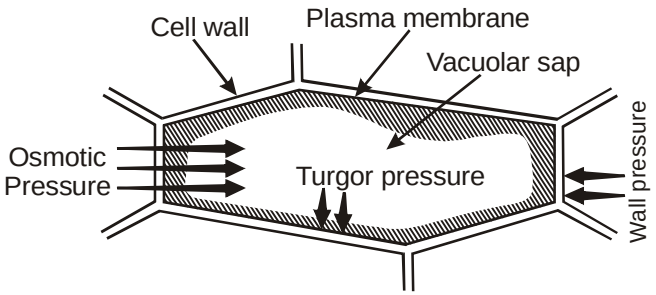
- Water absorption from the soil by the plants.
- Transport of water from cell to cell in plants.
- To maintain turgor pressure.
- Origin of root pressure.
- Opening & Closing of stomata is affected by Osmosis.

TURGOR PRESSURE OR T.P.

"When a cell is immersed in water, then water enter into the cell because osmotic pressure of the cell sap is higher. The cell content press upon the wall or develop a pressure against the cell wall, which is called turgor pressure."

- Turgor pressure is **not applicable for free solution.** This is only applicable for osmotic system of a plant cell. Turgor pressure is also known **hydrostatic pressure.**
- The turgor pressure in encounter balanced by an equal but opposite pressure of the thick cell wall on

the enclosed solution or protoplasm is known as **wall pressure.** It means whatever the amount of pressure exerted inner side on the cytoplasm.



TURGOR PRESSURE

- Therfore, **wall pressure and turgor pressure are equal** to each other but W.P. is inward in direction.

$$\boxed{TP = WP}$$

- Plant cell does not burst, when placed in pure water due to wall pressure, but an animal cell burst when placed in pure water because wall pressure is absent due to absence of cell wall.
  For example the consequence of endosmosis in animal cell can be demonstrated by placing RBCs of human blood in distilled water.
- A **flaccid cell has zero turgor pressure.**
- The **highest value of turgor pressure is found in fully turgid cell** and it is equal to the osmotic pressure. **Fully turgid cell has TP = OP**
- The value of **turgor pressure is normally from zero to in between the osmotic pressure** in plant cell.
- The value of **turgor pressure is assumed as negative (–ve) during the plasmolysis** of the cell.

Significance of T.P. :

- Protoplasm of the cell attached with the cell wall due to turgidity of the cell and cell is in stretched condition. It **maintains the normal shape of the cell** in which physiological processes are going on.
- The **3-D structure of mitochondria, chloroplast and microbodies** is maintained due to turgor pressure, which is essential for their physiological activities.
- Turgor pressure is essential for **maintaining definite shape of delicate organs.**
- Turgor pressure helps in **cell elongation or growth of cell.**
- Plant movement like, **movement of guard cells of stomata, wilting movements and seismonastic movements** etc. depend upon turgor pressure.
- Turgor pressure provides essential power to the plumule to coming out from the soli and help in penetration of radicle into the soil.

DIFFUSION PRESSURE DEFICIT (DPD) OR SUCTION PRESSURE

DPD : The difference between the diffusion pressure of the solution and it's pure solvent at particular temperature and pressure is called **DPD.**

or The DPD of any solution is the difference between the diffusion pressure of the water, which is present in the solution and diffusion pressure of pure water.

- The term **Diffusion Pressure deficit (DPD)** is used by **B.S. Mayer. Renner** named as **Suction Pressure (S.P.)** in cell.
- DPD determines the direction of osmosis and it is the power of absorption of water for the cell (Suction Pressure).
- This is also known as **demand of water** in cell. **DPD ● concentration** of solute.
- The diffusion of water takes place from the region of lower DPD to the region of higher DPD in the process of osmosis.

$$\text{Lower DPD} \xrightarrow[H_2O]{SPM} \text{Higher DPD}$$

- Normally, osmotic pressure is greater than the turgor pressure in a cell. The difference between osmotic pressure and turgor pressure is called **suction pressure** or DPD.

  DPD = OP – TP
- The DPD of any free solution is equal to the osmotic pressure of that solution.

  DPD = OP

(i) DPD in partialy turgid or normal cell :

DPD = OP – TP

(ii) DPD for fully turgid cell :

- When a cell is placed in pure water or hypotonic solution then water enter into the cell, results turgor pressure develop in the cell. The cell starts swelling due to the turgor pressure. Simultaneously, concentration of cell sap decreases due to continuous inflow of water. Therefore OP is goes on decreasing and T.P. increase due to this, when value of TP will be equal to the OP then DPD will be zero.

  At this stage cell becomes fully turgid. Therefore in a fully turgid cell.

  DPD = OP – TP

  When, OP = TP or OP – TP = O

  So that DPD = O

(iii) DPD in flaccid cell :

- If, the cell is in flaccid state then its T.P. or WP would be zero and value of DPD would be equal to O.P.

  TP or WP = O

  Therefore, DPD or S.P. = OP
- If a flaccid cell placed in water then water enters into cell because DPD of the cell sap is higher.

(iv) DPD for plasmolysed cell :

- Sometimes the value of turgor pressure is negative as in plasmolysed cell. In this state

  DPD = OP – TP

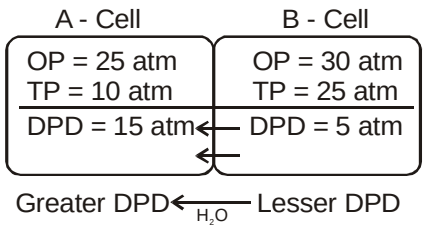
  ∴ [TP = – Ve]

  DPD = OP – [– TP] = OP + TP
- So that the DPD of the plasmolysed cell is greater than osmotic pressure.

  It means - DPD = OP + TP

  Demand of water = Plasmolysed cell > Flaccid cell > Partially turgid cell > Fully turgid cell
- The demand of water in plasmolysed cell is highest.
- It means, when the osmotic pressure and turgor pressure will be equal, then the DPD will be zero. Water will not enter in this type of cell and cell become fully turgid.
- But, when turgor pressure is lesser than the osmotic pressure, in normal cell then some DPD will be definitely present in the cell and water would enters into the cell.

  e.g.,



WATER POTENTIAL OR ψ_w

"The difference between the free energy of molecules of pure water and free energy of the solution is called **water potential** of the system."

- Now a day according to concept of free energy and thermodynamics DPD of a solution is also represented by water potential. (Given by **Taylor** and **Slatyer**)

- The water potential of pure water is maximum the pure water has greater free energy. The free energy, lower down by addition of solute.
- Water always flows from higher water potential to lower water potential.
- Water potential is represented by Greek word ψ (Psi)/ ψ_W and it is measured in **bars** or **Pascal (Pa).** Water potential is equal to DPD, but opposite in sign. Its value is negative.

$\psi_W = \psi_S + \psi_P + \psi_g$ and DPD = O.P. – T.P.

So, $\boxed{\psi_W = -DPD}$

ψ_S = Solute potential = – O.P.

ψ_P = Pressure potential = T.P.

ψ_g, ψ_m is neglesible

- Water potential has following components :

1. Osmostic potential (ψ_s) :

- Osmotic potential or solute potential represents the concentration of the solutes. Water potential (ψ_W) is negative in the presence of solutes. So that osmotic potential is also negative.
- According to thermodynamics, osmotic pressure is called **solute potential** or **osmotic potential.** It is represented by ψ_S and shown by negative sing (–ve) or it is better to say osmotic potential on the basis of free energy.
- Osmotic potential or solute potential measured in bars. (1 Bar = 0.987 atmospheric pressure)
- OP = 22.4 atm => osmotic potential = –22.4 atm. (1 M glucose solution)

2. Pressure potential (ψ_P)

- Turgor pressure is known as **pressure potential.** It is shown by positive sign **(+ve).**
- 1 Bar = 10^6 dynes/sq. cm. or 0.987 atm. (1 megapascal = 10 bars)
- According to this concept their relation is as follows.
  Water potential = Osmotic potential + pressure potential + matric potential
  $\Delta\psi$ or $\psi_W = \psi_S + \psi_P + \psi_m$

$\boxed{\psi_W = \psi_S + \psi_P}$ As ψ_m and ψ_g (Matric potential and gratitational potential) are negligible

$$\boxed{\begin{aligned}\psi_W &= -ve\\ \psi_S &= -ve\\ \psi_P &= +ve\end{aligned}}$$

- According to the above concept the relation of the three phases of the cell by the water potential will be as follows :-

[A] In case of fully turgid cell -

- There is **no flow of water in a fully turgid cell,** because the cell is in equilibrium condition with water which is present out side the cell. So that water potential will be zero at this state. Because osmotic potential and pressure potential are equal in the cell.
- For example - If the value of osmotic potential of a cell is – 10 and pressure potential (ψ_p) is + 10, then water potential will be zero as-

$$\boxed{\begin{aligned}\psi_W &= \psi_S + \psi_P\\ \psi_W &= -10 + 10\\ \psi_W &= 0\end{aligned}}$$

[B] In case of flaccid cell -

- Turgor pressure is zero at this stage. It means pressure potential is zero. If osmotic potential of the cell is – 10 bar then, $\psi_W = \psi_S$

$$\boxed{\begin{aligned}\psi_W &= \psi_S + \psi_P\\ \psi_W &= -10 + 0 \text{ bar}\\ \psi_W &= -10 \text{ bar}\end{aligned}}$$

$\because$ ψ_P = 0 = TP

[C] In Plasmolysed cell-

- The pressure potential (ψ_p) means turgor pressure is negative in this stage. Therefore water potential (ψ_w) of this cell will be more negative [more – ve].
- If the value of osmotic potential is –10 bar of a plasmolysed cell and value of pressure potential is –2 bars then its water potential (ψ_w) will be –12 bars.

$$\psi_W = \psi_S + \psi_P$$
$$\psi_W = -10 + (-2) \text{ bar}$$
$$\psi_W = -12 \text{ bar}$$

- So, this is the conclusion that **water always move from higher water potential towards the lower water potential.**
- For example if the water potential of 'A' cell is –10 bars and water potential of 'B' cell is –12 in two cells, then water will be flow from 'A' cell to the 'B' cell.

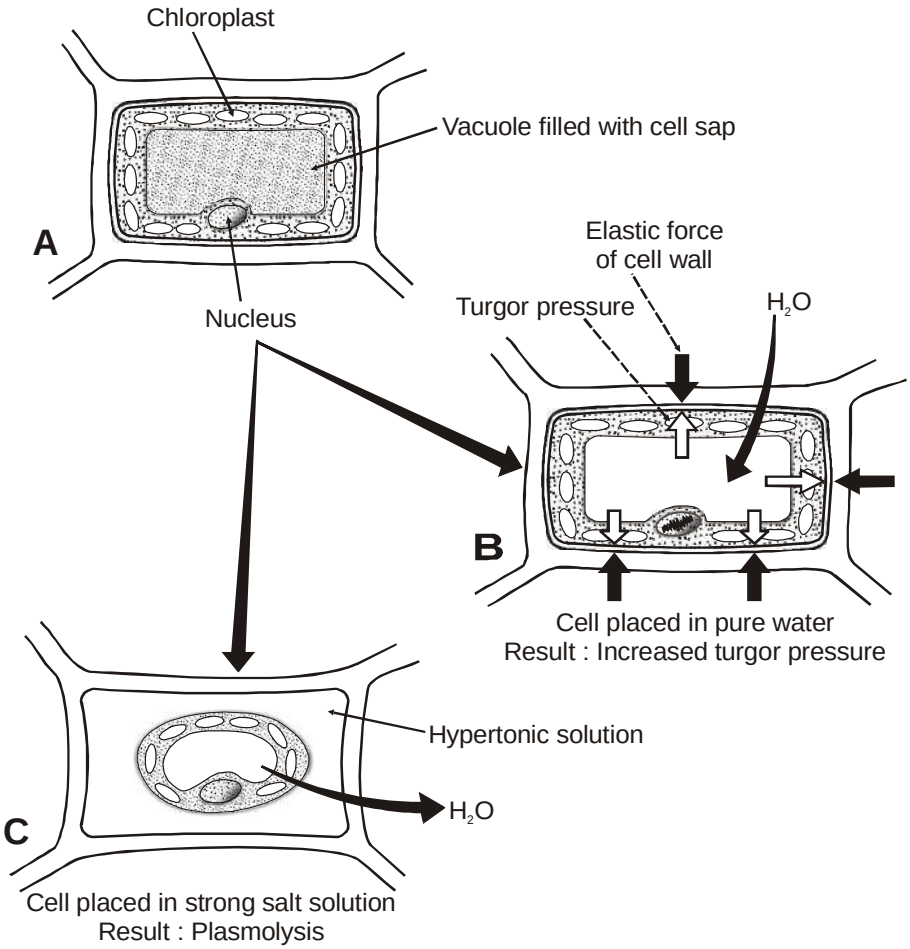
PLASMOLYSIS

"If a plant cell placed in a hypertonic solution, water molecules diffused out from the cell. As a result of exosmosis, the protoplasm of the cell detached from the cell and starts shrinking. This is called **plasmolysis**."

- The various sequences of plasmolysis are as follows -

(i) In a turgid cell, the cell sap pushed away the protoplasm, so that it is in close contact with cell wall.

(ii) When it placed in a hypertonic solution, the volume of the cell reduces due to shrinking of cell because some amount of water of cell sap diffuses out by exosmosis. Turgor pressure decreases by which cell wall is not pushed by the protoplasm, so that shrinking cell membrane reduces in total volume of the cell. This situation is called the first stage of plasmolysis or limiting plasmolysis.



Plasmolysis :

A - A cell in normal stage, B - A cell placed in pure water and resulting in increased turgor pressure and C - A cell placed in strong salt solution leading to plasmolysis

(iii) If the diffusion of water to the outside is continue by the exosmosis then central vacuole contracts and with this protoplasm also shrinks but cell wall is not contracting. So that protoplasm is seems to detach from the corners of cell wall. This condition is known as second phase of the plasmolysis or incipient plasmolysis.

(iv) The shrinking of protoplasm is continuous due to continuous exosmosis, it detaches from the cell wall and assumed a spherical shape. This phase is known as **evident plasmolysis / full plasmolysis.**

- Hypertonic solution is present in between the cell wall and protoplasm.

Significance of plasmolysis

[i] A living cell is distinguished from the non living [dead] cell through the plasmolysis. Because plasmolysis does not occur in dead cell.

[ii] The osmotic pressure of any cell can be measured by **incipient plasmolysis.**

[iii] If the plasmolysis remains for long duration in a cell then it dies. To destroy the weeds, salts puts in their roots.

[iv] Fishes and meat are prevented from spoilage by salting, which inhibits the growth of bacteria and fungus.

[v] Higher concentration of sugar in jams and jellies stops the growth of bacteria and fungus.

[vi] High amount of chemical fertilizers near the root causes death or browning of the plant due to plasmolysis.

[vii] The fresh water growing plants are either wilted or die when they are kept in marine water.

IMBIBITION

Adsorption of undissolved liquid by any solid material is called **imbibition or adsorption** of water by hydrophilic colloids is known as **imbibition**.

- This is a physical process by which a dry solid colloid material swells up by adsorption of water.
- The cell wall is made up of colloidal substance as cellulose, pectin, hemicellulose etc. All they are hydrophilic in nature. Therefore they imbibe water.
- Proteins, Agar - agar, starch etc, these are all imbibant materials.

  Agar - agar can adsorbs 99 times more water than that of its weight. Some of the proteins adsorb 15 times more water.

  Imbibition power = Agar – Agar > Pectin > Protein > Starch > Cellulose

  Affinity must be between imbibant and liquid material and movement of water occurs in order of water potential gradient.
- The heat released during the imbibition is called **heat of wetting.**
- A huge pressure is developed in material due to imbibition. This pressure is called **Imbibition pressure (IP).**
- IP is also called as **matric potential** with respect to water potential. $\Psi_W = \Psi_m$
- The imbibition is less in compact arranged material like wood, and more in lighter or soft material like gelatin.
- Imbibition decreases with increasing pressure on imbibant material.

Significance of Imbibition :

- **Absorption of water** during due the seed germination is only initiate through the imbibition.
- **Breaking of seed coat** during the seed germination is due to imbibition process. Proteins, fats and

starch is present in the kernel. This kernel swells up more as compared to the seed coat which breaks the seed coat.

- Initial process of water absorption in roots by root hairs is imbibitions.
- Resurrection in many plants like Selaginella, Lichen take place due to the process of imbibition.
- The water enter into the aerial roots and dry fruits is due to imbibition.
- Newly formed wood swells up in rainy season.
- Dry wood is filled in the natural grooves of rocks and watered them. The rocks are broken due to their swelling.

Movement of water molecules :

Higher D.P. ⟶ Lower D.P.
Lower O.P. ⟶ Higher O.P.
Lower DPD ⟶ Higher DPD
Higher (less −ve) Ψ_W ⟶ Lower (more −ve) Ψ_W
Higher T.P. ⟶ Lower T.P.
Hypotonic ⟶ Hypertonic
Lower conc. of solution ⟶ Higher conc. of solution.

ABSORPTION OF WATER BY PLANTS

SIGNIFICANCE OF WATER IN PLANTS

- 75-80% part of cells is water. In aquatic plant cells, upto 95% water may be present.
- Water is a **universal solvent.**
  (a) Gases, solids, minerals and organic compounds are found dissolved in it. Their transfer in plants occurs through aquatic medium.
  (b) Water is essential for **metabolic reactions** occuring in plants.
- Water is used in many reactions (hydrolysis, photosynthesis etc.)
- The cells remain turgid due to water, so that shape of cells/organs is maintained. Many types of movements, opening and closing of stomata, metabolic reactions, growth etc. are affected by turgidity.
- Water protects the plants from harmful effects due to high and low temperatures.
- Water is essential for **seed germination**.

FORM OF WATER

- Water is mainly obtained through rain. Some of the water goes into the reservoirs. This is called **run off water.** Rest of the water enter into the land. Water present in soil is of following types-

(a) Gravitational water :-

Form of water, which reaches at the soil water table due to the gravitational force after the rainfall. This form is not available to the plants but available by mechanical methods or by tubewell irrigation. Some plants can absorbe this water - **Calotropis, Prosopis, Capparis, etc.**

(b) Hygroscopic water :-

Thin film of water is tightly held by the soil particles is called hygroscopic water. This water is also **not available** to the plants.

ψ_W of hygroscopic water is highly negative or very low.

(c) Chemically combined water :-

The amount of water present in the chemical compounds, which are present in the particles of soil. This is **not available** to the plants ..... 24 H_2O, ... 7 H_2O

(d) Capillary water :-

Water exists between soil particles in small capillary pores is called **Capillary water**. It is **the most common available form to the plants. Plants only obsorb this form of water.**

(e) Atmospheric humidity :-

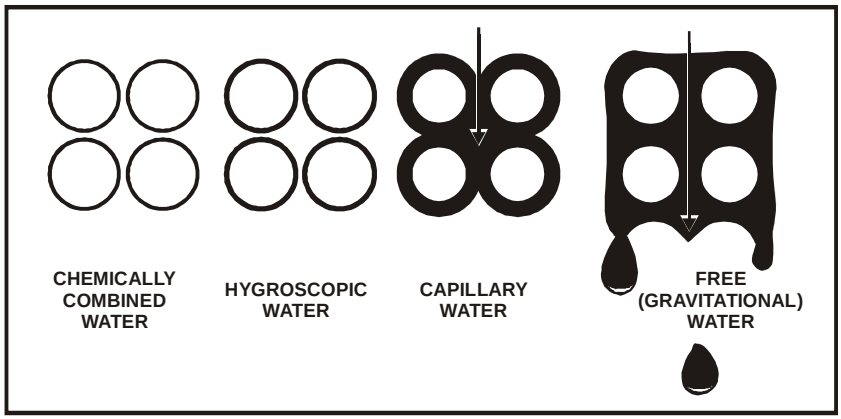
This is water vapour present in air, which can be absorbed by hanging roots of the epiphytes due to presence of velamen tissue and hygroscopic hairs.

Holard : It is the **total amount of water presents in the soil.**

Holard = Chresard + Echard

Chresard : This is the **water available** to the plants.

Echard : This **water is not available** to the plants.



WATER ABSORBING SYSTEM

- In thalophytes (fungi and algae) water absorption takes place through the whole surface of all cells.
- In Bryophyta it occurs by **Rhizoids**.
- In Pteridophyta & spermatophyta it occurs **by roots**.
- Root System consists of following parts -

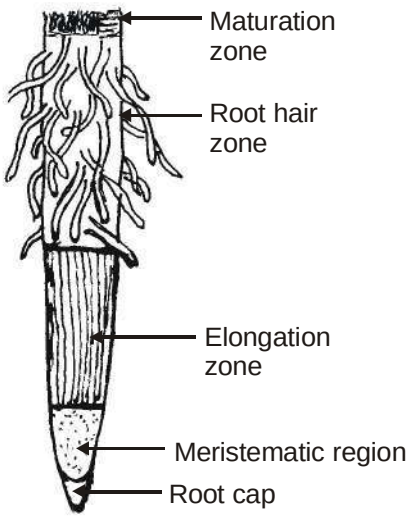
(a) **Root cap region** or **calyptra**- Present at the apex of the root as a protective tissue ; it is **impermeable** to water & solute absorption.

- It percept the **stimuli of gravity.**

(b) **Meristematic region**-Region of active cell division situated above root cap.

- **Mineral absorption** mainly occurs from this region.

(c) **Region of cell elongation -** Next to meristematic region, here growth in length of the root takes place.



Water absorbing system

(d) **Maturation region** - The cells at this region are highly differentiated to carry out different function. It includes root hair region.

- Root hairs are the **water absorbing** organs of plants.

PATH OF MOVEMENT OF WATER

- Water present in soil must reach the xylem of roots. Root hair is in contact with soil water. Their cell wall is thin & water easily diffuses in.
- From root hairs water reaches epidermis & from their to cortex made of parenchymatous cells.
- From innermost layer of cortex water enters in endodermis consisting of thin walled **passage cells** found against each protoxylem.
- In last, water reaches to xylem passing through **thin** walled **pericycle**.

In Short : -Soil water → Root hair → Epiblema → Cortex → endodermis (passage cells) → Pericycle → Xylem

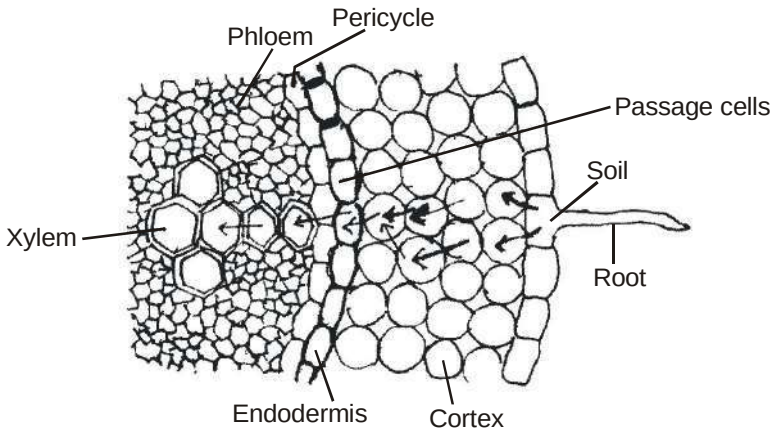


Fig.: Water Absorption Pathway

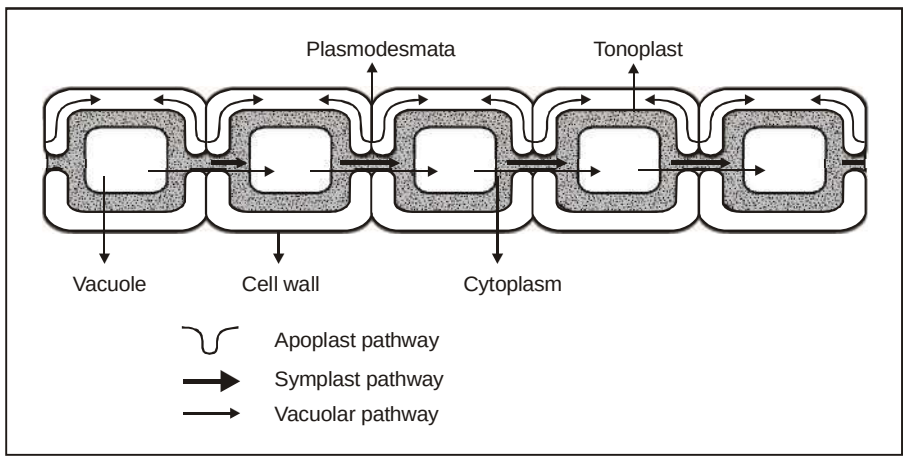
Pathway of Apoplast and Symplast :

(A) Symplast -

A substainable **living path** is known as symplast. This is the living passage. The movement of water from cell to cell through plasmodesmata is called **symplastic path** in plant. This movement of water through cell membrane is also called as **transmembrane pathway.**

(B) Apoplast -

This is the **non living path** in plants. Watered cell wall, intercellular space and xylem cavity associate together to form apoplast.



- Term **"apoplast"** & **"symplast"** given by **Munch**
- The path of water from root hair to cortex, may be apoplastic or symplastic. In **endodermis** suberised **casparian strips** blocks the apoplast, thus water must passes through passage cell via symplast.

MECHANISM OF WATER ABSORPTION

- Term active & passive absorption was proposed by **Renner.**
- Water is absorbed by two different ways-

(1) Active water absorption **(2) Passive water absorption**

1. ACTIVE ABSORPTION OF WATER

According to this method water is absorbed due to the osmotic acitivity of roots or by expenditure of ATPs.

I. Osmotic active water absorption ➡ This is given by **Atkins** & **Priestley.** According to this method water is absorbed due to the osmotic activity of roots in order to O.P. & D.P.D. **No direct ATP are consumed** in this method. It is effective during night in herbaceous plant and developes root pressure.

(A) Root Pressure :

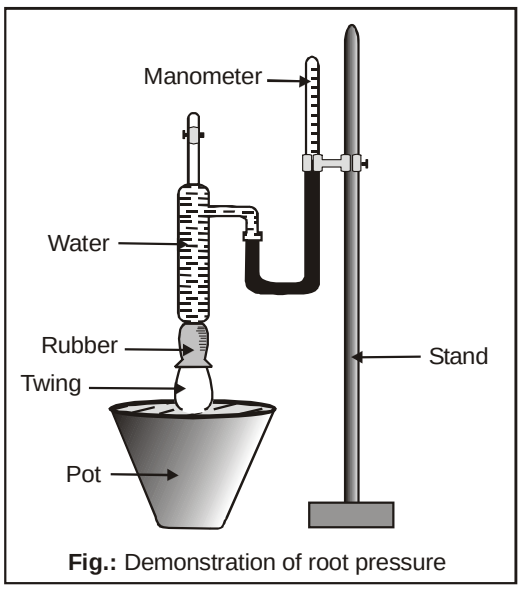


Fig.: Demonstration of root pressure

- Root pressure is the **positive hydrostatic pressure** which develops due to turgidity of cortical cells of root which excert pressure on the xylem sap of roots due to accumulation of water absorbed by roots, during night.
- Term **root pressure** was coined by **Stephan Hales**.
- Root pressure is developed when **rate of osmotic active water absorption is more than the rate of transpiration** and due to which water is pushed up in tracheary elements of roots.
- When a plant is cut near the base, the oozing of the liquid from the cut end is called **bleeding or exudation**. It is indicative of root pressure.
- The **maximum value** of root pressure can be upto **2 atm.**
- Its maximum value is found in plants growing in well aerated, well watered soil under and moist environment.
- **Root pressure** is **absent** in most of the **conifers, woody plants** and **in rapidly transpiring plants** (negative pressure is effective).
- Guttation is also the **result of root pressure**.
- Root pressure is high under favourable conditions (rains and spring). At this time **transpiration** rate is comparatively **low**. **In summers**, when there is greatest need for water, **root pressure is lacking**.
- Thus root pressure is not important in most plants. It may be effective in herbaceous plants which transpire slowly, during night.

(B) Guttation :

Loss of water from the margin of leaves of the herbaceous plant in the form of water droplets is called as **guttation**.

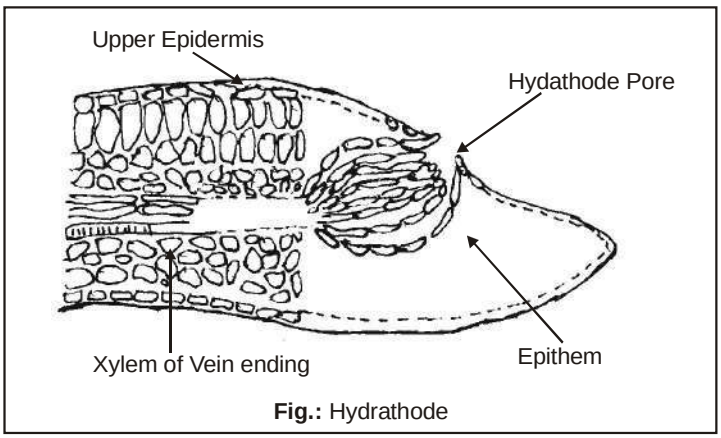


Fig.: Hydrathode

- The term **"Guttation"** was coined by **Burgerstein.**
- Exuded liquid of guttation along with water contains some **organic and inorganic (dissolved)** substances. It means it is not pure water.
- Normally, guttation process is found in herbaceous plants like **Grasses, Tomatos, Balsum, Nausterium, Colocasia, Saxifraga** and in some of the plants of **Cucurbitaceae** family.
- Guttation occurs from the margins of the leaves through the special pore (always open) like structure are called **hydathodes** or **water stomata.**
- Generally guttation occurs during mid night or early morning.
- Parenchymatous and loose tissue are lie beneath the hydathode, which are known as **epithem** or **transfer tissues.**
- The process of guttation take place due to **root pressure,** develop in cortex cells of root.

(C) Bleeding :

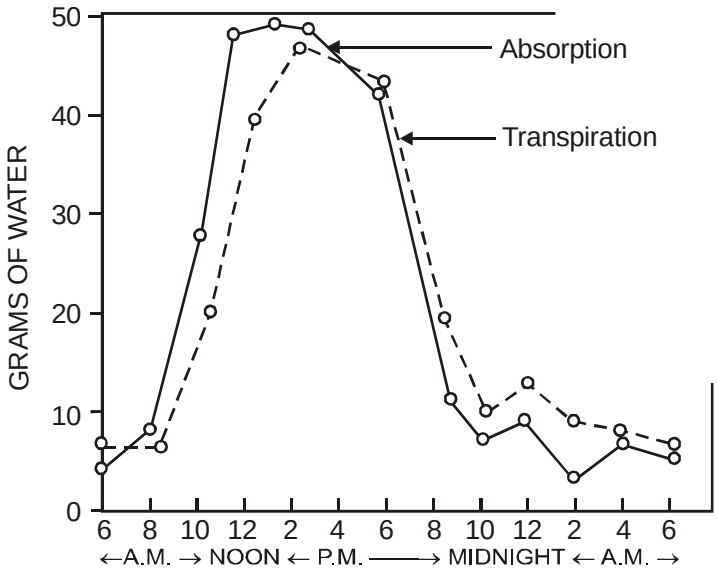
Fast flowing of liquid from the injured or cut parts of the plants is called bleeding or exudation.

- This process takes place due to high **root pressure.**
- Sugar is obtained from the sugar mapple by this process.
- The highest bleeding is found in **Caryota urens** (Toddy palm) (about 50 liter per day)
- Bleeding is important in economic biology, because **Opium, latex of rubber** is obtained by this method.

II. Non osmotic active water absorption ➡ Proposed by **Thieman, Bennet-Clark.** According to this method absorption of water occur **against the osmotic concentration** by direct investment / **expenditure of metabolic energy** in the form of ATPs. Generally this process present in **Halophytes.** Only 4% of total absorbed water is taken by this process.

2. PASSIVE ABSORPTION OF WATER

Given by **Kramer**. According to this method forces for the absorption of water originates in **aerial parts** by rapid transpiration & roots remain as passive organ. According to **Kramer** water absorption in plants is followed by transpiration. **About 96% of water is absorbed by passive method.** Due to rapid transpiration, D.P.D. of leaf cells ↑ result in suction force, which suck the water from roots.



Wilting :

- Drooping of soft parts of the plants due to loss of turgidity in their cells is called wilting. Wilting is caused due to high rate of transpiration during mid-day or deficiency of water in soil and also in prolonged drought condition.
- Wilting may be temporary or permanent.
- **Incipient wilting :** This is starting of wilting without any external symptom is called incipient wilting.

FACTORS AFFECTING WATER ABSORPTION

[1] Available soil water :-

- **Plant absorbs capillary water,** which is present in soil. Absorption of water depends on the amount of capillary water present in the soil. Absorption increases by increasing amount of capillary water.
- If, water is present in higher amount in the soil then such type of soil is called **"Water logged soil".** This soil is **Physiologically dry** and lack oxygen. Because of this an aerobic respiration takes place in roots, and alcohol is formed. Roots can be degenerate due to this alcohol. (**Dry soil** is physically dry.)

[2] Soil temperature :-

- Soil temperature affects the following mechanisms-
  - [i] Low temperature decreases the permeability of cell membrane.
  - [ii] It is essential for the activity of enzymes for the formation of root hairs.
  - [iii] At low temperature viscosity of capillary water is increased.
- Generally, normal absorption of water take place at temperature of soil between 20 - 35ºC.
- Increasing or decreasing soil temperature of soil between 20 - 35ºC.

  Cold soil is as **physiologically dry.**

[3] Soil Air :-

- Absorption of water proceeds more rapidly in well aerated soil. Deficiency of oxygen in soil causes improper respiration in roots.
- **Poorly aerated soil is physiologically dry.**

[4] Soil Concentration :

- The rate of the absorption is inversely proportional to the concentration of minerals present in soil.

$$\text{Water Absorption} \propto \frac{1}{\text{concentration of soil minerals}}$$

- Water absorption take place in appropriate soil solution. If the concentration of soil minerals is high, it decreases the rate of absorption. Therefore **saline soil** is **physiologically dry.** Halophytes can grow only in this soil.

[5] Transpiration :-

- According to **Kramer** the rate of water absorption is directly proportional to the rate of transpiration. The rate of absorption increases due to increase in the transpiration. Because passive water absorption increases due to transpiration.

ASCENT OF SAP

INTRODUCTION

- Upward conduction of water from roots to leaves through stem against force of gravity is called **ascent of sap.**
- The **inorganic substances** dissolved in xylem water are called **sap**.

PROBLEMS RELATED TO ASCENT OF SAP

(1) Path of Ascent of sap **(2) Mechanism of Ascent of Sap**

1. PATH OF ASCENT OF SAP

- The path of ascent of sap is **xylem** though exact mechanism is not clear.
- Important evidences -

(i) Ringing or Girdling Experiment **(ii) Staining Experiment**

(i) Ringing or Girdling Experiment :

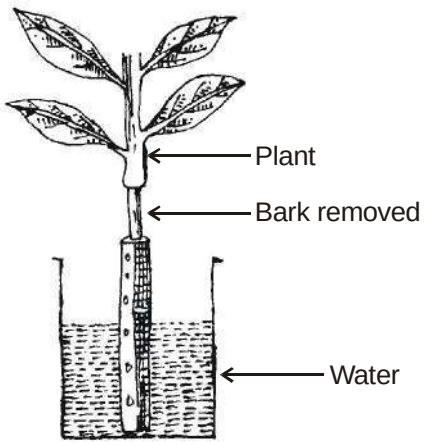


Fig.: Girdling Experiment : To show xylem as path of ascent of sap

- **Malpighi** (1671), **Stephen Hales** (1731) and **Hartig** (1837) proved by ringing experiment that ascent of sap not occurs through phloem or food conduction occurs by phloem.
- When ring or girdle upto 2-3cm of Bark (Secondry Phloem) is removed, the branches remain healthy.
- Ringing experiment cannot be performed in monocots due to presence of scattered vascular bundles in stem.
- Conclusion - Phloem is food conducting tissue or phloem is not water conducting tissue.

(ii) Staining Experiment–

- When a cut shoot of Balsam plant is dipped in solution of Eosine, **only xylem tissue is found stained**.
- **Blockage experiment -** By **Dixon,** xylem is blocked by wax.
- From above observations following conclusions can be drawn-

  Main path for ascent of sap is through **xylem cavities.**

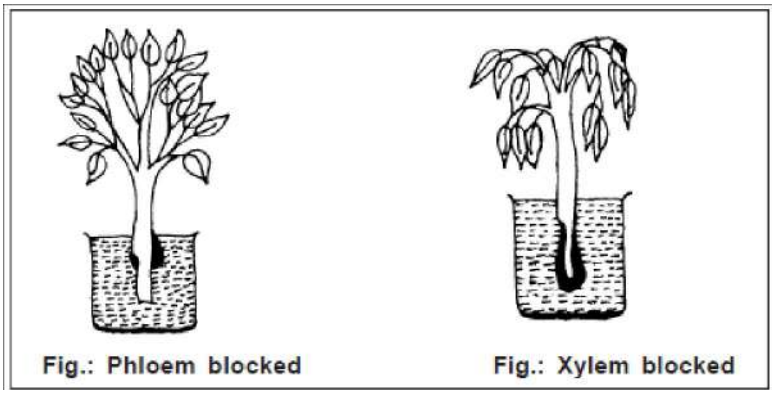


Fig.: Phloem blocked Fig.: Xylem blocked

2. MECHANISM OF ASCENT OF SAP

Two types of theories have been proposed for the mechanism of ascent of sap.

(i) Vital Force Theory **(ii) Physical Force Theory**

(i) Vital Force Theory :

According to this theory ascent of sap is due to vital activities of cells or living cells are responsible for ascent of sap. Main Supporters of this theory are -

- **Westermaier** (1884) was of the opinion that xylem parenchyma is responsible for ascent of sap. Tracheids and vessels only function as water reservoir.
- **Godlewski** (1884) gave **clambering force theory** or **relay pump theory** :

(i) According to this theory cells of xylem parenchyma and medullary rays shows rhythmic changes in osmotic pressure which causes upward movement of water.

(ii) When O.P. value of parenchyma rises, they absorb water from adjoining xylem vessel. Water rises up in parenchyma due to atmospheric pressure.

- **J.C. Bose - Pulsation theory :**

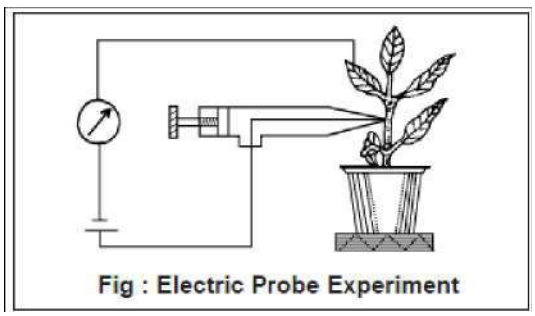


Fig : Electric Probe Experiment

(i) According to which innermost layer of cortex (=just outside the endodermis) is responsible for ascent of sap.

(ii) He concluded that these cells pulsate like heart and push water into the xylem cavity leading to ascent of sap.

(iii) He verified this with the help of electric-probe experiment. When electric probe reached in innermost layer of cortex, vibrations in galvanometer were observed.

(iv) Bose performed his experiment in Desmodium gyrans (a member of Papilionatae).

- **Strasburger** (1891) proved experimentally that living cells are not essential for ascent of sap. Ascent of sap can occur even after making the live cells dead by poisoning them (using Picric acid, $HgCl_2$ etc.)
- **Root Pressure Theory (By Priestley) :**

  Root pressure is respobsible for ascent of sap.

  Objections -

  – Root pressure is absent in woody plants, as secondry growth occurs in woody plant roots.

  – When root pressure is high, during night, then ascent of sap is low.

(ii) Physical Force Theories :

Supporters of this theory are of opinion that forces responsible for upward conduction of water are physical in nature and even dead cells can conduct water.

- **Capillary force theory : -** Proposed by **Boehm**. Xylem vessels acts as capillaries and water rises up due to capillary action.
- **Jamin's Theory : -** Also known as **chain theory**.

  – According to Jamin, there are alternate regular layers of water and air in vessels.

  – Ascent of sap occurs due to expansion of air.
- **Imbibition force theory :**

  – Proposed by **Unger** (1868) and supported by **Sachs** (1878).

  – According to this theory imbibition by thick walls of xylem vessels is responsible for ascent of sap.

  – **Sachs** considered hydrophilic colloidal substances present in cell wall of vessels to be responsible for this process.
- **Transpiration pull-cohesion force theory :**

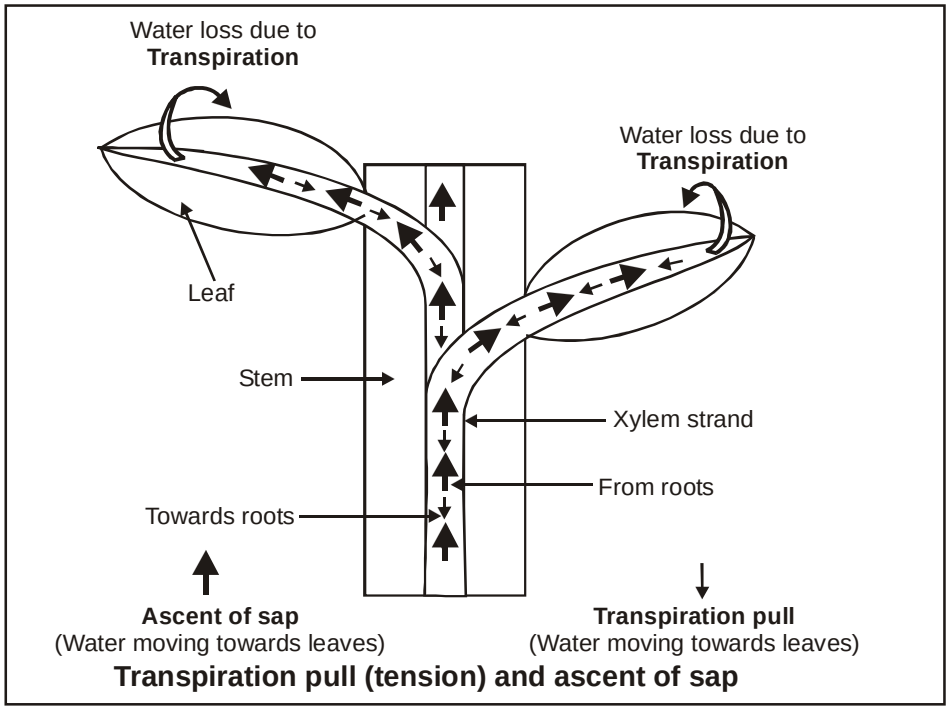
  – This theory was proposed by **Dixon** and **Jolly** (1894).

  – Most accepted or universally accepted theory of ascent of sap. According to it three components are involved in ascent of sap.

(a) Cohesion : Mutual attraction between the water molecule is called **cohesion force,** which helps in forming water coloum in xylem elements.

(b) Adhesion : Attraction between xylem walls and water molecules is called **adhesion force,** which helps in maintainance of water coloumn of xylem.

(c) Transpiration Pull : A tension or negative pressure develops in xylem due to rapid transpiration in leaves (because of high DPD), this creates a transpiration pull, which is responsible for the pulling up of water column in xylem. So ascent of sap is constitutive effect of cohesion, adhesion and transpiration pull.



Transpiration pull (tension) and ascent of sap

FACTORS AFFECTING ASCENT OF SAP

- Amount of water in Soil
- Temperature
- Atmospheric humidity
- Atmospheric pressure
- Movement of wind
- Number of stomata in leaves
- Besides them, all other factors which affects root pressure and transpiration process, also affects ascent of sap directly or indirectly.

FOOD TRANSILOCATION IN PLANTS

- Food/organic material conduction in plants mainly occurs by phloem. (Proved by Girdling experiment).
- Food conduction occurs in between **source** and **sink**. Source is net exporter while sink is net importer.
- Generally green photosynthetic plant parts acts as **source** like leaves while non photosynthetic parts like root, shoot, fruits acts as **sink**.
- Food conduction may be in any required direction or **bidirectional** unlike the water conduction which is a unidirectional process.
- Translocation of food mainly occurs in the form of **sucrose** or it is non-reducing sugar and chemically inert in it's pathway of conduction.
- **Pressure flow/mass flow hypothesis of food/sucrose translocation - Given by E. Munch (1930).** This is the most accepted theory of food conduction in plants.

According to it food translocation occur in between source and sink in order of turgor pressure gradient i.e., high T.P. to low T.P.

- **Phloem loading/sucrose loading at source** → It is an active process occurs with expenditure of ATP and helped by carrier molecules. At source due to phloem loading concentration of sieve cells increase, results in increase in osmotic pressure and water will moves from nearby xylem into sieve cells results in **increase in turgor pressure** (T.P.) and increase in water potential (Ψ_W). It establish a higher T.P at source end in sieve tubes. Sucrose moves from source in sieve tube towards sink from high T.P./ High ψ_W to towards the low T.P./low $\Psi_{W.}$
- **Phloem unloading/sucrose unloading at sink** → It is also active process occurs with expenditure of ATP and helped by carrier molecules. At sink sucrose is unloaded results in decrease in osmotic pressure (O.P.), it results in exit of water into near by xylem leads to decrease in Turgor pressure (T.P.) and water potential (Ψ_W) of phloem. In sink cells the unloaded sucrose is either changed into starch (as starch not change O.P.) or consumed, to maintain low O.P. and continuous unloading .
- The translocation of food between source and sink end is **passive process** as occurs in order of T.P. or Ψ_W gradient.
- So, the process of sucrose loading at source and unloading at sink continues. This turgor pressure difference will maintained and water will continue to move in at soure and out at sink.
- This mechanism was experimentally demonstrated by **Bimodel** exp. of **Munch.**
- According to evidences of modern research phloem conduction is an active process (only phloem loading and unloading) and it required metabolic energy of phloem cells.

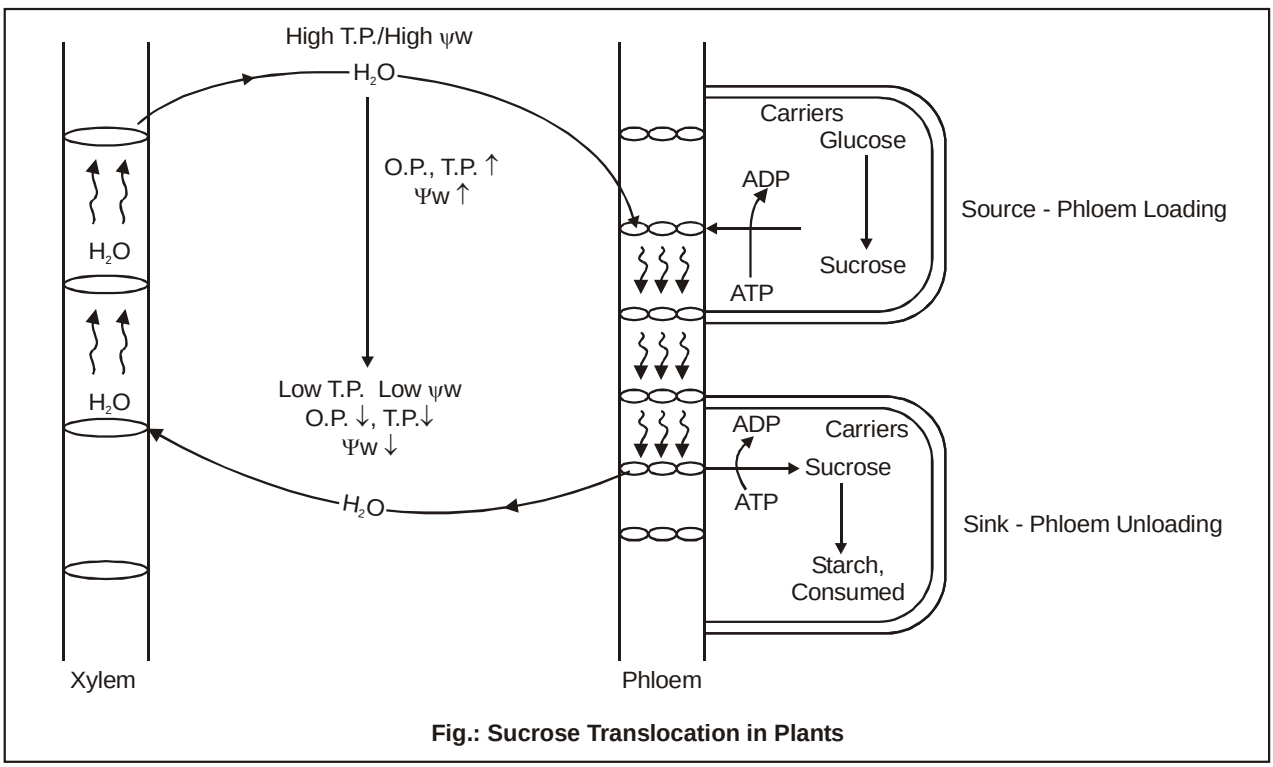


Fig.: Sucrose Translocation in Plants

TRANSPIRATION

INTRODUCTION

- Though large quantities of water is absorbed by the roots from soil, but only 2-5% of it is utilized by plant and rest 95-98% is lost in form of **transpiration**.
- Definition :- The loss of water from the aerial parts of plant in the form of vapours is **called transpiration**.
- The instrument used for measuring transpiration is **potometer**.
- **"Transpiration is an essential evil" - by Crutis.**

  "Transpiration is an unavoidable evil" - by Steward.
- The minimum transpiration is found in succulent xerophytes and no transpiration in submerged hydrophytes.
- **Maximum transpiration is found in mesophytes.**

Significance of transpiration :

[1] In regulation of temperature :

- **Cooling effect** on the surface of leaves is produced by the process of transpiration, due to which temperature remains constant in plants.
- The plant are protected from the burning of heat due to transpiration. Evaporation of water produces cooling effect.

[2] In mineral absorption :

- Mass flow of water is found during the passive absorption of water. Hence it is assumed that minerals enter the roots through the water.

[3] In ascent of sap

[4] In water absorption

[5] Distribution of absorbed salts

[6] Gaseous exchange

[7] Control of hydrological cycle

TYPES OF TRANSPIRATION

(A) Lenticular transpiration :

- Loss of water through **lenticles** (pores found in epidermis of mature stems, some roots & some fruits)
- It results in **0.1%** of water loss out of total transpiration.

(B) Cuticular transpiration :

- **10%** of total transpiration occurs from **surface**, outer wall of epidermis of aerial parts.
- The outer wall has cuticle which affects diffusion of water. It is inversely proportional to thickness of cuticle & amount of water.
- Cuticle minimize stomatal transpiration.

(C) Stomatal transpiration :

- Loss of water through **stomata** (small opening on the epidermis of leaves).

- **90%** of total transpiration occurs through **stomata**.
- The water lost from leaves is called **foliar transpiration.**

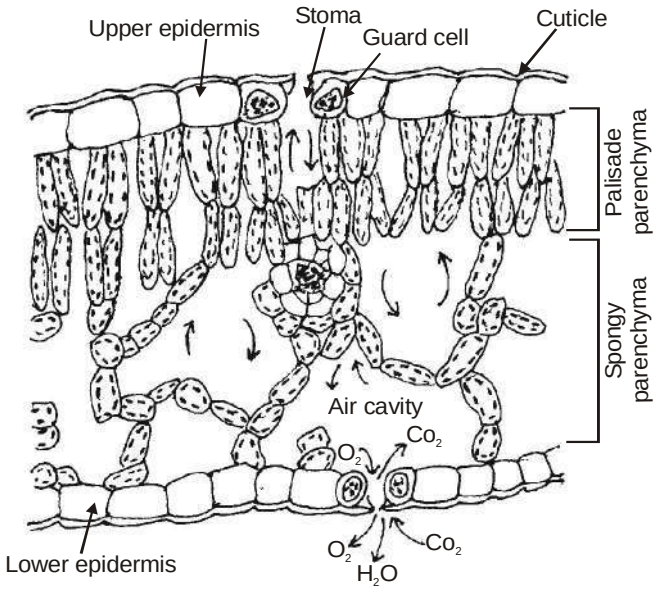


Fig.: T.S. of a leaf showing the stomatal transpiration.

STOMATA

- The name '**stomata**' was given by **Malpighie.**
- Stomata was discovered by **Pfeffer**.
- Stomata cover 1-2% of leaf area.
- Algae, fungi and submerged plants do **not possess stomata**.

Structure of stomata :

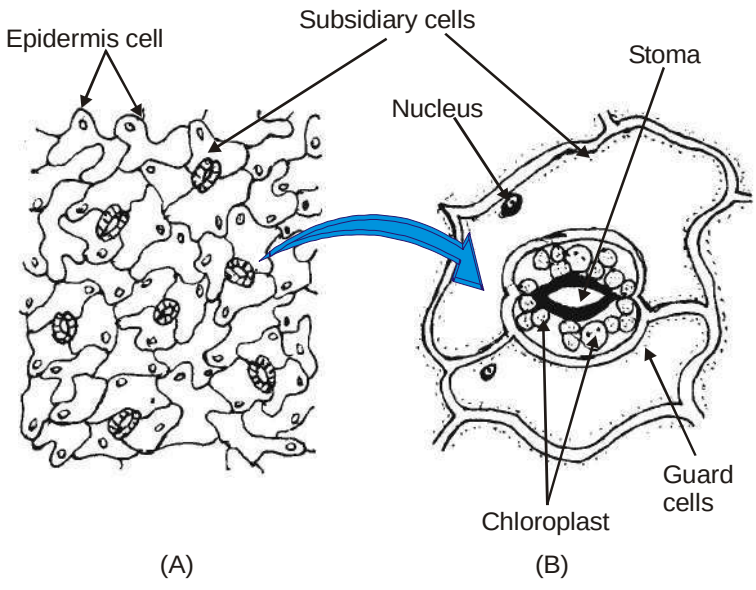


Fig.: (A) Lower epidermis of a leaf to show stomata
(B) Structure of one stomata

- Stomata are small **elliptical pores** found on the epidermis of plant leaves.
- The size of the pore varies from plant to plant. e.g. - In maize the size of pore is **4µ wide to 26µ long**.
- This pore is surrounded by **kidney shaped** or bean shaped epidermal cells called **guard cells**.
- Guard cells are living & have nucleus, chloroplast, vacuole and cytoplasm.
- Chloroplast is functionally active only in dicots. In monocots it is either rudimentry or absent or functionally inactive.
- Inner wall is thick & less elastic and outer wall is thin & more elastic in guard cells.
- Guard cells are surrounded by specialized epidermal cells called **subsidiary** or **accessory cells**.
- The pore opens or closes by the movement of guard cells.
- In the inner tangential walls of guard cells micro filaments of cellulose are present in circular form called as **radial micellation**.
- The air cavities to which the stomata opens are called as **substomatal cavity.**

Distribution of stomata :

- In monocots, stomata are **uniformly distributed** and are present on the upper and lower surface of the leaf.
- In dicots, stomata are **unevenly distributed** and are present more on the lower surface.
- In dicots guard cells are **kidney shaped**, reniform or bean like.
- In monocots, guard cells are **elliptical** or **dumbell shaped** which are called as **Graminaceous stomata.**
- In xerophytes stomata are situated in a **groove** and are thus called as **sunken stomata.**

Types of Stomata :

- **On the basis of distribution : 5 types**

Apple or Mulberry or Hypostomatous	**Potato type or Amphistomatous**	**Oat type or Amphistomatous**	**Water lily type or Epistomatous**	**Potomogeton or Astomatous**
Stomate present only on lower surface of leaf. **e.g.,** Apple, Oxalis, Mulberry	Stomata present on both surface of leaf but more on lower surface **e.g.,** Potato, Pea, Tomato, Cauliflower & other dicots.	The no. of stomata are equal on both sides. **e.g.,** Oat & other monocots like grasses, cereals, Maize	Stomata on upper suface only. **e.g.,** Water lily, Lotus, Victoria	Stomata absent or vestigeal. **e.g.,** Potamogeton, Hydrilla, Vallisneria

- **On the basis of subsidiary cells :- 4 types**

Anomocytic	**Anisocytic**	**Paracytic**	**Diacytic**
Subsidiary cells are similar in structure & 5 or 6 in no. **e.g.,** Ranunculaceae family	Subsidiary cells are in 3 in no. & one is bigger than other two. **e.g.,** Crucifereae family	Subsidiary cells two in no. & are situated parallely with gaurd cells. **e.g.,** Rubiaceae family	Subsidiary cells are two in no. & are longitudinal with guard cells. **e.g.,** Caryophyllaeceae family

- **On the basis of daily stomatal movement :- 4 types (Loftfield, 1912)**

Alfa – Alfa Type	Potato Type	Barley Type	Equisetum Type
Stomata open in day. **e.g.,** Sunflower, Pea, Apple, Grapes, Mustard, Raddish	Stomata open in day & night but get closed in the evening for few hours. **e.g.,** Potato, Banana, Onion, Cabbage, Cucurbita, Pumpkin	Stomata open for some time in day & then remain closed. **e.g.,** In Cereals, like – Wheat, Maize, Barley	Stomata always remains open. **e.g.,** Amphibious plants.

- **On the basis of Light :- 3 types**

Photoactive	Scotoactive	Hydroactive
Stomata opens in presence of light. **e.g.,** In all normal plants	Stomata opens only at night. **e.g.,** Opuntia	Stomata opens only in presence of moisture. **e.g.,** Some epiphytes plants

- **On the basis of development (Pant , 1965) : 3 types**

Mesogynous Type	Perigynous Type	Mesoperigynous Type
In this type of stomata guard cells as well as subsidiary or Accessory cells both are developed from one mother cell. **e.g.,** Rubiaceace & Brassicaceae	In this type guard cells are formed from mother cell while subsidiary cells from nearby mother cells. **e.g.,** Cucurbitaceae family	In this type guard cells & one subsidiary cell is formed from mother cell while other subsidiary cells develop independently. **e.g.,** Ranunculaceae, Caryophyllaceae family

Stomata in Gymnosperms :

(i) **Syndetochielic –** When subsidiary cells & guard cells originate from single cell.

(ii) **Haplochielic –** Both cells arises from separate cells.

MECHANISM OF TRANSPIRATION

This involves 3 steps :

1. **Osmotic diffusion of water in the leaf :**
   - Inside the leaf mesophyll cells are in contact with xylem & also with inter cellular spaces above the stomata.
   - Mesophyll cells draw water from the xylem which makes the cells turgid. Their diffusion pressure deficit and osmotic pressure decreases and in turn they release water in the form of vapours in intercellular spaces close to stomata by diffusion.
   - After releasing water the O.P. & D.P.D. of mesophyll cells increases & hence they draw water from xylem again.
2. **Opening & closing of stomata :**
   - When guard cells becomes **turgid** stomatal pore **opens**, while when they becomes **flaccid** stomatal pore **closes**.

- Stomata generally open during the day and closed during the night except in CAM plants. The important theories of stomatal movements are as follows-

(i) Photosynthesis in guard cell hypothesis :

This theory was proposed by **Schwendener and Von mohl.** According to this theory guard cell chloroplast perform photosynthesis during the day time. This produce sugars in guard cell which increases the O.P. of GC, compared to adjacent epidermal cells (subsidiary cells). Water enters in guard cells form subsidiary cells by endosmosis, due to this guard cells become turgid and stomata will open.

Objections -

(i) In CAM plants stomata open during dark/night.

(ii) Chloroplast of monocot guard cells are non-functional (inactive) photosynthetically.

(ii) Starch → Sugar interconversion theory :

- This theory was proposed by **Sayre** (1926). First of all Lloyd stated that amount of sugar in GC is increases during the day time and starch in night.
- Detail study of this change was done by **Sayre** & given **starch hydrolysis theory.** According to **Sayre,** starch converts into sugar during day time when pH of guard cell is high. Sugar changes into starch during night at low pH in guard cells (Supported by **Scarth**). **Sayre** clarified that CO_2 reacts with water during night. Due to accumulation of H_2CO_3, pH in guard cell is decreases.
- **Hanes -** Stated that this change takes place by phosphorylase enzyme.
- **Yin & Tung** reported the presence of phosphorylase enzyme in guard cells.

$$\text{Starch + ip} \underset{\text{Night pH- 4.5-5}}{\overset{\text{Day ph 7.5}}{\rightleftharpoons}} \text{Glucose-1, P} \Rightarrow \text{conc. of GC increased} \rightarrow \text{Entry of } H_2O \text{ in GC}$$

GC - Turgid → Stomata open.

- **Stewards modification -** According to Steward (1964) appreciable change in O.P. of GC is possible after the conversion of glucose - 1 P into Glucose & ip (inorganic phosphate)

(i) Glucose-1, P $\xrightarrow{\text{Mutase}}$ Glucose-6P

(ii) Glucose-6, P $\xrightarrow{\text{Phosphatase}}$ Glucose + iP

⇩

Conc. of GC increased

↓

osmotic entry of **H_2O → GC-Turgid → open.**

(iii) Glucose + ATP $\xrightarrow{\text{Hexokinase}}$ Glucose-1, P ➡ Starch ➡ Stomata closed

Objections -

(i) Starch is absent in GC of some monocots like onion.

(ii) Formation of organic acid is observed during stomatal opening.

(iii) Active K^+ ➡ H^+ exchange theory or active proton pump mechanism-

- Given by **Levitt (1973-74)**. This is modern and most accepted theory for stomatal opening and closing.

- First of all **Fujino** observed that influx of K^+ions in guard cells during stomatal opening. (Supported by Fisher and Hsiao). Detail study of this phenomenon was done by **Levitt**, who proposed this theory. According to him stomata opens by following mechanism.

(i) Cabohydrates $\xrightarrow{\text{Enzymes}}$ PEP + CO_2 $\xrightarrow[\text{Carboxylase}]{\text{PEP}}$ OAA

(ii) O.A.A. $\longrightarrow$ Malic Acid $\begin{cases} \rightarrow H^+ \rightarrow K^+ \\ \rightarrow ATP \\ \rightarrow Malate^- \end{cases}$

(iii) Malate + K^+ $\longrightarrow$ K-malate $\longrightarrow$ Conc. of GC increased $\downarrow$

Entry of H_2O in GC $\rightarrow$ **GC turgid** $\rightarrow$ **Stomata open**

- **Closing of stomata :-** Plant hormone ABA-acts on guard cells, which interfere the exchange of $K^+ \rightarrow H^+$ ions in gurad cells, results in reverse of reaction. of opening of stomata, hence stomata closed. pH of guard cells is decreases during night, which favours stomatal closing.

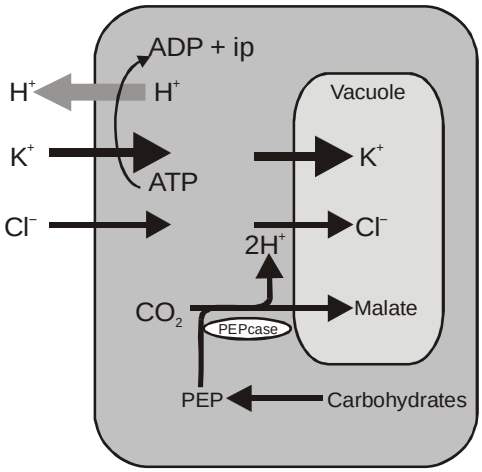


Fig.: Role of potassium, chloride and malate ions in stomatal opening. The ions accumulate in the vacuole of guard cells, lowering the water potential and thereby increasing water uptake and subsequently opening the stomata (PEPCase = Phosphoenol pyruvate carboxylase)

- High concentration of K^+ ions in guard cells is electrically balanced by uptake of Cl^- and malate ions in guard cells.

(iv) Ca-ABA second messenger model - Given by **Desilva** & **Cowan** (1985) this is modern explanation of stomatal closing only.

- **Ramdas & Raghvendra** suggested that ATPs for stomatal movement comes from cyclic ETC.
- **Bowlings :** Malate switch hypothesis.

  Raschke : K^+ ions in guard cells comes from subsidiary cells.
- Stomata opens during the night in succulent plants and closed during the day. This nature of stomata in opuntia is called **Scotoactive stomata.**
- In CAM plants organic acid is formed during night which broken down during day and CO_2 is liberated which is used in photosynthesis.

FACTORS AFFECTING RATE OF TRANSPIRATION

Factors affecting stomatal opening and closing :

[1] Light :

In most of the plants stomata open during the day except succulent xerophytic plants and close during the dark. Opening of stomata completes in the presence of blue and red light. **Blue light is most effective** and causing stomatal opening.

[2] Temperature :

Loft field show temperature quotient of opening of stomata is **$[Q_{10}] = 2$**

[3] CO_2 concentration :

- Stomata opens at low concentration of CO_2 while closed at high concentration of CO_2.

[4] Growth Hormones :

- **Cytokinin hormone induce opening of stomata.** It increase the influx of K^+ ions and stimulate the stomata for opening.
- While **ABA** stimulate the stomata for closing. This hormone **oppose the induction effect of cytokinin.**
- ABA effects the permeability of the guard cells. It prevent the out flux of H^+ ions and increase the out flux of K^+ ions. Because of this pH of the guard cells decreased.

  Cl^- ions also plays important role in stomatal movement. Above mentioned effects also found in high amount of CO_2
- ABA is formed due to high water stress in chloroplast of leaves.

[5] Atmospheric humidity :

- Stomata opens for long duration and more widen in the presence of humid atmosphere, while stomata remains closed in dry atmosphere or partial opening at higher atm. humidity transpiration will be stop but stomata remains completly open.

Factors affecting the rate of transpiration :

Factors affecting the rate of transpiration are divided into two types :

[A] External Factors (Environmental factor)

[B] Internal Factors

1. EXTERNAL FACTORS (Environmental factor)

(i) Atmospheric humidity : $T_r \propto \frac{1}{\text{Relative humidity}}$

- This is the most important factor. The rate of transpiration is higher in low atmospheric humidity while at higher atmospheric humidity, the atmosphere is moistened, resulting decreasing of rate of transpiration.
- Therefore, the rate of transpiration is high during the summer and low in rainy season.

(ii) Temperature : $T_r \propto \text{Temperature}$

- The value of Q_{10} for transpiration is 2. It means by increasing 10ºC temperature, the rate of transpiration is approximately double. (By Loftfield)

- Water vapour holding capacity of air increased at high temperature, resulting the rate of transpiration increased.
- On contrary vapour holding capacity of air decreased at low temperature so that the rate of transpiration is decreased.

(iii) Light :

- Light stimulates, transpiration by heating effect on leaf.
- **Action spectrum** of transpiration is **blue** and **red.**
- Rate of transpiration is **faster in blue light** than that of red light. Because stomata are completely opened as their full capacity in the blue light.

(iv) Wind velocity : $T_r \propto$ Wind velocity

- Transpiration is less in constant air but if wind velocity is high the rate of transpiration is also high, because wind removes humid air (saturated air) around the stomata.
- Transpiration increases in the beginning at high wind velocity [30-50 km./hour] But latter on it cause closure of stomata due to mechanical effect and transpiration decrease.

(v) Atmospheric pressure :

- The speed of the air increase at low atmospheric pressure, due to this rate of the diffusion increase which increase the rate of transpiration.
- The rate of transpiration is found maximum in the high intensity of light at high range of hills.

Transpiration ratio (TR) : Moles of H_2O transpired / moles of CO_2 assimilated.

- Ratio of the loss of water to the photosynthetic CO_2 fixation is called TR.
- TR is low for C_4 plants (200–350) while high of C_3 plants (500–1000). It means C_4 conserve water with efficient photosynthesis.
- CAM plants possess minimum TR (50–100).

(vi) Anti transpirants :

- Chemical substances which reduce the rate of transpiration are known as **antitranspirants.** Anti transpirants are as follows-
- **Phenyl Mercuric Acetate (PMA), Aspirin, (Salicylic acid), Abscisic acid (ABA), Oxi-ethylene, Silicon oil, CO_2 and low viscous wax.**
- PMA closed the stomata for more than two weeks partially.
- Antitranspirants are used in dry farming.

2. INTERNAL FACTORS :

- These factors are concerned with structure of plants. These are following types :

(i) Transpiration area :

Pruning increase the rate of transpiration per leaf but overall reduce the transpiration.

(ii) Anatomical characteristics of leaf and leaf orientation :

Several structures of leaf effect the transpiration as follows :-

Stomatal characteristics :

Transpiration is effected by the structure of stomata, position of stomata, distance between the stomata, number of stomata per unit area and activity of the stomata.

By Salisbury - Stomatal Index (SI) = $\frac{S}{E+S}$

SI = Stomatal index S = Number of stomata/unit area

E = Number of epidermal cells in same unit area.

(iii) Water status of leaves

(iv) Root - Shoot Ratio :

- The rate of transpiration decreases with decrease in root-shoot ratio.
- The rate of transpiration increases with increase in root-shoot ratio.

The following characteristics are found in leaf to reduce the transpiration.

(i) Leaves modify in spines.

(ii) Leaves transformed into needle e.g. **Pinus**

(iii) Folding and unfolding of leaves by bulliform cells. eg., **Amophilla, Pea etc.**

(iv) Small size of the leaves.

(v) Presence of thick waxy layer on leaves. eg., **Banyan tree.**

SPECIAL POINTS

- Transpiration in old stems and fruits occurs through **lenticels**.
- The loss of water through transpiration in increasing unit dry weight of the plant is called **transpiration ratio**.
- The quantity of water transpired by unit area of leaf surface in unit time is called **transpiration flux**.
- The diurnal periodicity was diagrammatically represented by **Von mohl**.
- Fresh weight of a plant would be maximum in the morning and minimum in the afternoon.
- The main reason of osmotic pressure for stomata is potassium chloride or potassium malate**.**
- Porometer is used to find out the area of stomata on the leaf.
- Transpiration measuring instrument is called **Potometer**. The rate of absorptioon of water is measured through this instrument. In potometer rate of water absorption is proportional to the rate of transpiration.
- **Cobalt-chloride test :** This method is used for the comparision of transpiration at both the surface of the leaves. It is first of all shown by **Stahl.**
- Stomata covers 1-2% of total leaf area. Size of stomata is 10-40μ (Length) × 3 – 12μ (width)
- The photophosphorylation process in the guard cells is a energy metabolic process, not CO_2-metaboic process.
- The rate of transpiration of C_4 plants is less as compared to C_3 plants. In CAM plants minimum transpiration occurs.
- **Distribution of stomata on leaf surface :**

Plant Type	Stomata No./mm²	
Dicots	**Upper epidermis**	**Lower Epidermis**
Sunflower	120	175
Alfa-Alfa	169	188
Geranium	29	179
Monocots		
Wheat	50	40
Barley	70	85
Onion	175	175

- **Auxins** which increases metabolic activities of the cells stimulate absorption of water.
- **Wilting Coefficient :** The amount of water expressed as percentage of dry weight of soil, which is left in soil at the time of permanent wilting is called **wilting co-efficient.**
- Value of **Tensile strength** of xylem sap is upto 300 atm.
- The maximum value of transpiration pull has been found to be 20 atm. 1 atm force can raise water upto 10 m height. Thus ascent of sap can occur upto 200 meters height by transpiration pull.
- Besides the translocation of water upwards, water is also translocated radially and downwards. Radial translocation is more common.
- Cytokinin enhances opening of stomata while ABA induce closing of stomata.
- In moist environment, stomata open more widely and for longer time & opposite is the case in dry environment.
- The OP of guard cells when stomata open is 30-40 atm.
- During wilting rate of photosynthesis also decreases.
- The no. of stomata per unit area of leaf is called **stomatal frequency**. It depends on position of leaf, external enviromment etc. In a leaf, it increases from base to tip and from midrib to lateral sides.

EXERCISE - 1

DIFFUSION,OSMOSIS & RELATEDTERMS

Q.1 The physical process involved in the release of molecular oxygen from leaves is : -

(1) Diffusion (2) Transpiration

(3) Osmosis (4) Capillarity

Q.2 Who is called father of plant physiology ?

(1) K.V. Thimann (2) Stephan Hales

(3) M. Calvin (4) E. Rabinowitch

Q.3 Who is called father of Indain plant physiology?

(1) J.C. Bose (2) Calvin

(3) R. Mishra (4) K.K. Nanda

Q.4 One molar solution of which substance will have maximum O.P : -

(1) NaCl (2) Glucose

(3) Fructose (4) Starch

Q.5 Pieces of beet root do not lose their colour in cold water, but so in boiling water because :-

(1) The cell wall is killed in boiling water

(2) Hot water can enter cells readily

(3) The plasma membrane gets killed in boiling water and becomes permeable

(4) The pigment is not soluble in cold water

Q.6 The movement of molecules from their higher concentration to lower concentration is called-

(1) Osmosis (2) Diffusion

(3) DPD (4) DPG

Q.7 Osomosis is the diffusion of a solution of a weaker concentration when both are seperated by semi-permeable membrane. What is error in the statement ?

(1) The movement of solvent molecule is not specified

(2) There is no mention of DPD

(3) Behavior of semipermeable membrane is not specified

(4) The exact concentration of solutions are not indicated

Q.8 What statement can be cited for 10% sodium chloride solution and 10% sugar solution present ?

(1) Both have equal OP

(2) The concentration of sodium chloride solution will be less than concentration of sugar solution

(3) The OP of sugar solution will be higher than OP of sodium chloride solution

(4) DPD of sodium chloride solution will be higher than DPD of sugar solution

Q.9 If a plant cell is immersed in water, the water continues to enter the cell until the : -

(1) Concentration of the salts is the same inside the cells as outside

(2) Cell bursts

(3) Concentration of water is the same inside the cell as out side

(4) Diffusion pressure deficit is the same inside the cell as out side

Q.10 If a cell swells, after being placed in solution, the solution is : -

(1) Neutral (2) Hypotonic

(3) Hypertonic (4) Isotonic

Q.11 Osmosis means : -

(1) Solute from low concentration to higher

(2) Solute from higher concentration to low

(3) Solvent from low concentration of solution to higher conc. of solution

(4) Solvent from higher concentration solution to low concentration solution

Q.12 If cell is reduced in size (shirnks) of placing in a solution of sugar, the solution is : -

(1) Hypertonic (2) Hypotonic

(3) Isotonic (4) None of the above

Q.13 The process of osomosis involves : -

(1) Movement of solute through a semipermeable membrane

(2) Movement of solvent through a semipermeable membrane

(3) Movement of solution through semipermeable membrane

(4) None of the above

Q.14 A cell increases in volume if the external medium is

(1) Hypotonic (2) Slightly hypertonic

(3) Isotonic

(4) Much more concentrated than the protoplasm of the cell

Q.15 Osmosis involves diffusion of : -

(1) Suspended particles from higher to lower concentration

(2) Suspended particles from lower to higher concentration

(3) Water from more to less conentration solution

(4) Water from less to more concentrated solution

Q.16 A cell placed in a strong salt solution will shrink because : -

(1) They cytoplasm will be decomposed

(2) Mineral salts will break the cell wall

(3) Salt will enter the cell

(4) Water will move out the cell by exosomosis

Q.17 Grapes placed in salt solution shrink due to :

(1) Imbibition (2) Endosmosis

(3) Exosmosis (4) Osmosis

Q.18 Process of selective transmission of a liquid through semi permeable membrane is called :-

(1) Diffusion (2) Osmosis

(3) Plasmolysis (4) Transmission

Q.19 Water enters into the root hair from the soil in its normal condition because the osmotic pressure of the soil solution :-

(1) Remains lesser than that of root hair sap

(2) Remains equal to that of root hair sap

(3) Remains higher than that of root hair sap

(4) And that of root hair sap remains zero

Q.20 Potato slices are immersed in a series of solution of diffferent osmotic concentrations. No change in volume or weight is observed with slices in a 0.3 M solutions. The osmotic concentration of vacuolar sap, therefore : -

(1) 0.3 M

(2) Greater than 0.3M

(3) Less than 0.3 M

(4) Not related at all to the out side solution

Q.21 Which helps in maintaining form and structure of cells & soft parts of plants ?

(1) Osmotic pressure (2) Turgor pressure

(3) Atmospheric (4) DPD

Q.22 Who propounded the concept of osmosis ?

(1) Abbe Nollet (2) Mayer

(3) Dixon and jolly (4) Renner

Q.23 In terms of permeability, the cell wall and plasmalemma are : -

(1) Permeable and differentially permeable respectively

(2) Both semipermeable

(3) Semipermeable and permeable

(4) Both differentially permeable

Q.24 Plasma membrane controls : -

(1) Passage of water only

(2) Passage of water and solutes in and out of the cell

(3) Passage of water and solutes into the cell

(4) Movement of cell contents out the cell

Q.25 Which process occurs against a concentration gradient of solute ?

(1) Diffusion (2) Osmosis

(3) Transpiration (4) Translocation

DPD (SP)

Q.26 When a cell is fully turgid which of the following will be zero ?

(1) Turgor pressure (2) Wall pressure

(3) Suction pressure (4) Osmotic pressure

Q.27 Water from the soil enters in to the root hairs on account of : -

(1) Turgor pressure

(2) Suction pressure DPD

(3) Barometric pressure

(4) Osmotic pressure

Q.28 In a fully turgid cell the values of DPD, OP and TP should be : -

(1) DPD = 10 atm., OP = 15 atm., TP = 5atm

(2) DPD = 5 atm., OP = 12 atm., TP = 7atm

(3) DPD = 10 atm., OP = 15 atm., TP = 5atm

(4) DPD = 0 atm., OP = 15 atm., TP = 15atm

Q.29 When the cell is placed in water, it takes water this is due to ?

(1) Osmotic pressure

(2) Suction pressure

(3) Diffusion

(4) Water potential and TP

Q.30 What is the direction of the movement of water if two cells have the same OP but differ in TP ?

(1) No net flow

(2) From lower T.P to higher TP

(3) From higher TP to lower TP

(4) Data insufficient

Q.31 The hydrostatic pressure developed in the cell is called : -

(1) Turgor pressure (2) Wall pressure

(3) Osmotic pressure (4) Suction pressure

Q.32 In fully turgid cell : -

(1) DPD = WP (2) DPD = OP

(3) DPD = OP - TP (4) DPD = 0

Q.33 In flaccid cell : -

(1) DPD = WP (2) DPD = OP

(3) DPD = 0 (4) DPD = OP - TP

Q.34 Turgor pressure of a plasmolysed cell is : -

(1) Positive (2) Zero

(3) Negative (4) None of these

Q.35 When water enters into a cell what happens to its OP, TP and DPD ?

(1) OP & TP increase & its DPD increase

(2) OP & DPD increase & TP decrease

(3) TP & DPD decrease & OP increase

(4) OP & DPD decrease & TP increase

Q.36 What is the value of DPD of a cell ?

(1) DPD = OP × TP (2) DPD = OP + TP

(3) DPD = OP – TP (4) DPD = OP ÷ TP

Q.37 Under natural conditions the osmotic pressure is : -

(1) More than turgor pressure

(2) Less than turgor pressure

(3) Equal to turgor pressure

(4) Zero

Q.38 What maintains the shape of a cell ?

(1) Osmotic pressure (2) Turgor pressure

(3) Suction-pressure (4) Wall-pressure

Q.39 Osmotic potential is numerically equal to :-

(1) Turgor pressure (2) Wall pressure

(3) Osmotic pressure (4) D.P.D

Q.40 You are given three cells, a root hair, a cell of the inner cortical layer and a cell of the mesophyll arrange them in ascending order of DPD : -

(1) Root hair < Cortical cell < Mesophyll

(2) Cortical cell < Mesophyll < Root hair

(3) Mesophyll < Root hair < Cortical cell

(4) Root hair < Mesophyll < Cortical cell

Q.41 Osmotic pressure is highest in : -

(1) Atriplex confertifolia

(2) Salsola foetida

(3) Rhizophora

(4) Chenopodium

PLASMOLYSIS & PERMEABILITY

Q.42 Plasmolysis can be used for : -

(1) Good growth of plants

(2) Good growth of weeds

(3) Killing the weeds (4) None of the above

Q.43 Along with plasmolysis which decreases in the cell -

(1) Osmotic pressure (2) Diffusion pressure

(3) Imbibition pressure

(4) Turgor pressure

Q.44 If a plasmolysed cell is placed in distilled water then it returns to its original state & become turgid, this is called as : -

(1) Plasmolysis (2) Exosmosis

(3) Endomosis (4) Deplasmolysis

Q.45 If there is high amount of fertilizer present in soil & it is deficient in water then what will be the effect

(1) Over growth (2) Under growth

(3) No effect (4) Wilting of plants

Q.46 Plant cells do not burst in distilled water because : -

(1) Cell wall is permeable

(2) Cell wall is living

(3) Cell wall is elastic, rigid and get stretched

(4) Cell wall is dead and impermeable

Q.47 When a plant cell is placed in a hypertonic solution it becomes plasmolysed what shall be present between cell wall and plasmalemma at this stage ?

(1) Water and air

(2) Cell sap

(3) Hypertonic solution

(4) Solutes

Q.48 Bacteria can not survive in a highly salted pickle. Because

(1) Salt inhibits reproduction of bacteria

(2) Enough light is unavailable for photosynthesis

(3) They become plasmolysed and death occurs

(4) Nutrients in the pickle medium can not support life

WATER POTENTIAL

Q.49 Value of water potential for pure water is : -

(1) 1 (2) 2

(3) 3 (4) Zero

Q.50 Water potential is affected by : -

(1) Osmotic potential (2) Matric potential

(3) Pressure potential (4) All of the above

Q.51 When the solute has been added to the solution; it water potential will ?

(1) Increases (2) Decreases

(3) Remains unchanged

(4) First increases then decreases

Q.52 Water potential of a cell when its placed in hypertonic solution : -

(1) Decreases (2) Increases

(3) First increases then decreases

(4) No change

Q.53 Osmotic potential (ΨS) of a solution is always-

(1) Positive (2) Negative

(3) Zero (4) Variable

Q.54 Water potential (Ψ) of a solution is always :-

(1) + Ve (2) – Ve

(3) Zero (4) Variable

Q.55 When the water potential of a cell become zero, it is said to be in ?

(1) Fully turgid state

(2) Flaccid state

(3) Incipiently plasmolysed state

(4) Completely plasmolysed state

Q.56 A root hair cell under ordinary coditions have a water potential in the range of : -

(1) – 1 to – 4 atm. (2) – 1 to + 4 atm.

(3) 1 to 2 atm. (4) – 1 to 2 atm.

Q.57 Why hygroscopic water is not available to plants ?

(1) Because its Ψ_ω is greatly increased

(2) Because its DPD is greatly decreased

(3) Because its Ψ_ω becomes strongly negative

(4) Because its Ψ_ω is increased and DPD is decreased

Q.58 The concept of water potential was propounded by : -

(1) Robert mayer (2) Abbe Nollet

(3) Slatyer & Taylor (4) Levitt

Q.59 The solute potential can be determined in a simple manner by : -

(1) Water potential

(2) DPD

(3) Osmotic pressure

(4) Suction pressure

Q.60 The accurate equation for presenting water potential is : -

(1) $\Psi\omega = \Psi_s + \Psi_p + \Psi_m$

(2) $\Psi_s = \Psi\omega + \Psi_p + \Psi_m$

(3) $\Psi\omega = \Psi_s - \Psi_p - \Psi_m$

(4) $\Psi\omega = -\Psi_s - \Psi_p - \Psi_m$

IMBIBITION

Q.61 Seeds swell when placed in water due to : -
(1) Osmosis (2) Imbibition
(3) Hydrolysis (4) All of these

Q.62 During rainy season wooden doors generally swell up due to : -
(1) Osmosis (2) Imbibition
(3) Bad wormanship (4) Wood quality

Q.63 Imbibition process involves : -
(1) Both diffusion and capillary action
(2) Only diffusion
(3) Only capillary action
(4) None of the above

Q.64 The most powerful imbibant is : -
(1) Agar - agar (2) Proteins
(3) Cellulose (4) Lignin

Q.65 Swelling of wooden planks and door-penals during the rainly season is due to : -
(1) Imbibition (2) Endosmosis
(3) Deplasmolysis (4) Diffusion

Q.66 First step of influx of water into a plant (or) a root hair cell (or)a seed is : -
(1) Osmosis (2) Imbibition
(3) Absorption (4) Suction

Q.67 Which of the following is imbibiant ?
(1) Proteins (2) Pectin
(3) Starch (4) All of the above

Q.68 Which of the following seeds develope a greater imbibition pressure ?
(1) Wheat seed (2) Gram seed
(3) Rice seed (4) Mustard oil seed

Q.69 Swelling in wooden block placed in water is due to
(1) Endosmosis (2) Capillarity
(3) Absorption (4) Imbibition

Q.70 The right sequence for imbibition is : -
(1) Agar agar > cellulose > protein
(2) Protein > cellulose > agar agar
(3) Agar agar > protein > cellulose
(4) Agar agar < protein < cellulose

Q.71 Which of the following statement is not correct ?
(1) Plants absorb excess quantity of water
(2) Plants take small quantity of mineral salts through soil water
(3) Water and inorganic salts may also simultaneously by root hair
(4) Plant absorb only one thing at a time water or inorganic salts

Q.72 Which of the following is a rapid type of absorption ?
(1) Passive absorption
(2) Active absorption
(3) Salt absorption (4) Root absorption

Q.73 The form of water absorbed by plant's root system, from the soil is : -
(1) Hygroscopic water
(2) Gravitational water
(3) Capillary water (4) All of these

Q.74 The pathway of water from soil upto the secondary xylem : -
(1) Soil $\rightarrow$ root hair $\rightarrow$ cortex $\rightarrow$ endodermis $\rightarrow$ pericycle $\rightarrow$ protoxylem $\rightarrow$ Meta xylem
(2) Metaxylem $\rightarrow$ protoxylem $\rightarrow$ pericyle $\rightarrow$ cortex $\rightarrow$ endodermis $\rightarrow$ soil $\rightarrow$ root hair
(3) Cortex $\rightarrow$ root hair endodermis $\rightarrow$ pericycle $\rightarrow$ protoxylem $\rightarrow$ metaxylem
(4) Pericycle $\rightarrow$ soil $\rightarrow$ root hair $\rightarrow$ cortex $\rightarrow$ endodermis $\rightarrow$ protoxylem $\rightarrow$ metaxylem

Q.75 Humus in soil is necessary for plant growth because it : -
(1) Increase aeration and water absorption capacity of soil
(2) Makes soil compact
(3) Makes soil sterile
(4) Decreases rate of percolation

Q.76 Water will be absorbed by root hairs when : -
(1) Concentration of salts in the soil is high
(2) Concentration of solutes in the cell sap is high
(3) The plant is rapidly respiring
(4) They are separated from the soil by a semipermeable membrane

Q.77 Water in plants is transported by ascent of sap takes place through : -

(1) Cambium (2) Phloem

(3) Xylem (4) Epidermis

Q.78 In poorly aerated soil, the rate of water absorption will : -

(1) Increase x

(2) Decrease

(3) Remains the same

(4) None of these

Q.79 Which of the following water comes under echards ?

(1) Available to the plant

(2) Whole of the soil water

(3) Amount of water not available to the plant

(4) None of the above

Q.80 Which plant hormone help in active absorption of water ?

(1) Auxin (2) GA

(3) Cytokinin (4) ABA

Q.81 What is true for the water available in the soil?

(1) Holard = Chresard + Echard

(2) Holard = Chresard – Echard

(3) Chresard = Holard + Echard

(4) Echard = Holard + Chresard

ASCENT OF SAP

Q.82 Water rises in the stem due to : -

(1) Cohesion and transpiration pull

(2) Turgor pressure

(3) Osmotic pressure

(4) None

Q.83 Sap ascends in woody stem because of : -

(1) Transpiration pull

(2) Capillarity

(3) Molecular adhesion

(4) Photosynthesis

Q.84 Pulsation theory to explain ascent of sap in Desmodium was proposed by : -

(1) Dixon and Jolly (2) Curtis

(3) J.C. Bose (4) None of these

Q.85 Dixon and Jolly are associated with : -

(1) Light reaction photosynthesis

(2) An aerobic respiration

(3) Cohesion and transpiration pull theory of ascent of sap

(4) Apical dominance

Q.86 The continuity of water column in xylem is maintained due to : -

(1) Presence of air bubbles

(2) Cohesive property of water

(3) Evaporation power of water

(4) None of the above

Q.87 Relay pump theory of ascent of sap was proposed by : -

(1) Boase (2) Godlewsky

(3) Westermaier (4) Von sachs

Q.88 The first vital theory to explain ascent of sap was proposed

(1) J.C. Bose (2) Godlewski

(3) Westermaier (4) Dixon and Jolly

Q.89 Capillary force theory to explain ascent of sap was proposed by :-

(1) Boehm (2) Sachs

(3) Jamin (4) Priestley

Q.90 Ringing experiment to explain ascent of sap path was firstly done by : -

(1) Hartig, Malpighi

(2) Dixon & Jolly

(3) Godlewski & J.C. Bose

(4) Stephen hales and Boehm

Q.91 Passage of ascent of sap is shown by :-

(1) Osmometer (2) Porometer

(3) Manometer

(4) Blockage experiment

Q.92 Transpiration - cohesion - tension theory operates in : -

(1) Active absorption

(2) Passive absorption

(3) Active & passive absorption

(4) None of the above

Q.93 Attractive forces of cell for water molecules is termed as : -

(1) Adhesion (2) Cohesion

(3) Osmosis (4) Plasmolysis

Q.94 The imbibition theory for the ascent of sap was suggested by : -

(1) Sir J.C. Bose (2) Strassburger

(3) Sachs (4) Dixon and Jolly

Q.95 If all the tissue of a plant to certain points are removed except the xylem which is left intact-

(1) The leaves will wilt

(2) The stem will die first

(3) The root will die first

(4) The whole plant will die at the same time

Q.96 Which of the following is incorrect match?

(1) Pulsation theory - J.C. Bose

(2) Relay pump theory - Godlewsky

(3) Imbibition theory - Von Sachs

(4) Capillary theory - Priestley

Q.97 Which tissue are removed when a plant is girdled ?

(1) Xylem & pith

(2) Xylem & Phloem

(3) Phloem to epidermis

(4) Phoem to pith

TRANSPIRATION

Q.98 Opening of stomata is due to : -

(1) Turgidity of guard cells

(2) Size of guard cells

(3) Number of gurad cells

(4) Amout of CO_2 in the atmosphere

Q.99 Transpiration in plants will be lowest when :-

(1) There is high humidity in the atmosphere

(2) High wind velocity

(3) There is excess of water in the soil

(4) Environmental conditions are very dry

Q.100 The metal ion involved in the stomatal regulation is

(1) Iron (2) Magnesium

(3) Zinc (4) Potassium

Q.101 The following percentage of water absorbed by herbaceous plants is lost in transpiration :-

(1) 80% (2) 60%

(3) 40% (4) 99%

Q.102 Transpiration from plants would be most rapid when

(1) There is lot of humidity in atmosphere

(2) The air is more humid

(3) There is excess rain fall

(4) Environmetal conditions are dry

Q.103 Processes occur in leaves, which may lower their temperature is : -

(1) Respiration (2) Photosytnhesis

(3) Hydrolysis (4) Transpiration

Q.104 When Oak leaf stomata opens, process is :-

(1) Water molecules enter adjacent guard cells

(2) Atmosphere outside stomata become less humid

(3) Auxins are accumulated in guard cells

(4) Salt molecules are excreted by adjacent gurad cells

Q.105 Wilting of a plant result from excessive : -

(1) Respiration (2) Photosynthesis

(3) Absorption (4) Transpiration

Q.106 The rate of transpiration is high when : -

(1) The atmosphere is saturated with water vapour

(2) Light is very dim

(3) The temperature is low

(4) The atmosphere is dry and the temperature is high

Q.107 Excessive loss of water causes wilting of leaves, it can be prevented by : -

(1) Keeping the plant in bright light

(2) Spraying the plant with alcohol

(3) Applying vaseline on the leaf surface

(4) Adding high amounts of fetilizers to the soil

Q.108 Leaves which appear wilted in the day time recover at night because : -

(1) Light is esstential for photo synthesis

(2) The stomata close down, temperature decrease, transpiration is reduced and the plant is able to absorb more water from the soil

(3) Respiration and translocation of organic substance both increases

(4) The plant is ***sleeping*** because of dark conditions

Q.109 Conversion of starch to organic acid is essential for

(1) Stomatal closure (2) Stomatal opening

(3) Stomatal initiation (4) Stomatal growth

Q.110 Increase in CO_2 concentration around leaf results in : -

(1) Rapid opening of stomata

(2) Partial closure of stomata

(3) Complete closure of stomata

(4) No effect on stomatal opening

Q.111 Which of the following wall of guard cells is thick ?

(1) Outer (2) Inner

(3) Sidewall (4) All the three

Q.112 Potometer and Clinostat are used to study :-

(1) Photosynthesis and respiration

(2) Transpiration and growth

(3) Phototropism and Geotropism

(4) Transpiration and Geotropism

Q.113 The rate of transpiration will be high when there is ?

(1) Rainy season (2) Winter season

(3) Summer season (4) None of these

Q.114 Which type of transpiration is more common -

(1) Cuticular (2) Stomatal

(3) Lenticular (4) Bark transpiration

Q.115 Maximum transpiration is taking place through the

(1) Stomata (2) Lenticel

(3) Hydathode (4) Cuticle

Q.116 The inter conversion of sugar & starch is dependent on pH changes in the guard cells; was demonstrated by : -

(1) Levitt (2) Lloyd

(3) Sayre (4) Steward

Q.117 The spray of PMA causes :-

(1) Decrease in transpiration

(2) Increase in transpiration

(3) Increase in absorption

(4) Increase in guttation

Q.118 When the stomata are opening; we observe following changes in the gurad cells ?

(1) OP increase, TP decreases

(2) OP & TP increases

(3) OP decreases, TP increases

(4) OP & TP decreases

Q.119 The pH in the guard cells was observed when stomata were open it ranges : -

(1) 9 - 10 (2) 4 - 5

(3) 7.5 (4) 2 - 4

Q.120 What will be the effects on stomata, if relative humidity is 100% in atmosphere ?

(1) Completely open (2) Partially open

(3) No effects (4) Closed

Q.121 Which of the following is produced during water stress condition ?

(1) Cytokinin (2) ABA

(3) Phytochrome (4) ATPase

Q.122 Which chemical is used to detect transpiration comparatively ?

(1) Calcium carbonate

(2) Cobalt carbonate

(3) Cobalt chloride

(4) Mercuric acetate

Q.123 Active K^+ ion exchange mechanism of opening and closing of stomata was given by :-

(1) Khorana (2) Scrath

(3) Levitt (4) Kohli

Q.124 Cuticular transpiration is observed mainly in :-

(1) Xeropytes (2) Herbaceous plants

(3) Trees (4) Shrubs

Q.125 What is action spectrum of transpiration ?

(1) Green and U.V (2) Blue and Yellow

(3) Blue and far red (4) Blue and red

Q.126 In which of the following plants, the metabolism will be hindered if upper surface of leaves are coated with wax ?

(1) Hydrilla (2) Nelumbium

(3) Vallisneria (4) Utricularia

Q.127 Which of the following substance serve as an anti-transpirant in plant ?

(1) Phenyl mercuric acetate

(2) Asprin

(3) Silicon oil (4) All of these

Q.128 Which of the factor acts as anti-transpirant?

(1) SO_2 (2) CO

(3) CO_2 (4) All pollutant gasses

Q.129 Transpiration is a non-enzymatic process its Q_{10} value is : -

(1) 1 (2) 2

(3) 3.5 (4) Zero

Q.130 The most important factor affecting transpiration is

(1) Light (2) Temperature

(3) Wind

(4) Atmospheric humidity

Q.131 Presence of thick cuticle, hairs, scales & fewer sunken stomata are found in the leaves of xerophyte it is to : -

(1) Stop transpiration

(2) Facilitate transpiration

(3) Store water

(4) Check excessive transpiration

Q.132 Which factor regulates the loss of water through transpiration : -

(1) Nitrogen

(2) Humidity

(3) Level of O_2 in air

(4) Xylem

Q.133 With increase in temperature the rate of transpiration becomes : -

(1) Low

(2) High

(3) Low in herbs and high in tress

(4) Immediately stopped

Q.134 Which of the following plant do not transpire ?

(1) Alage

(2) Fungi

(3) Submerged hydrophytes

(4) All the above

Q.135 Wilting of plant results from an excessive :-

(1) Absorption

(2) Photosynthesis & poor osmosis

(3) Respiration

(4) Transpiration

Q.136 Transpiration is completely absent in : -

(1) Xerophytes

(2) Mesophytes

(3) Submerged hydrophtes

(4) Succulents at night

Q.137 Who states "Transpiration to be an unavoidable evil' ?

(1) Blackman (2) Steward

(3) Priestley (4) Curtis

Q.138 Which pigment regulates opening and closing of stomata ?

(1) Chlorophylls (2) Carotenoids

(3) Phytochrome (4) Flavines

Q.139 Which photoreceptor controls the opening & closing of stomata ?

(1) Chlorophyll-a (2) Chlorophyll-b

(3) Phytochrome (4) Carotene

Q.140 For plants transpiration is : -

(1) Not very important

(2) Important to same

(3) A neccessary evil

(4) An important burden

Q.141 Significance of transpiration lies in : -

(1) Circulation of water

(2) Absorption and distribution of water

(3) Regulating the temperature of the plant body

(4) All of the above

Q.142 In apple type of stomata : -

(1) Stomata are present only on the upper surface of leaf

(2) Stomata are present only on the lower surface of leaf

(3) Stomata are present on both surfaces of leaf

(4) Stomata are vestigeal

Q.143 Which of the following plant product act as an internal anti-transpirant ?

(1) Phenyl mercuric acetate

(2) CO_2 and malic acid

(3) Abscisic acid

(4) Ferulic acid

Q.144 In the mechanism of the opening to stomata, the important factor is : -

(1) Turgidity of the guard cells

(2) Chlorophyll content of the guard cells

(3) Hormone content of the subsidary cells

(4) Protein content of the epidermal cells

Q.145 Stomata open at day because in day the guard cells have :-

(1) To help gas exchange

(2) A low pH

(3) A high level of sugar, organic acid ATP & K^+ ion

(4) Unequally thickened walls

Q.146 Basis of stomatal opening is : -

(1) Exosmosis

(2) Endosmosis

(3) Decrease in cell sap concentration

(4) Plasmolysis of guard cells

Q.147 Guard cells are found in : -

(1) Stomata

(2) Hydathodes

(3) Both

(4) None of the above

Q.148 Shape of guard cells in gramineae family :-

(1) Kidney shaped (2) Oval

(3) Round (4) Dumbel shaped

Q.149 Scotoactive stomata are occurs in : -

(1) Sacculent xerophytes

(2) Hydrophytes

(3) Mesophytes

(4) None of the above

Q.150 With decrease in atmospheric pressure the rate of transpiration will : -

(1) Remain unaffected

(2) Increased

(3) Decrease slowly

(4) Decrease rapidly

GUTTATION, BLEEDING, ROOT PRESSURE, WILTING

Q.151 Root presence is maximum, when : -

(1) Transpiration is high and absorption is very low

(2) Transpiration is very low and absorption is high

(3) Absorpton is very high and transpiration is also very high

(4) Absorption is low and transpiration is alwo very low

Q.152 Wilting in plant occurs when : -

(1) Xylem is blocked

(2) Epidermis is pealed off

(3) Pith is removed

(4) Phloem is blocked

Q.153 Pressure exerted on the fluid contents of the cortical cells of root by turgidity. Which forces the water in to xylem vessels and upward in the stem for a certain height is : -

(1) Imbibition (2) Root pressure

(3) Capillarity (4) Turgor pressure

Q.154 The process of the escape of liquid from the tip of uninjured leaf is called : -

(1) Evaporation (2) Transpiration

(3) Guttation (4) Evapo-transpiration

Q.155 Guttation take place during night when : -

(1) Root pressure is positive

(2) Root pressure is negative

(3) Always take place

(4) It does not takes place at all

Q.156 The hydathodes are related with : -

(1) Transpiration (2) Guttation

(3) Bleeding (4) All

Q.157 Who discovered the root pressure :-

(1) Stephen hales (2) Priestley

(3) Dixon (4) Renner

Q.158 Root pressure can be measured by the instrument

(1) Potometer (2) Auxenometer

(3) Manometer (4) Barometer

Q.159 In summer afternoon, rate of transpiration is greater than the rate of absorption then what happens to plants : -

(1) Temporary wilting

(2) No effect

(3) Leaves becomes yellow

(4) Plant will die

Q.160 Which conditions favours "Guttation" ?

(1) High water absorption

(2) High transpiration

(3) Low transpiration

(4) (1) and (3) both

Q.161 When stem of a herbaceous plant is cut, water or sap oozes out, this is due to ?

(1) Guttation (2) Transpiration pull

(3) Root pressure (4) Imbibition

ANSWER KEY

EXERCISE - 1

Q.1	1	Q.2	2	Q.3	1	Q.4	1	Q.5	3	Q.6	2	Q.7	1
Q.8	4	Q.9	4	Q.10	2	Q.11	3	Q.12	1	Q.13	2	Q.14	1
Q.15	4	Q.16	4	Q.17	3	Q.18	2	Q.19	1	Q.20	1	Q.21	2
Q.22	1	Q.23	1	Q.24	2	Q.25	2	Q.26	3	Q.27	2	Q.28	4
Q.29	2	Q.30	3	Q.31	1	Q.32	4	Q.33	2	Q.34	3	Q.35	4
Q.36	3	Q.37	1	Q.38	2	Q.39	3	Q.40	1	Q.41	1	Q.42	3
Q.43	4	Q.44	4	Q.45	4	Q.46	3	Q.47	3	Q.48	3	Q.49	4
Q.50	4	Q.51	2	Q.52	1	Q.53	2	Q.54	2	Q.55	1	Q.56	1
Q.57	3	Q.58	3	Q.59	3	Q.60	1	Q.61	2	Q.62	2	Q.63	1
Q.64	1	Q.65	1	Q.66	2	Q.67	4	Q.68	2	Q.69	4	Q.70	3
Q.71	4	Q.72	1	Q.73	3	Q.74	1	Q.75	1	Q.76	2	Q.77	3
Q.78	2	Q.79	3	Q.80	1	Q.81	1	Q.82	1	Q.83	1	Q.84	3
Q.85	3	Q.86	2	Q.87	2	Q.88	3	Q.89	1	Q.90	1	Q.91	4
Q.92	2	Q.93	1	Q.94	3	Q.95	3	Q.96	4	Q.97	3	Q.98	1
Q.99	1	Q.100	4	Q.101	4	Q.102	4	Q.103	4	Q.104	1	Q.105	4
Q.106	4	Q.107	3	Q.108	2	Q.109	2	Q.110	2	Q.111	2	Q.112	4
Q.113	3	Q.114	2	Q.115	1	Q.116	3	Q.117	1	Q.118	3	Q.119	3
Q.120	1	Q.121	2	Q.122	3	Q.123	3	Q.124	2	Q.125	4	Q.126	2
Q.127	4	Q.128	3	Q.129	2	Q.130	4	Q.131	4	Q.132	2	Q.133	2
Q.134	4	Q.135	4	Q.136	3	Q.137	2	Q.138	3	Q.139	3	Q.140	3
Q.141	4	Q.142	2	Q.143	3	Q.144	1	Q.145	3	Q.146	2	Q.147	1
Q.148	4	Q.149	1	Q.150	2	Q.151	2	Q.152	1	Q.153	2	Q.154	3
Q.155	1	Q.156	2	Q.157	1	Q.158	3	Q.159	1	Q.160	4	Q.161	3

EXERCISE - 2

DIFFUSION, OSMOSIS & RELATED TERMS

Q.1 When a plant cell is placed in a hypotonic solution, which of the following will not apply?
(1) Wall pressure is decreased
(2) The cell become turgid
(3) Suction pressure of the cell sap will decrease
(4) Water potential of the cell sap will increase

Q.2 When beet root slices are washed and then placed in cold water, anthocyanin does not come out, because plasma membrane is ?
(1) Differentially permeable to anthocyanin
(2) Dead structure
(3) Impermeable to anthocyanin
(4) Permeable to anthocyanin

Q.3 Osmotic pressure is highest in : -
(1) Xerophytes (2) Lithophytes
(3) Halophytes (4) Mesophytes

Q.4 If osmotic potential of a cell is – 10 bars and its pressure potential is 5 bars, its water potential would be :-
(1) – 5 bars (2) 5 bars
(3) – 10 bars (4) 10 bars

Q.5 Osmosis means : -
(1) Movement of molecules from higher concentration to lower concentration
(2) Uptake of water by roots
(3) Passage of solvent from a weaker solution to stronger solution across a semipermeable membrane
(4) Passage of solvent from a weaker to a stronger solution separated by a membrane

Q.6 The osmotic pressure of distilled water will be-
(1) Zero
(2) Maximum
(3) Higher than any solution
(4) Variable

Q.7 Tonoplast is : -
(1) Permeable membrane
(2) Semi permeable membrane
(3) Impermeable membrane
(4) Selectively permeable membrane

Q.8 If in a cell suction pressure value is 30 atm. While osmotic pressure 42 atm. then calculate the turgidity developed in form of TP in the cell-
(1) 12 atm. (2) 72 atm.
(3) – 12 atm. (4) 1.4 atm.

Q.9 If the molar concentration of the given sugar solution is 0.3 M, find out the osmotic pressure of this solution : -
(1) 6.72 atm (2) 67.2 atm
(3) 2.24 atm (4) 5.60 atm

Q.10 Osmosis is the phenomenon expressed by :-
(1) Solutes present in the solution
(2) Solution
(3) Semi-permeable membrane
(4) O_2

Q.11 The osmotic pressure of the cell is measured by : -
(1) Plasmolysis method
(2) Osmometer
(3) Molar concentration of the cell sap
(4) Deplasmolysis

Q.12 When grapes are placed in water, then which process occurs ?
(1) Plasmolysis (2) Exomosis
(3) Endosomosis (4) None of the above

Q.13 Maximum osmotic pressure is found in : -
(1) Root hair
(2) Cortex cell of the root
(3) Passage cell of the root
(4) Mesophyll cell

Q.14 The osmotic pressure is due to : -
(1) Solute
(2) Semi permeable membrane
(3) Hypertonic solution
(4) Water

DPD (SP)

Q.15 The direction of the movement of water : -
(1) From low OP to high OP
(2) From low DPD to high DPD
(3) From high DP to low DP
(4) All of the above

Q.16 The term "DPD" was coined by : -

(1) Renner (2) Kamer

(3) B.S. mayer (4) Stephen hales

Q.17 The entry of water from the soil up to xylem elements of root is due to : -

(1) Gradient of suction pressure

(2) Turgor pressure

(3) Degree of imbibition

(4) Concentration of ions in water

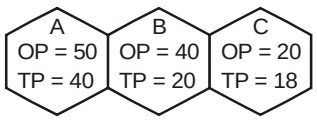
Q.18 The three cells A, B & C are joined in a linear manner. Demostrate the movement of water & direction in these ?

(1) A → B → C

(2) A ← B ← C

(3) A → B ← C

(4) A ← B → C



Q.19 When the solute has been added in the solution, then following observation can be made ?

(1) The DPD of the solution decreases

(2) The Ψ_w of the solution increases

(3) DPD of the solution decreases while its Ψ_w increases

(4) DPD of the solution increases while its Ψ_w decreases

Q.20 If the given solution is of 25% concentration; then what cannot be presented for this :-

(1) OP (2) DPD

(3) Solute potential (4) TP

Q.21 In a flaccid cell which condition does not occur-

(1) TP = 0 (2) SP = 0

(3) WP = 0 (4) SP = OP

Q.22 Osmotic pressure of a cell is zero when :-

(1) T.P. is maximum

(2) DPD is maximum

(3) T.P. is zero

(4) Not possible

Q.23 The accurate relationship between SP, OP, TP can be expressed as -

(1) SP = OP + TP (2) OP = SP – TP

(3) TP = SP – OP (4) SP = OP – TP

Q.24 In which condition the Turgor pressure of the cell becomes equal to the osmotic pressure : -

(1) In flaccid cell

(2) In plasmolysed cell

(3) In fully turgid cell

(4) It never happens

Q.25 Select the correct statement -

(1) Pure water has minimum Ψ_w

(2) Pure water has maximum Ψ_w

(3) Pure water has maximum D.P.D

(4) Pure water has variable Ψ_w & D.P.D.

Q.26 The best condition by which fully turgid cell can be identified is : -

(1) TP is minimum (2) SP is maximum

(3) OP less than SP (4) TP = OP

WATER POTENTIAL

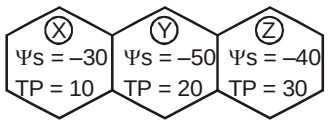
Q.27 The direction of the water flow in given cells X,Y & Z can be presented as : -

(1) X → Y ← Z

(2) X → Y → Z

(3) X ← Y ← Z

(4) X ← Y → Z



Q.28 The water potential & osmotic potential of pure water is : -

(1) 100 & zero (2) Zero & zero

(3) 100 & 200 (4) Zero & 100

Q.29 The relationship between DPD & Ψw can be expressed as : -

(1) DPD = Ψ_w (2) Ψ_w – DPD = 0

(3) $\frac{DPD}{\psi_w} = 0$ (4) Ψ_w = – DPD

Q.30 Solute potential can be presented as : -

(1) Ψs = – OP (2) Ψw = OP

(3) OP – Ψs = 0 (4) $\frac{\psi s}{OP} = 0$

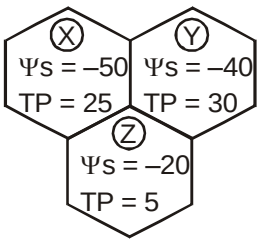
Q.31 In plant water relations, Ψ indicates -

(1) DPD (2) Solute potential

(3) Water potential (4) Suction pressure

Q.32 If the solute is added in the given solution than what osbervation can be made -
(1) Its DPD decreases
(2) It's water potential decreases
(3) DPD & water potential remains unchanged
(4) Its water pontential increases

Q.33 If three cells X, Y and Z are joined to each other & their solute potential & Turgor pressure values are given in the figure; then demonstrate the direction of flow of water in this system : -



(1)

(2)

(3)

(4)

Q.34 In 0.1M solution of a non-electolyte, Ψw value will be : -
(1) zero bar (2) +2.3 bar
(3) – 2.3 bar (4) –22.4 bar

Q.35 If a cell is placed in a hypertonic solution then Ψ_w of the cell will be : -
(1) Increased (2) Decreased
(3) Unchanged
(4) First increases then decreases

Q.36 The Ψ_w of pure water is : -
(1) Minimum (2) Less than DPD
(3) Maximum (4) Variable

Q.37 If the OP of any osmotic system is 35 atm and its turgor pressure 9 units. Find out water pontential present in the osmotic system : -
(1) – 44 unit (2) – 26 unit
(3) 26 unit (4) – 3.88 unit

IMBIBITION

Q.38 Passive absorption of water takes place by : -
(1) Osmosis
(2) The presence of energy
(3) Root pressure
(4) Transpiration pull

Q.39 Root hairs occurs in : -
(1) Meristematic zone
(2) Cell elongation zone
(3) Cell maturation zone
(4) Old root

Q.40 All the following involves osmosis except :-
(1) Movement of water from soil to root
(2) Movement of water from root hair to endodermis and pericycle
(3) Movement of water between xylem elements
(4) Movement of water from xylem to mesophyll cells of the leaves

Q.41 Suitable temperature for active absorption of water by root is : -
(1) 40-45ºC
(2) 10-15ºC
(3) 20-35ºC
(4) Can take at any temperature

Q.42 "Osmotic theory" for an active absorption of water was given by : -
(1) Thiman (2) O. Hertwig
(3) Atkin & Priestley (4) J.C. Bose

Q.43 Root cap plays no role in the absorption of water in a plant because : -
(1) Its cells are loosly arranged
(2) It has no root hairs
(3) It has no connection with xylem tissue
(4) it's cells are dead

Q.44 Energy dependent absorption of water against osmotic phenomenon is : -
(1) Active absorption
(2) Passive absorption
(3) Imbibition
(4) Bulk absorption

Q.45 In a young root the most active absorption of water takes place through : -
(1) Root cap region
(2) Root hair region
(3) Zone of elongation
(4) Mature region with a corkly layer

Q.46 Water is actively absorbed by root when : -

(1) Soil solution is hypotonic

(2) Soil solution is hypertonic

(3) Transpiration rates are high

(4) Shoot pressure is high

Q.47 Maximum absorption of water by a root occur in the region of : -

(1) Cell division

(2) Cell elongation

(3) Cell maturation

(4) Cell division and root cap togther

Q.48 Absorption of water is increased when : -

(1) Transpiration is increased

(2) Photosynthesis is increased

(3) Respiration is increased

(4) Root pressure is increased

Q.49 Passive absorption of water from the soil by the root is mainly effected by : -

(1) Typical tissue organisation

(2) Respiratory activity of root

(3) Tension on cell sap due to transpiration

(4) None of the above

Q.50 Active absorption of water from the soil by the root is mainly effected by : -

(1) Typical tissue organisation

(2) Resipiratory activity of root

(3) Tension on cell sap due to transpiration

(4) None of the above

Q.51 The water held tightly by the soil particles around them is known as : -

(1) Field capacity

(2) Run away water

(3) Hygroscopic water

(4) Capillary water

Q.52 Percentage of water left in the soil when a plant begins to wilt is known as : -

(1) Wilting coefficient

(2) pH value of soil

(3) Field capacity

(4) Water holding capacity

Q.53 Which of the following factors inhibit the absorption of water by roots ?

(1) Low soil temperature

(2) High concentration of soil solution

(3) Low soil aeration

(4) All of the above

Q.54 Which of the plants can absorb water in the form of vapour from its atmosphere ?

(1) All xerophytes

(2) Low transpiring cacti

(3) Succulents plants

(4) Epiphytes & Lichen

Q.55 "Non-osmotic" theory for an active absorption of water was given by : -

(1) Thimann & Bennet clark

(2) Atkin & Priestley

(3) J.C. Bose (4) O. Hertig

Q.56 When the temerature of soil becomes 1ºC then?

(1) Absorption of water increases

(2) Absorption of water decreases

(3) Absorption of water remains unaffected

(4) Both (2) and (3) are correct

Q.57 When the concentration of the soil solutes is low, the absorption of water is ?

(1) Retarted (2) Increase

(3) Remains normal (4) Stopped

Q.58 Which type of plant are physiologically dry ?

(1) Hydrophytes (2) Epiphytes

(3) Lithophytes (4) Halophytes

Q.59 Which method is responsible for most of the absorption in higher plants?

(1) Active absorption

(2) Passive absorption

(3) Osmotic absorption

(4) Non osmotic absorption

Q.60 The absorption of water due to expenditure of energy is called : -

(1) Non osmotic active absorption

(2) Osmotic active absorption

(3) Passive absorption

(4) All

Q.61 Halophytes can grow on physiologically dry soil due to -

(1) Dry soil

(2) Excessive humidity outside

(3) Excessive salts in plants

(4) Excessive salts in water

ASCENT OF SAP

Q.62 Removal of a ring of bark from the trunk of a tree eventually kills it because : -

(1) Water can not go up

(2) Fungi & insects attack exposed parts

(3) Food does not travel down & root becomes starved

(4) Air blocks the xylem

Q.63 Which would do maximum harm to a tree ?

(1) The loss of half of its leaves

(2) The loss of all its leaves

(3) The loss of half of its branches

(4) The loss of its bark

Q.64 Ringing experiment can not be done on a sugar cane plant because : -

(1) Its xylem is scanty

(2) Its phloem is with out phloem parenchyma

(3) Its vascular bundles are sacttered

(4) Its phloem is present inside the xylem

Q.65 In plants the translocation of organic solutes take place through : -

(1) Epidermis (2) Xylem

(3) Phloem (4) Pith

Q.66 Most accepted theory for Ascent of sap given by : -

(1) Godlewski & Sacks

(2) J.C. Bose

(3) Stephan Hales (4) Dixon and Jolly

Q.67 Ringing experiment is to show : -

(1) Path of ascent of sap

(2) Comparision of transpiration

(3) Passive absorption

(4) Stomatal opening & closing

Q.68 The conduction of water from root hair to root xylem is :-

(1) Symplastic (2) Apoplastic

(3) Osmotically

(4) Symplastic + Apoplastic

Q.69 Dixons blockage experiment is concerned with

(1) Transpiration (2) Passive absorption

(3) Path of ascent of sap

(4) Vital theory for ascent of sap

Q.70 The pulsation theory is related with : -

(1) Guttation (2) Bleeding

(3) Vital theory for ascent of sap

(4) Physical theory for ascent of sap

Q.71 Root pressure theory was proposed by : -

(1) Priestley (2) Stephen Hales

(3) Levitt (4) Sachs

Q.72 By which process absorbed water reaches upto the leaves ?

(1) Transpiration (2) Guttation

(3) Root pressure (4) Ascent of sap

Q.73 Ringing experiment was performed in : -

(1) Balsom plant (2) Mirabilis plant

(3) Indian telegraph plant

(4) Avena plant

TRANSPIRATION

Q.74 Which of the following statement is not true ?

(1) Transpiration is increased when root shoot ratio is increased

(2) Transpiration is increased when latex & mucilage is increased in tissue

(3) Transpiration is decreased when stomata are sunken

(4) Transpiration is decreased when leaves becomes leathery of hairy

Q.75 Which one of the following will reduce the rate of transpiration ?

(1) Increase in wind velocity

(2) Rise in temperature

(3) Increase in water uptake by plants

(4) Decrease in light intensity

Q.76 The most important fuction of transpiration in plants is to cause : -
(1) Loss of surplus water
(2) Cooling of the plant
(3) Rapid ascent of sap
(4) Rapid rise of minerals

Q.77 Which of the following plants economises transpiration loss of water ?
(1) C_3-plants (2) C_4-plants
(3) Both equally (4) C_2-plants

Q.78 The change in turgor pressure which causes the opening and closing of Stomata is caused by-
(1) Reversible starch-sugar conversions
(2) Reversible absorption and loss of K-ions
(3) Loss of chloride ions
(4) None of these

Q.79 The "proton transport concept" for the opening of photoactive stomata was given by :-
(1) Yin tung (2) Levitt
(3) Sachs (4) Sayre

Q.80 According to Scarth the opening & closing of stomata is governed by :-
(1) pH (2) Phosphorylation
(3) $NaDPH_2$ (4) Enzymes

Q.81 Before opening of stomata accumulation of the following ion is seen in : -
(1) PO_4 (2) K^+
(3) Mg^{++} (4) Na^+

Q.82 In sacculent plants the stomata opens at night and closes by day. Which of following would be best hypothesis to explain the mechanism of stomata opening at night only?
(1) CO_2 used up, increased pH results in accumulation of sugars
(2) CO_2 accumulates, reduces pH stimulates enzymes resulting in accumulation of carbohydrate
(3) Increase in CO_2 concentration, conversion of organic acids in to starch resulting in the increased uptake of potassium ions and water
(4) High CO_2 concentration causes accuumulation of organic acids in guard cells resulting in to the increased concentration of cell sap

Q.83 Guard cells differ from other epidermal cells in having :-
(1) Large vacuoles
(2) Secondary walls
(3) Chloroplast with PEP-carboxylase enzyme
(4) Absence of mitochondria

Q.84 The trunk of a tree shrinks in day due to : -
(1) Rapid translocation of food
(2) Transpiration induced tension
(3) Rapid growth in day hours
(4) Light induced elongation of plant

Q.85 Transpiration occures from : -
(1) Leaves (2) Stems
(3) All parts (4) All aerial parts

Q.86 Leaves of submerged hydrophytes are : -
(1) Epistomatic (2) Hypostomatic
(3) Astomatic (4) Above 1 & 2

Q.87 The diffusion of water vapours through areial parts of the plants is called : -
(1) Osmosis (2) DPD
(3) Transpiration (4) All

Q.88 If the absorption is more, but transpiration is less; then process affected will be : -
(1) Root pressure (2) Guttation
(3) Bleeding (4) All

Q.89 Active $K^+ \rightleftharpoons H^+$ exchange theory explained -
(1) Ascent of sap (2) Phloem conduction
(3) Ion absorption
(4) Stomatal movement

Q.90 Transpiration is a necessary evil, given by -
(1) Levitt (2) Curtis
(3) Steward (4) Sachs

Q.91 Potassium ions concentration is more in guard cells when stomata are open but less when stomata are closed. This was reported by :-
(1) Hsio, Fisher (2) Fujino
(3) Levitt (4) Lloyd

Q.92 The loss of water in the form of water drops is taking place through the : -
(1) Hydathodes (2) Lentical
(3) Stomata (4) All

Q.93 The potometer is based on the principle that : -

(1) Transpiration is based on stomatal opening

(2) Stomata open during day time

(3) Absorption = Transpiration

(4) Transpiration tension present in leaves

Q.94 Guttation is dependent on : -

(1) Root pressure

(2) Active absorption

(3) Flaccidity of root cortical cells

(4) High rate of transpiration

Q.95 Due to increasing temperature, transpiration:-

(1) Increases

(2) Decreases

(3) First increases then decreases

(4) Unaffected

Q.96 If temperature remains constant then with increasing alttitude, the transpiration will : -

(1) Increases

(2) Decreases

(3) First decreases then increases

(4) Unaffected

Q.97 The conversion of starch to organic acid is essential for stomatal : -

(1) Closure (2) Growth

(3) Initiation (4) Opening

Q.98 Transpiration increases when atmospheric temperature rises, due to : -

(1) Wider opening of stomata

(2) Stomatal opening becomes narrow

(3) Water holding capacity of the air increases

(4) More photosynthesis in guard cells

Q.99 The names of Yin & Tung are assoicated with findings of : -

(1) Phosphorylase enzyme

(2) Sugar-starch conversion

(3) Localization of phosphorylase enzyme in guard cells

(4) Exchange of K^+ & H^+

Q.100 Due to more wind velocity, the transpiration rate will be : -

(1) Less

(2) More

(3) Unaffected

(4) First increases then decreases

Q.101 Foliar transpiration : -

(1) Includes stomatal and cuticular transpiration

(2) Does not occur

(3) Includes all type of transpiration

(4) Shows stomatal transpiration

Q.102 Radial micellation of cellulose occurs at :-

(1) Outer wall of guard cells

(2) Inner wall of guard cells

(3) Inner wall subsidiary cells

(4) None of the above

GUTTATION, BLEEDING, ROOT PRESSURE, WILTING

Q.103 Maximum bleeding occurs in : -

(1) Agave (2) Vitis

(3) Betula (4) Caryota urens

Q.104 Guttation usually occurs in a well watered herbaceous plant and well drained soil only in-

(1) Morining hours (2) Evening hours

(3) Noon hours (4) Day hours

Q.105 Hydathodes open during -

(1) Hight hours (2) Day hours

(3) Noon hours (4) Always open

Q.106 The "Guttation" word was given by : -

(1) Bergerstein (2) Sayre

(3) Scarth (4) Stephen hales

Q.107 Which of the following is not a rhythmic phenomenon ?

(1) Stomatal opening & closing

(2) Guttation

(3) Nyctinasty

(4) Photonastic movments

Q.108 Water of guttation is : -

(1) Pure water

(2) Water with dissolved salts

(3) Solution of organic food

(4) Condensed water vapour

Q.109 Cells present on hydathodes is -

(1) Complementary cells

(2) Epithem cells

(3) Guard cells

(4) Kranz cells

Q.110 The process involved in the formation of Toddy is : -

(1) Guttation (2) Transpiration

(3) Bleeding (4) All

Q.111 The whitish powder around hydathode is due to : -

(1) Guttation

(2) Salt depositon from air

(3) Salt formation over surface

(4) Bleeding

ANSWER KEY

EXERCISE - 2

Q.1	1	Q.2	3	Q.3	3	Q.4	1	Q.5	3	Q.6	1	Q.7	4
Q.8	1	Q.9	1	Q.10	3	Q.11	1	Q.12	3	Q.13	4	Q.14	1
Q.15	4	Q.16	3	Q.17	1	Q.18	3	Q.19	4	Q.20	4	Q.21	2
Q.22	4	Q.23	4	Q.24	3	Q.25	2	Q.26	4	Q.27	1	Q.28	2
Q.29	4	Q.30	1	Q.31	3	Q.32	2	Q.33	3	Q.34	3	Q.35	2
Q.36	3	Q.37	2	Q.38	4	Q.39	3	Q.40	3	Q.41	3	Q.42	3
Q.43	2	Q.44	1	Q.45	2	Q.46	2	Q.47	3	Q.48	1	Q.49	3
Q.50	2	Q.51	3	Q.52	1	Q.53	4	Q.54	4	Q.55	1	Q.56	2
Q.57	2	Q.58	4	Q.59	2	Q.60	1	Q.61	3	Q.62	3	Q.63	4
Q.64	3	Q.65	3	Q.66	4	Q.67	1	Q.68	4	Q.69	3	Q.70	3
Q.71	1	Q.72	4	Q.73	3	Q.74	2	Q.75	4	Q.76	2	Q.77	2
Q.78	2	Q.79	2	Q.80	1	Q.81	2	Q.82	4	Q.83	3	Q.84	2
Q.85	4	Q.86	3	Q.87	3	Q.88	4	Q.89	4	Q.90	2	Q.91	2
Q.92	1	Q.93	3	Q.94	1	Q.95	3	Q.96	1	Q.97	4	Q.98	3
Q.99	3	Q.100	4	Q.101	1	Q.102	2	Q.103	4	Q.104	1	Q.105	4
Q.106	1	Q.107	2	Q.108	2	Q.109	2	Q.110	3	Q.111	1		

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 When stomata open, the pH of guard cells : -
[Uttaranchal PMT 2004]
(1) Increases (2) Decreases
(3) Remains same (4) Both 'A' and 'B'

Q.2 Water lost in guttation is : -
[Uttaranchal PMT 2004]
(1) Pure water (2) Impure water
(3) In vapour form (4) Either 'A' and 'B'

Q.3 What will happen if plant cells are placed in hypertonic solution :
[Uttaranchal PMT 2004]
(1) Turgid (2) Plasmolysed
(3) Deplasmolysed (4) Lysed

Q.4 Loss of water from tips of leaves is called :
[Uttaranchal PMT 2005]
(1) Bleeding (2) Guttation
(3) Respiration (4) Transpiration

Q.5 Root pressure is measured by :
[Uttaranchal PMT 2005]
(1) Manometer (2) Potometer
(3) Auxanometer (4) Osmometer

Q.6 Which of the following apparatus is commonly used to measure the rate of transpiration is :
[Uttaranchal PMT 2006]
(1) Porometer (2) Altimeter
(3) Potometer (4) Luxmeter

Q.7 Leaves of Nelumbo plant are :
[West Bengal JEE 2007]
(1) Epistomatic (2) Hypostomatic
(3) Amphistomatic (4) None of these

Q.8 0.1 M solution has water potential of :
[C.G. PMT 2004]
(1) –2.3 bars (2) 0 bar
(3) 22.4 bars (4) +2.3 bars

Q.9 A small mesophytic twig with green leaves is dipped into water in a big beaker under sunlight. It demonstrates : **[C.G. PMT 2004]**
(1) Photosyntesis (2) Respiration
(3) Transpiration (4) None of the above

Q.10 Which one is not related to transpiration :
[C.G. PMT 2004]
(1) Regulation of plant body temperature
(2) Absorption and distribution of mineral salt
(3) Circulation of water
(4) Bleeding

Q.11 Sotmata can open at night also in
[C.G. PMT 2005]
(1) Xerophyte (2) Gametophyte
(3) Hydrophyte (4) None of these

Q.12 Who had said that "transpiration is necessary evil" : **[C.G. PMT 2005]**
(1) Curtis (2) Steward
(3) Andersen (4) J.C. Bose

Q.13 Stomata opens during day because the guard cells have : **[C.G. PMT 2006]**
(1) Outer walls thin (2) Kidney shape
(3) Chlorophyll (4) Large nuclei

Q.14 Stomata open and close due to :
[Jharkhand 2006]
(1) Turgor pressure change
(2) Hormone change
(3) Temperature change
(4) All of the above

Q.15 In plasmolysed cell, the space between cell wall and Protoplasm is occupied by :
[Jharkhand 2006]
(1) Hypotonic solution
(2) Hypertonic solution
(3) Isotonic solution
(4) Distil water

Q.16 In CAM plants stomata are :
[Jharkhand 2005]
(1) Closed at night and open during the day
(2) Closed at the day and open at night
(3) Never closes (4) Never opens

Q.17 The real force resposible for the movement of water from cell to cell is : **[Jharkhand 2005]**
(1) OP (2) TP
(3) DPD (4) WP

Q.18 Which of the following have sunken stomata : **[Jharkhand 2003]**

(1) Nerium (2) Mangifera

(3) Hydrilla (4) Zera mays

Q.19 When a plasmolysed cell is placed in a hypotonic solution then water will move inside the cell. Which force causes this : **[Jharkhand 2003]**

(1) DPD (2) OP

(3) WP (4) None of these

Q.20 Rate of transpiration is measured by : **[Jharkhand 2003]**

(1) Manometer (2) Auxanometer

(3) Potometer (4) Barometer

Q.21 If a cell shrinks when placed in a solution, this solution is : **[Jharkhand 2003]**

(1) Hypotonic (2) Hypertonic

(3) Isotonic (4) Pure solvent

Q.22 If a cell A with DPD 4 bars is connected to cell B, C, D whose osomotic pressure and turgor pressure are respectively 4 and 4, 10 and 5, 7 and 3 bar, the flow of water will be : **[Jharkhand 2002]**

(1) B to A, C and D (2) A to D, B and C

(3) C to A, B and D (4) A to B, C and D

Q.23 Guard cell controls : **[Bihar 2004]**

(1) Intensity of light entering

(2) Photosynthesis

(3) Closing and opening of stomata

(4) Change in green colour

Q.24 Active transport : **[Bihar 2003]**

(1) Releases energy (2) Requires energy

(3) Produces ATP

(4) Produces a toxic substance

Q.25 Valamen tissues are associated with **[Bihar 2002]**

(1) Hautorial function (2) Assimilation

(3) Aborption of moisture

(4) Nutrition

Q.26 Cohesion-tension theory regarding ascent of sap was given by : **[Bihar 2001]**

(1) Dixon and Jolly (2) J.C. Bose

(3) Cristian Wolf (4) Godlewski

Q.27 Velamen tissue is found in : **[Bihar 2004]**

(1) Mesophytes (2) Epiphytes

(3) Hydrophytes (4) Xerophytes

Q.28 In a fully turgid plant cell which one is zero : **[Bihar 2001]**

(1) Trugor pressure (2) Wall pressure

(3) Suction pressure (4) None of these

Q.29 Who proposed the 'Chohesion Theory of ascent of sap: **[Bihar 2006]**

(1) Strasburger (2) Godlewski

(3) Western (4) Dixon and Jolly

Q.30 The most accepted theroy for ascent of sap is: **[UP CPMT 2001]**

(1) Relay pump theory

(2) Pulsation theory

(3) Root pressure theory

(4) Transpiration pull cohesion theory

Q.31 Transport of water and salt is mediated by : **[MP PMT 2006]**

(1) Xylem (2) Sieve tubes

(3) Sclerenchyma (4) Phloem

Q.32 Removal of ring of tissue outside the vascular cambium from the tree trunk kills it because : **[UP CPMT 2002]**

(1) Water cannot move up

(2) Food does not travel down and root become starved

(3) Shoot become starved

(4) Annual ring are not produced

Q.33 Wilting of plant is present in : **[UP CPMT 2002]**

(1) Moss (2) Fern

(3) Algae (4) Angiosperm

Q.34 Root hair absorb water from the soil on account of :

(1) Turgor pressure (2) Osmotic pressure

(3) Suction pressure (4) Root pressure

Q.35 Increased humidy in atmosphere decreases rate of : **[UP CPMT 2003]**

(1) Transpiration (2) Photosynthesis

(3) Glycolysis (4) Growth

Q.36 In osmosis there is movement of : **[UP CPMT 2003]**

(1) Solute only

(2) Solvent only

(3) Both (1) and (2)

(4) Neither solute nor solvent

Q.37 Guttation takes place through : **[UP CPMT 2005]**

(1) Lenticels (2) Phenumatophores

(3) Stomata (4) Hydathodes

Q.38 Which of the following statements is correct ? **[UP CPMT 2003]**

(1) Cell membrane is involved only in exosmosis

(2) Cell membrane is involved only in endosmosis

(3) Cell membrane is involved both in exosmosis and endosomosis

(4) None of the above

Q.39 The root hairs absorb which of the following type of water : **[UP CPMT 2006]**

(1) Capillary water

(2) Hygroscopic water

(3) Gravitational water

(4) All of the water

Q.40 If flowers are cut and dipped in dilute NaCl solution, then : **[UP CPMT 2007]**

(1) Transpiration is low

(2) Endo-osmosis occurs

(3) No bacterial growth takes place

(4) Absorption of solute inside flower cell takes place

Q.41 Plant cell plasmolysed in a solution which is : **[MP PMT 2006]**

(1) Hypotonic (2) Hypertonic

(3) Isotonic

(4) Concentration no means

Q.42 Nitrogenase enzyme is found in Nostoc in the cell of : **[MP PMT 2001]**

(1) Vegetative (2) Heterocyst

(3) Both vegetative and heterocyst

(4) None of these

Q.43 Turgidity in guard cells is controlled by :

(1) Chloride

(2) Malic acid

(3) Potassium

(4) Potassium, chloride and malic acid

Q.44 Stomata are not found in : **[MP PMT 2001]**

(1) Algae (2) Mosses

(3) Ferns (4) Liverworts

Q.45 In which of the following the rate of transpiration is high : **[MP PMT 2001]**

(1) CAM plant (2) C_3 plants

(3) C_2 and C_4 plants (4) C_4 plants

Q.46 Cell sap is found in which cell organelle : **[MP PMT 2001]**

(1) Nucleous (2) Chloroplast

(3) Vacuole (4) Golgi Apparatus

Q.47 Which one of the following fixes nitrogen **[MP PMT 2002]**

(1) TMV (2) Yeast

(3) Nostoc (4) Denitrifying bacteria

Q.48 Active transport of ions by the cell requires : **[MP PMT 2002]**

(1) High temperature (2) ATP

(3) Alkaline pH (4) Salts

Q.49 To initiate cell plasmolysis, the salt concentration must be : **[MP PMT 2002]**

(1) Isotonic (2) Hypotonic

(3) Hypertonic (4) Atonic

Q.50 The basis of stomatal opening is : **[MP PMT 2004]**

(1) Endosmosis

(2) Plasmolysis of guard cells

(3) Decrease in cell sap concentration

(4) Exosmosis

Q.51 Plants absorb carbon dioxide from : **[MP PMT 2005]**

(1) Millets

(2) Cereals

(3) Carbohydrates present in the soil

(4) Aotmosphere

Q.52 Transpiration will increase with the increase of: **[MP PMT 2005]**

(1) Humidity (2) Temperature

(3) Carbon dioxide (4) Sulphur dioxide

Q.53 If is possible to drop a small particle through the stomata of leaf, what will you conclude : **[MP PMT 2005]**

(1) It will fall on the earth surface

(2) It will stop on lower epidermis

(3) It will stop on mesophyll cells

(4) It will stop on vascular tissue

Q.54 During transpiration turgidity in guard cells is controlled by : **[MP PMT 2006]**

(1) Potassium (2) Bromine

(3) Sodium (4) Oxalic acid

Q.55 What will happen if plant cells are placed in hypertonic solution : **[Uttaranchal PMT 2004]**

(1) Turgid (2) Plasmolysed

(3) Deplasmolysed (4) Lyse

Q.56 To initiate cell plasmolysis, the salt concentration must be : - **[MPPMT-2002]**

(1) Isotonic (2) Hypotonic

(3) Hypertonic (4) Atonic

Q.57 When a plasmolysed cell is placed in a hypotnonic solution then water will move inside the cell this will happen due to which force **[RPMT-2002]**

(1) DPD (2) OP

(3) W.P (4) None of them

Q.58 Apparatus used for measuring the transpiration: **[RPMT-2002]**

(1) Evapometer (2) Potometer

(3) Osmometer (4) Tensiometer

Q.59 Which of the following theory gives the latest explanation for closure of stomata ? **[BHU 2002]**

(1) ABA theory (2) Munch theory

(3) Starch-glucose theory

(4) Active K^+ transport theory

Q.60 The Sugarcane plant has : - **[AIIMS-2004]**

(1) Dumb-bell shaped guard cells

(2) Pentamerous flowers

(3) Reticulate venation

(4) Capsular fruits

ANSWER KEY

EXERCISE - 3

Q.1	1	Q.2	2	Q.3	2	Q.4	2	Q.5	1	Q.6	3	Q.7	1
Q.8	1	Q.9	3	Q.10	4	Q.11	1	Q.12	1	Q.13	1	Q.14	1
Q.15	2	Q.16	2	Q.17	3	Q.18	1	Q.19	1	Q.20	3	Q.21	2
Q.22	1	Q.23	3	Q.24	2	Q.25	3	Q.26	1	Q.27	2	Q.28	3
Q.29	4	Q.30	4	Q.31	1	Q.32	2	Q.33	4	Q.34	3	Q.35	1
Q.36	2	Q.37	4	Q.38	3	Q.39	1	Q.40	1	Q.41	2	Q.42	2
Q.43	4	Q.44	1	Q.45	1	Q.46	3	Q.47	3	Q.48	2	Q.49	3
Q.50	1	Q.51	4	Q.52	2	Q.53	3	Q.54	1	Q.55	2	Q.56	3
Q 57	1	Q 58	2	Q.59	1	Q.60	1						

These questions consist of two statements each, printed as "ASSERTION" and "REASON". While answering these Questions you are required to choose any one of the following responses.

(1) If both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.

(2) If both Assertion and Reason are True but Reason is not correct explanation of the Assertion

(3) If Assertion is True but the Reason is False.

(4) If both Assertion and Reason are false.

Q.1 **A :** Rate of water absorption decreases by decrease in temp. of soil.
R : Permeability of cell membrane decreases at low temperature.

Q.2 **A :** Most available form of water in plants is capillary water.
R : Ψ_ω of capillary water is highly negative.

Q.3 **A :** Ascent of sap takes place by vessels & trachieds.
R : These are non living elements of phloem.

Q.4 **A :** Endosmosis causes flaccidity in Guard cells.
R : Stomata opens due to flaccidity in Guard cells.

Q.5 **A :** Plant ash contains many inorganic substances or mineral elements.
R : All the elements presents in plant ash are essential.

Q.6 **A :** Chlorine, Calcium & Manganese are important for light reaction.
R : Photolysis of water is helped by these elements.

Q.7 **A :** Osmotic pressure of solution is always higher than pure solvent.
R : O.P. is property of solvent molecules.

Q.8 **A :** In transpiration water, vapour diffuses from leaves in atomosphere.
R : Diffusion takes place from higher conc. to lower conc.

Q.9 **A :** Ascent of sap continues, after the living cells of xylem are killed by poison.
R : Path of ascent of sap is symplastic.

Q.10 **A :** In a plasmolysed cell the space between cell wall and plasma membrane is occupied by hypertonic solution.
R : Cell wall is permeable.

Q.11 **A :** Root pressure is maximum during noontime.
R : Temperature & light intensity is higher during noontime.

Q.12 **A :** T.P. of Guard cells determines the mechanism of opening and closing of stomata.
R : Inner wall of Guard cell is thin.

Q.13 **A :** Plant leaves become wilted after girdling or ringing.
R : Ascent of sap is taking place by phloem.

Q.14 **A :** DPD in plasmolysed cell is higher than O.P.
R : T.P. is negative in plasmolysed cell.

Q.15 **A :** The movement of ions from epidermis to xylem elements is an active process.
R : It requires the metabolic energy.

Q.16 **A :** Ringing Experiment is impossible in sugarcane plants.
R : Vascular bundles in sugarcane are scattered.

Q.17 **A :** Ascent of sap is function of Xylem parenchyma.
R : Xylem parenchyma is non living element.

Q.18 **A :** Active absorption of water takes place in Halophytes.
R : Halophytes can absorbe water non-osmotically.

Q.19 **A :** O.P. of pure water is higher.
R : O.P. is property of solvent.

Q.20 **A :** Root cells have lower Ψ_ω than leaf cells.
R : Root cells have greater solute concentration as compared to leaf cells.

Q.21 **A :** Rate of transpiration is higher in dry & hot atmosphere.
R : Diffusion of water vapour is rapid in dry atmosphere.

Q.22 **A :** Guttation occurs during night & morning.
R : Hydathodes remain open during all time.

Q.23 **A :** Minerals mainly absorbed by Meristematic zone of roots.
R : Metabolic energy is produced by photosynthesis in meristematic part of roots.

Q.24 **A :** The movement of ions from soil to endodermis & Xylem elements is an active process.
R : It requires metabolic energy.

Q.25 **A :** Wooden doors and windows are hard to open or close in moist season.
R : They imbibe water in humid rainy season and increase in volume.

Q.26 **A :** Guttataion is loss of water in liquid form from the hydathodes.
R : Hydathodes open during day time.

Q.27 **A :** Halophytes can grow on salty soil.
R : Osmotic pressure in halophyte is higher as comapred to normal plants.

Q.28 **A :** Transpiration is higher in humid climate.
R : Rate of water absorption is higher in heliophytes.

Q.29 **A :** Water is mainly absorbed by passive process in plants.
R : Passive absorption occurs by expenditure of metabolic energy.

Q.30 **A :** Cold soil is physiologically dry.
R : Viscosity of water is higher in cold soil.

Q.31 **A :** Ascent of sap occurs by xylem tissue.
R : Xylem is presents only in dicot plants.

Q.32 **A :** Root hair cells absorb water from soil.
R : O.P. of soil is lower than root cells.

Q.33 **A :** Ascent of sap is stopped by killing the xylem parenchyma.
R : Ascent of sap occurs by parenchyma.

Q.34 **A :** Passive absorption of H_2O increases by increase in transpiration.
R : Passive absorption of water requires ATP.

Q.35 **A :** O.P. of leaf cells is lower than root cells.
R : Root cells has more solute.

Q.36 **A :** Ascent of sap occurs by living part of xylem.
R : Ascent of sap requires metabolic energy.

Q.37 **A :** Maximum transpiration takes place through the stomata.
R : Stomatal transpiration occurs through the leaves.

Q.38 **A :** Rate of transpiration decreases with increase in conc. of CO_2.
R : CO_2 reacts with ABA in subsidiary cells.

Q.39 **A :** **Potamogeton** possesses non-functional stomata.
R : **Potamogeton** is submerged hydrophyte.

Q.40 **A :** Transplanted plant can not grow easily.
R : Uptake of CO_2 is not possible at new places.

Q.41 **A :** Rate of water absorption decreases at low temp.
R : Viscocity of water is increased at low temp.

Q.42 **A :** Ascent of sap occurs by xylem vesseles ad tracheids.
R : These are living elements of xylem.

Q.43 **A :** Orchids or epiphytes can absorb atm. humidity.
R : Orchids are photosynthetic plants.

Q.44 **A :** Rate of transpiration decreases with increase in atm. humidity.
R : At high atm. humidity sotmata close.

ANSWER KEY

EXERCISE - 4

Q.1	1	Q.2	3	Q.3	3	Q.4	4	Q.5	3	Q.6	1	Q.7	3
Q.8	1	Q.9	3	Q.10	1	Q.11	4	Q.12	3	Q.13	4	Q.14	1
Q.15	1	Q.16	1	Q.17	4	Q.18	1	Q.19	4	Q.20	4	Q.21	1
Q.22	2	Q.23	3	Q.24	1	Q.25	1	Q.26	3	Q.27	1	Q.28	4
Q.29	3	Q.30	1	Q.31	3	Q.32	1	Q.33	4	Q.34	3	Q.35	4
Q.36	4	Q.37	2	Q.38	3	Q.39	1	Q.40	3	Q.41	1	Q.42	3
Q.43	2	Q.44	3										

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

MINERAL NUTRITION

INTRODUCTION

- Soil the main source of mineral nutrients. These mineral nutrients are mainely absorbed by the **meristemetic region of roots**.
- Mineral nutrients are present with soil particles in colloidal form and in water as soil solution. Conduction of mineral nutrients is done through the xylem.
- Absorption of meneral in plant is an active process.

ESSENTIAL ELEMENTS

About 50-60 elements are present in plant body but **16** elements are considered as essential elements According to **Arnon,-criteria** of essentiality of minerals are :

- The element must be neccessary for normal growth and reproduction of all plants.
- The requirement of element must be specific for plant life. That is indispensible element to plant.
- The Element must be directly involved in metabolism of plant.

C, H, O, N, K, S, Ca, Fe, Mg, P, Cu, Mn, B, Cl, Zn, Mo, Ni

CLASSIFICATION OF ESSENTIAL ELEMENTS

Arnon divides these necessary elements in two group on the basis of requirement of plant

- **Major element/Macro nutrients:** Concentration must be 1-10 mg L^{-1} more than 10 m mole $kg^{-1}$of dry matter. (mmole-Milimolar)

  C, H, O, N, P, Mg, S, K, Ca
- **Minor element/Micro nutrients:** (Concentration present 1.0-0.1 mg L^{-1} less than 10 m mole kg^{-1} per gram of dry matter)

  Cu, Zn, N, Mo, Mn, B, Cl, Fe

General functions of essential elements-

1. **Protoplasmic elements** - C, H, O, N, P, S
2. **Elements of Redox Reaction** - Fe, Cu, Mn, Cl
3. **Balancing / Antagonastic** - K, Ca
4. **Membrane Permeability** - K, Ca
5. **Co-factor of enzymes** - All micronutrients except B
6. **Osmotic pressure of cell.**

Benificial nutrients: Mineral elements other than essential elements, which satisfy specific additional nutrient requirement of some specific plants.

Ex. Na - Halophytes (eg. Atriplex - helps in C_4 pathway)

Si - Grasses (Provides mechanical strength)

Se - Astragalus

Co - Leguminous plants (root nodule formation)

- **Toxic elements/Toxicity:-** Any mineral ion concentration in plant tissue, that reduces the dry weight of tissue by about 10 percent is considerd as toxic elements and this effect is called toxicity.

- Most of the micronutrients become toxic as their required amount for plants is very low. This excess concentration inhibits activity of other essential elements.

  e.g., Toxicity of Mn (Manganese) may induce deficiency of iron, magnesium and calcium cause appearance of brown spots surrounded by chlorotic veins. Mn competes with iron (Fe) and magnesium (Mg) for uptake and for binding to enzymes. Mn also inhibits, calcium translocation into the shoot apex and causes disease **'Crickle leaf '**.

  So the dominant symptoms of Mn toxicity may actually be the symptoms of Fe, Mg and Ca deficiency.

  Deficiency symptoms and mobility of minerals :
- The deficiency symptoms of highly mobile elements in plants like **N, P, K, Cl** and **Mg** first appear in older plant parts. These minerals are present as structural constituent of biomolecules of mature plant parts and when plant parts become older, these biomolecules broken down making these elements available for younger plant parts.
- The deficiency symptoms of immobile elements like Ca, S, B, Fe first appear in young plant parts, as they are not transported from older plant parts.

MINERAL SALT ABSORPTION/MECHANISM OF MINERAL ABSORPTION

1. PASSIVE ABSORPTION OF MINERALS : (Without expenditure of ATP)

(i) By simple diffusion : According to this method mineral ions may diffuse in root cells from the soil solution. Facilitated diffusion of minerals also occurs with help of carrier proteins.

(ii) By mass flow : Proposed by Hylmo (Supported by Kramer) According to this method mineral ions absorption occurs with flow of water under the influence of transpiration.

(iii) By ion exchange : By Jenny and Over street. This is exchange of mineral ions with the ions of same charge.

(a) By contact exchange : When the mineral ion exchange occurs with the H^+ and OH^- ions.

(b) Carbonic acid exchange : When the mineral ion exchange takes place with the ions of carbonic acid.

(iv) By Donnan equilibrium : This theory explains the passive accumulation of ions against the concentration gradient or electrochemical potential (ECP) without ATP. At the inner side of cell membrane, which separates from outside (external medium), there are some anions, which are fixed or non diffusible and membrane is impermeable to these anions, while cations are diffusible.

- In such condition, for maintenance of equilibrium additonal cations are needed to balance negative charges of anions (at inner side of membrane). Thus some cations moves, inside the cell from soil solution.
- So according to this theory Donnan equilibrium is attained, if the anions and cations in the internal solution become equal to the anions and cations in external solutions.

Objections for passive mineral absorption / evidences in favour of active mineral absorption :

(1) Absorption of K^+ions in **Nitella** algae is observed against the concentration gradient.

(2) Rate of respiration of a plant is increases, when plant transferred to mineral solution. (Salt respiration)

(3) Factors like deficiency of oxygen, CO, CN, which inhibits rate of respiration, these factors also inhibit the absorption of mineral ions in plants.

Thus ion absorption in plants is considered mainly as an active process.

2. Active ion absorption : (By expenditure of ATPs)

(i) Cytochrome pump theory : By **Lundegardh and Burstrom (1933)** according to this theory, **only anions** are absorbed by active mechanism through cytochrome pumping and absorption of cation is passive process.

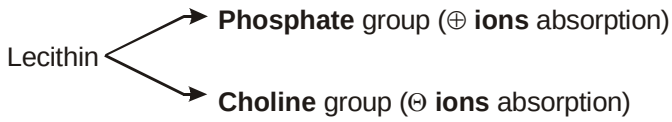
According to cytochrome pump theory **salt respiration** is called as **anion respiration.**

(ii) Carrier concept : By **Vanden Honert.** According to this theory some specific carrier molecules made up of **proteins** are present in cell membrane of root cell, which absorb both the ions and form **ion-carrier complex.** This complex is broken inside the cell membrane with the use of energy.

(iii) Protein - Lecithin theory : By **Bennet Clark**

According to this theory a **phospholipid lecithin** in root cell membrane works as carrier for both type of ions.

Lecithin has two type of groups:



- **Goldacre** - A contractile protein is associated, with absorption of minerals.
  Mineral absorbed by the roots of plants are carried by xylem by two pathways, apoplastic and symplastic pathway.
- **P.R. Stout** and **Hoagland** (1939) proved that mineral salts are translocated through xylem along with transpiration pull (exp. with help of radioisotopes).

SPECIFIC ROLES OF DIFFERENT ELEMENTS

Mineral Element	Principle Functions	Deficiency symptoms
1. Nitrogen NO_3^- /Nitrate form	(a) All living matter (b) Amino acids, proteins (c) Purines, pyrimidines (d) Early defoliation (e) NAD, NADP, FMN, FAD (f) Chlorophyll, cytochromes	Chlorosis first in older leaves, permature leaf fall reduced yield. Development of anthocyanin pigment (Mottled chlorosis)
2. Phosphorus $H_2PO_4^-$ & HPO_4^- orthophosphate anion form	(a) Nucleic acids (b) Nucleoproteins (c) Phospholipids (d) AMP, ADP, ATP (e) NAD, NADP (f) Indispensible role in energy metabolism	Chlorosis with necrosis, permature abscission of leaf, poor vasculature.
3. Potassium K^+ in free form	(a) Permieability (b) Osmotic regulation and hydration (c) Commonest free ion in cell (d) Stomatal movements (e) Translocation of sugars (f) Enzymes concerned with photosynthesis, nitrate reduction, protein bio-synthesis, respirations, etc.	Mottled chlorosis, premature death, loss of apical dominance lodging in cereal. Bushy habit. Cotton rust.

4. Calcium Ca^{++} form	(a) Cell wall Structure (b) Membrane structure (c) Influence nitrate reductase (d) In ion transport (e) In cell elongation and spindle formation (f) Activators of amylases, adenyl kinase, ATPase, etc.	Stunted growth, **degeneration of meristems**, chlorosis, curling first in young leaves. Black heart of *Celery*.
5. Magnesium Mg^{++} form	(a) Component of chlorophyll (b) Activators of a number of photosynthetic and respiratory enzymes (c) Combiness the subunits of ribosomes (d) Synthesis and hydrolysis of ATP	Marginal curling, interveinal chlorosis with anthocyanin accumulation first appearing in older leaves. 'Sand drown' of Tobacco.
6. Sulphur SO_4^{2-} form (Sulphate)	(a) Part of CoA, Ferredoxin, Vit. H, Thiamine, Lipoic acid. (b) Amino acids e.g. Cysterine, Cystine, methionine	Chlorosis first in young leaves, reduced nodulation in legume. **Tea yellow**, extensive root system.
7. Iron Fe^{++}/Fe^{+++} Form	(a) Structural component of porphyrin molecules, cytoch -romes, catalase, peroxidase leghaemoglobin	**Interveinal chlorosis** first in young leaves. Green Netting of Citrus.
8. Molybdenum MoO_4^{2-} form	(a) Component of nitrate reductase (b) Important in N_2 fixation	Mottled chlorosis, **whiptail of cauliflower**, loosening of inflorescence of cauliflower. Scald of beans.
9. Boron H_3BO_3 / BO_3^{-3} (Borate) form	(a) Translocation of sugars (b) For seed, pollen and spore germination (c) Enzymes of phosphorylation (d) RNA metabolism (e) Phenol metabolism and cell differentiation (f) Regulates pentose phosphate pathway (g) Flowering and fruiting	**Brown heart of turnip**, **internal cork** of apple, **heart rot** of sugarbeet, decreased nodulation in legumes. Hollow stem of caulifilower, stem crack of *Celery*.

10. Copper Cu^{++} form	(a) Oxidase enzyme : tyrosinases plastocyanin, cytochrome oxidase.	Dieback, exanthema, reclamation disease, blackening of potato, tubers, chlorosis
11. Manganese Mn^{++} form	(a) In chlorophyll synthesis (b) In photolysis of H_2O in photosynthesis (c) Maintenance of chloroplast membrane structure (d) Enzyme systems; RNA polymerase, NAD-malic enzyme in C_4 plants	Interveinal chlorosis, grey speck of oat, marsh spot disease of pea.
12. Zinc Zn^{++} form	(a) Tryptophan synthesis (precursor of auxin) (b) Dehydrogenase enzymes, pyriding nucleotide, alcohol, glucose-6-p and triose phosphate (c) Carbonic anhydrase (d) Promotes synthesis of cytochromes (e) Stabilizes ribosomal fractions	Little leaf, leaf rosettes leaf malformations. White bud, whip tip of maize, sickle leaf of cocao, khaira disease of rice.
13. Chlorine	(a) In the transfer of electron from water to PS II (Photolysis) (b) Maintain cation – anion balance	Bronze colour in leaves, chlorosis, necrosis, swollen root flower abscission.
14. Nickel	(a) Urease and hydrogenase activity	It helps in germination and early seedling growth of Jack Bean seeds. It causes necrotic spots.

N_2 METABOLISM

Role of Nitrogen in Plants:- Constituent of proteins, nucleic acids ATP, GTP, Vitamins, chlorophyll, alkaloids, cytochromes, hormones. Nitrogen is necessary to plants for heridity, reproduction, growth metabolism and development.

Sources of Nitrogen to plants :

(1) Atmospheric nitrogen:

$N \equiv N$ (Molecular, inert or elemental form) used by Rhizobium (Legumes), BGA, Lichens.

- These converts atm. N_2 into metabolically usefull ammonia (NH_3). This process is called as **biological nitrogen fixation**.

(2) NO_3^-,NO_2^-,NH_4^+ in soil:

These are major source of nitrogen to plants.

- **Nitrate ions (NO_3^-)** are cheif form of nitrogen used by majority of plants.

Plants grow in acidic soil & found in forest use ammonium ions (NH_4^+) as major N_2 source.
Nitrate ions are cheif source of N_2 for plants but they can not be used directly in metabolic pathway in plant cells, as it is highly oxidised form. so NO_3^- (Nitrate) first converted into NO_4^+ (ammonium ions) called **nitrate reduction**. So NH_4^+ ions enters in plant metabolism.

(3) Organic nitrogen in soil: as amino acids, protein body.
Due to death & decay of organisms. This is not a major source of N_2.

(4) Insect bodies: for some plants (insectivorous plants)

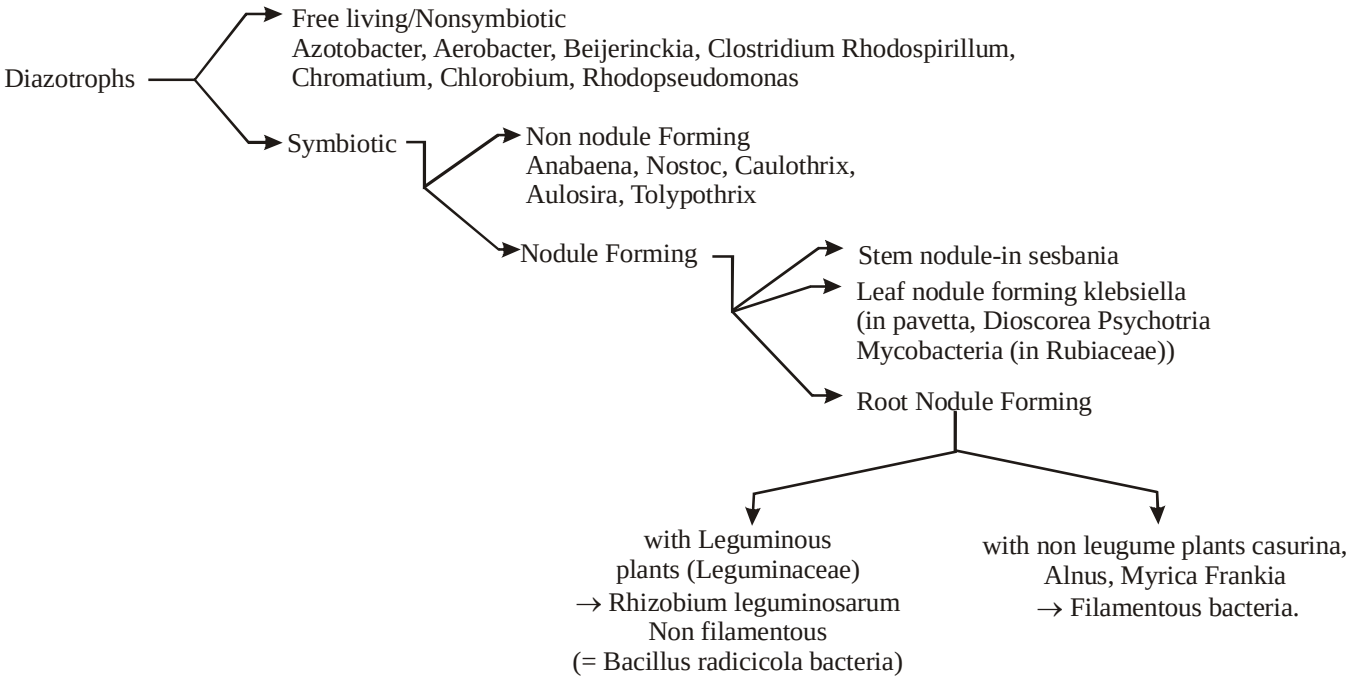
(5) Urea as chemical/artificial fertilizers

Nitrogen (N_2) Cycle:

(1) Biological Nitrogen Fixation/Diazotrophy ($N_2 \rightarrow NH_3$):- Conversion of molecular or elemental nitrogen ($N \equiv N$) into inorganic nitrogenous compounds (NH_3) through agency of living organisms is called as **biological nitrogen fixation** or **Diazotrophy.**

Nitrogen Fixing organisms (Diazotrophs):

- Free living diazotrophs carry out diazotropy only in free living condition while symbiotic diazotrophs only in symbiotic condition.



(2) Ammonification: Conversion of dead organic nitrogenous compounds into ammonia. **Bacillus mycoides**, **B. ramosus.**

(3) Nitrification: Oxidation of ammonia, produced by ammonification into nitrates by nitrifying bacteria is called as **nitrification**.

(i) $2NH_3 + 2O_2 \xrightarrow{\text{Nitrosomonas}} 2NO_2^- + 2H_2O + 2H^+$
Ammonia — Nitrite ion

(ii) $2NO_2^- + O_2 \xrightarrow{\text{Nitrobacter}} 2NO_3^-$
Nitrate ions

Some fungi like Aspergillus, Penicillium can also carry out this process.

(4) Denitrification: Nitrates or nitrites converts back into molecular or atm. nitrogen by denitrifying bacteria is denitrification. Ex. **Pseudomonas** denitrificance.

(5) Nitrate reduction:

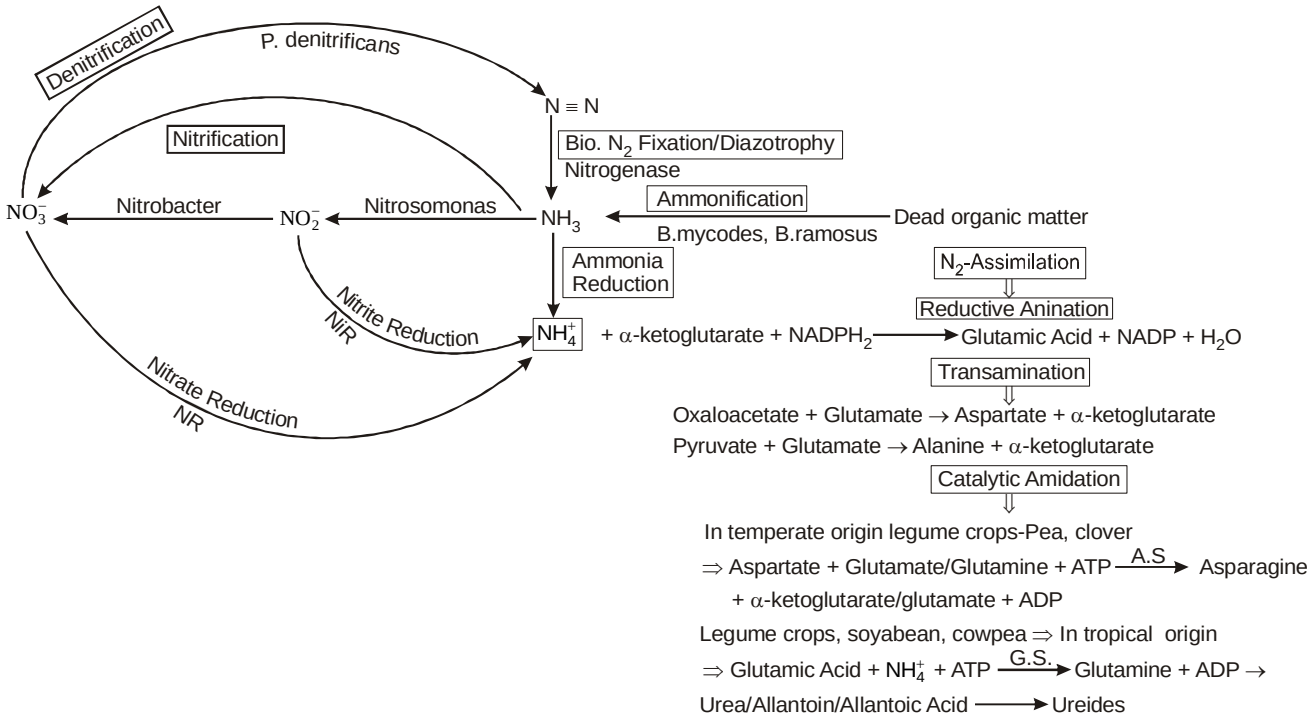
- Plants take nitrogen from soil, chiefly in nitrate forms which is highly oxidised form.
so NO_3 converts in ammonia by following method

(a) $NO_3^- + NADH_2 + H^+ \xrightarrow{\text{Nitrate reductase}} NO_2 + NAD + H_2O$

(b) $NO_2^- \xrightarrow{2e^-, 2H^+} NOH \xrightarrow{2e^-, 2H^+} NH_2OH \xrightarrow{2e^-, 2H^+} NH_4^+$

or $NO_2^- + 6H_2O + 4H^+ \xrightarrow{\text{Nitrate reductase}} 2NH_4^+ + 3O_2 + 4H_2O$

- Nitrate reductase is Molybdo flavoprotein isolated by Evans and Nason 1953 from Neurospora and Glycine max.



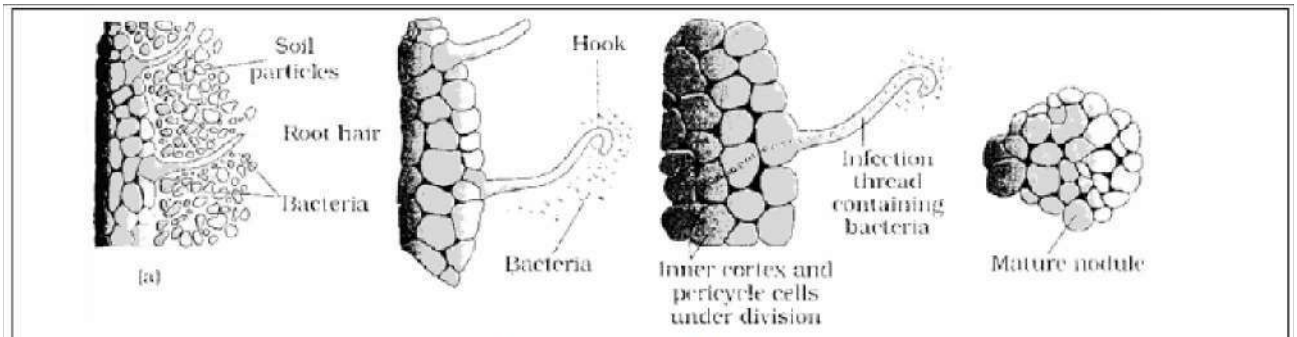
Symbiotic N_2 fixatiion (Diazotrophy) : It is done by symbiotic bacteria & free living bacteria. In leguminous plants (Fabaceae) by symbiotic bacterium **Rhizobium**, which form nodules in their roots.

- N_2 convert into NH_3 ion, which is used in plant metabolism.
- Root nodules act as site for N_2 fixation. It contains all necessary biochemical components like enzyme Nitrogenase, Leghaemoglobin, required in N_2 fixation.

NODULE FORMATION

It is due to interactions between bacteria and host root. It occurs in following steps:

- **Multiplication & colonization of Rhizobia** at Rhizosphere and attachment to epidermal root hair cells. Initial attraction of Rhizobia to host root is chemotactic (Rhicadhesin protein of bacterial cell identify host root) as root exude amino acids, sugars, organic acids and flavonoids.
- **Characterstic curling of root hairs and invasion of the bacteria** to form an **infection thread,** by the invagination of plasma membrane of root hair cells and it reaches up to the cortex of roots. Curling of root hairs is stimulated by specific complex polysaccharides found on the surface of rhizobia, recognised by Lectins (small proteins of host plant roots).
- **Nodule initiation & development in root cortex.** Mitogenic agents secreted (Kinetin) by bacteria & auxin produced by plant cell promotes cell division & extension leading to nodule formation. Nodule establishes direct vascular connection with host for exchange of nutrients. Root nudule cells have chromosome in double to other somatic cells. Thus nodule cells are polyploid specially **Tetraploid**.



Development of root nodules in soyabean : (a) *Rhizobium* bacteria contact a susceptible root hair, divide near it, (b) Upon successful infectionof the root hair cause it to curl, (c) Infected thread carries the bacteria to the inner cortex. The bacteria get modified into rod-shaped bacteroids and cause inner cortical and pericycle cells to divide. Division and growth of cortical and pericycle cells lead to nodule formation, (d) A mature nodule is complete with vascular tissues continuous with those of the root

Release of bacteria from infection thread and they differentiable as specilized nitrogen fixing cell.

- Bacteria continue to multiply during it's path in root thair cells & bacteria distribute in most of cells.
- The membrane of infection thread bud off to form small vesicles with containing one or more bacteria. Then bacteria stop dividing & enlarge & differentiate in **nitrogen fixing cells called bacteroid** & it's membrane called **peribacteroid membrane.**

MECHANISM OF BIOLOGICAL N_2 FIXATION

By Burris. The atm. N_2 is reduce by the addition of hydrogen atoms.

- The three bonds between two nitrogen atoms N ≡ N or dinitrogen are broken & ammonia (NH_3) is formed by reduction of N ≡ N.

$$N \equiv N + 8H^+ + 8e^- + 16ATP \xrightarrow[\text{Nitrogenase}]{} 2NH_3 + H_2 + 16ADP$$

(1) **Nitrogenase :**

⇒ Exclusively present in prokaryotes

⇒ Inducible enzyme

⇒ Larger sub unit/SU-I **Mo-Fe-protein**
smaller Subunit / SU-II-**Fe-S-protein/ ferredoxin**

⇒ Both Subunits bind together at the time of N_2 fixation.

⇒ Oxygen sensitive enzyme

(2) **O_2 Regulation:**

⇒ Most of diazotrophs are obligate anaerobes

⇒ Some diazotrophs are facultative like Rhizobium, perform anaerobic respiration at the time of diazotrophy

⇒ In root nodule of leguminous plants - O_2 Scavenger Leghaemoglobin (Lhb) (similar to haemoglobin of animals) is present, bind with O_2 to become oxyleghaemoglobin (OLHb) and regulates minimum O
2
concentration.

⇒ Leghaemoglobin is synthesized by combined activity of host (gives protein part globin) and bacteria (gives haem' part).

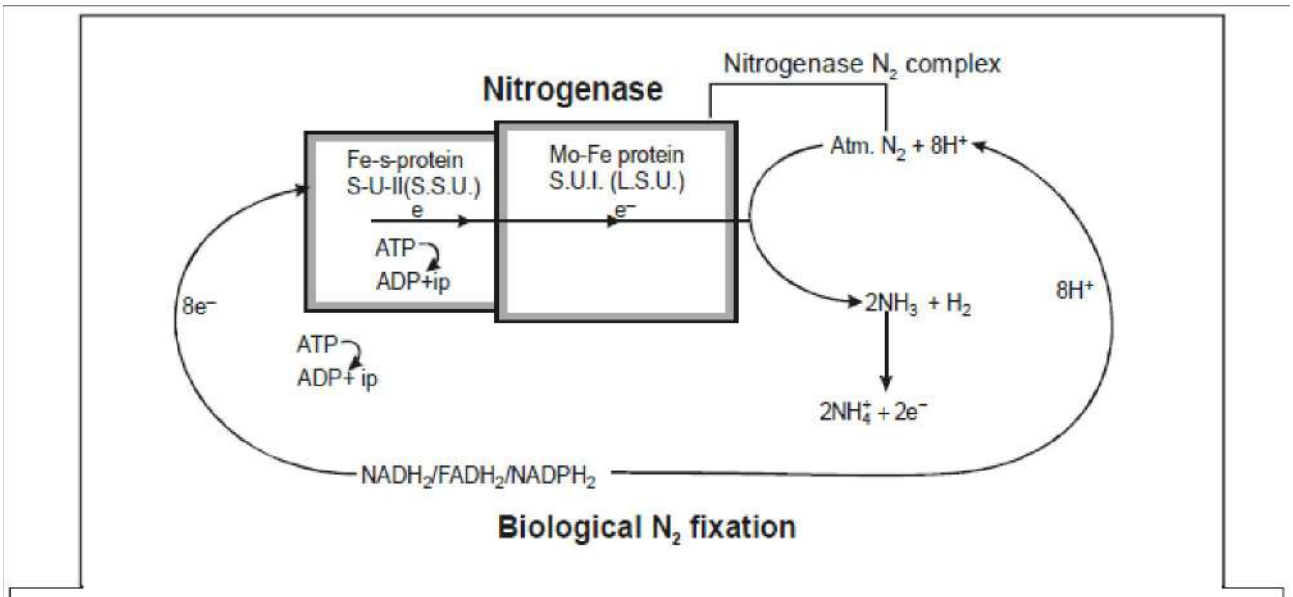
⇒ In the Heterocyst- Non photosynthetic and thick walled.

(3) **Source of H^+ and e^-**

⇒ Reducing agents $NADH_2/FADH_2/NADPH_2$ obtained from Photosynthesis and respiration

(4) **Source of ATP** ⇒ From Photosynthesis and respiration

(5) **Genes**
- Host-NOD(Nodulin protein forming gene)
- Bacteria-nod (Nodule forming gene)
- **Fix nif** (nitrogenase inducing factor)
- **Fix** (Nitrogen fixation gene)



Mechanism of nitrogen fixation

(a) The 2nd unit (ferredoxin) of nitrogenase, receive electrons from e^- donar ($FADH_2/NADH_2/NADPH_2$) and become reduced.

(b) This reduced 2nd unit is now activate by ATP and form a complex called **ferredoxin ATP complex.**

(c) On other side unit 1st (Fe-Mo protein) of nitrogenase, reacts with molecular nitrogen to form **nitrogenase-nitrogen complex.**

(d) Ferredoxin ATP complex then transfer electron to nitrogenase-nitrogen complex, so that the later gets reduced. This reaction utilize of ATP.

(e) The reduced nitrogenase-nitrogen complex now receives proton (H^+) resulting in formation of ammonia (NH_3).

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SYNTHESIS OF AMINO ACIDS & NITROGEN ASSIMILATION

Nitrogen assimilation:- Inorganic NH_3 (Produced by nitrate reduction or biological fixation or obtained from soil as NH_4^+) reacts with a TCA cycle intermediate-α-ketoglutaric acid to form an amino acid **glutamic acid**.This process known as **Reductive amination or Amino acid Biosynthesis.**

$$\alpha\text{-Ketoglutaric acid} + NH_4^+ + NADPH_2 \underset{\text{dehydrogenase}}{\overset{\text{Glutamate}}{\rightleftharpoons}} \text{Glutamic acid} + H_2O + NADP$$

Transamination:- Transfer of Amino group from glutamic acid to other keto acid is known as **transamination**. This is a process of formation of other amino acids in plats. **(transaminase enzyme)**

Ex. Glutamic acid + Pyruvic acid $\rightleftharpoons$ **Alanine** + α-ketoglutarate

Glutamic acid + OAA $\rightleftharpoons$ **Aspartic acid** + α-ketoglutaric acid.

- **Glutamic acid is first formed amino acid in plants** & can synthesize different amino acids by transamination.

Catalytic Amidation :

Transportation of fixed N_2/Assimilated N_2 in plants occurs mainly in the form of amides especially in leguminous plants as amides are more stable than amino acids and possess high Nitrogen to Carbon ratio (2N to 4C - in Asparagine, 2N to 5C in glutamine (as glutamate posses 1N to 5C)

Formation of amides from amino acids catalysed by enzymes called as catalytic amidation.

In legumes of temperate origine like pea and clover-Asparagine is translocated in non nodulated plant parts.

In legumes of tropical origin like soyabean and cowpea-ureides are translocated in non nodulated plant parts.

Glutamine synthesis:

$$\text{Glutamic acid/Glutamate} + NH_4^+ + ATP \xrightarrow{\text{Glutamine (G.S.) Synthase}} \text{Glutamine} + ADP + iP$$

Asparagine syntnesis:

$$\text{Glutamine/Glutamate} + \text{Aspartate} + ATP \xrightarrow{\text{Asparagine (A.S.) Synthase}} \text{Asparagine} + ADP + iP +$$

Glutamate / α-Ketoglutaric acid

SPECIAL POINTS

- C, H, O, N and P are main constituents of protoplasm (organic materials). So they are called **protoplasmic elements.** C, N & O from atmosphere and H_2O from soil for H & O.
- **C, H and O** are the main components of nucleic acid, proteins, enzymes, carbohydrates, fats. (frame work elements)
- Mostly soil is deficient of **NPK** and these elements are known as **critical elements,** NPK-fetilizer is good for crop yield.
- Silica (SiO_2) is present in cell wall of diatoms grasses and paddy straw.
- **Al** present in pteridophytes i.e. - Lycopodium.
- Mo, required in minimum quantity.

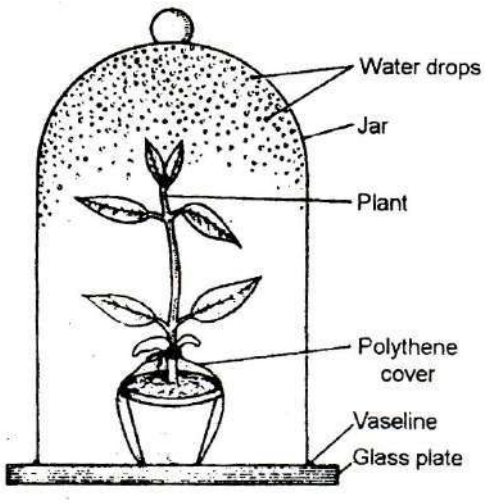
- **Hydroponics/solution culture/**soil less growth/tank farming and **ash analysis** is a technique which determines the role of nutrients in plants. (By Geriack)
- Gold (Au) present in Equisetum, mustard plants.
- Na^+ found in **halophytes** for their growth (marine plants).
- **Trace - elements are micro-nutrients,** while **tracer-elements** are **radio-isotopes**.
- Mg present in chlorophyll, as non-ionic form.
- Mg remains after chlorophyll burning.
- One abundant and stable form of Fe in leaves is stored in chloroplasts as an iron protein complex called **phytoferritin** (Seckback 1983).
- C, H, O are provided by H_2O, O_2 and CO_2, but 13 elements essential to all plants are absorbed as ions from the soil solution, is called a **solution mining.** (N_2 from soil & atm.)
- **Putrifaction/proteolysis:-** Bacillus, Pseudomonas, Clostridium.
- Proteins $\xrightarrow{\text{Proteases}}$ peptides $\xrightarrow{\text{Peptidase}}$ amino acids (conversion of proteins in to amino acids) smell of dead bodies.
- **Deamination:-** Removal of amino group as NH_3 from an amino acid.
- Root pressure is measured by **manometer**.

IMPORTANT EXPERIMENT

EXPERIMENT - 1

Bell jar experiments for demonstration of transpiration :

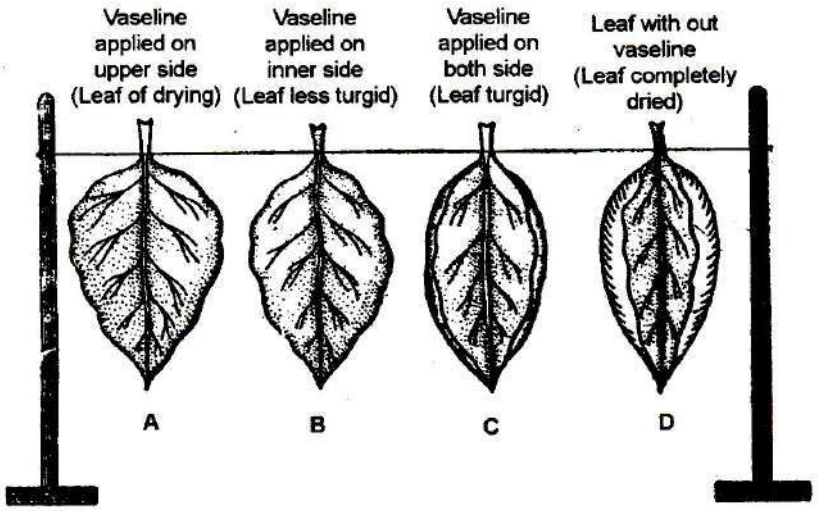
Take a small well watered potted plant. Cover the external surface of the pot and its soil thoroughly with polythene bag. Place the potted plant on a glass slab in a cool place invert a dry bell-jar over it. Seal the edges of bell-jar with vaseline. After some time drops of water will appear on the inner side of the bell-jar. The water drops have been formed by the condensation of water vapours given out by shoot of the plant in transpiration.



EXPERIMENT - 2

Compare the loss of water from the two sides of a leaf (By four leaf experiment) :

Remove four leaves of Pipal. They should be almost equal size. Seal the cut end of petioles with vaseline. Tie a thread to the petiole of each in the fashion of a loop. Apply vaseline to the upper surface of A, lower surface of B and both the surfaces of C. Keep the leaf D as such to function as control. Weight the leaves one by one. For weighing each leaf is picked up though the thread attached to its petiole. After initial weighing keeping the leaves hanging from stands by means of their threads for a few hours. Examine them closely. Leaves A & D wilt while B and C remain turgid. Weight them again. It will be seen that max loss of weigh occurs in D followed by A. Loss of weight is negligible in B.It is nill in case of C. In D leaf both surfaces loss water, while in A only the lower surface is exposed to transpire. The negligible loss of water in B shows that upper surface transpires little.



EXPERIMENT - 3

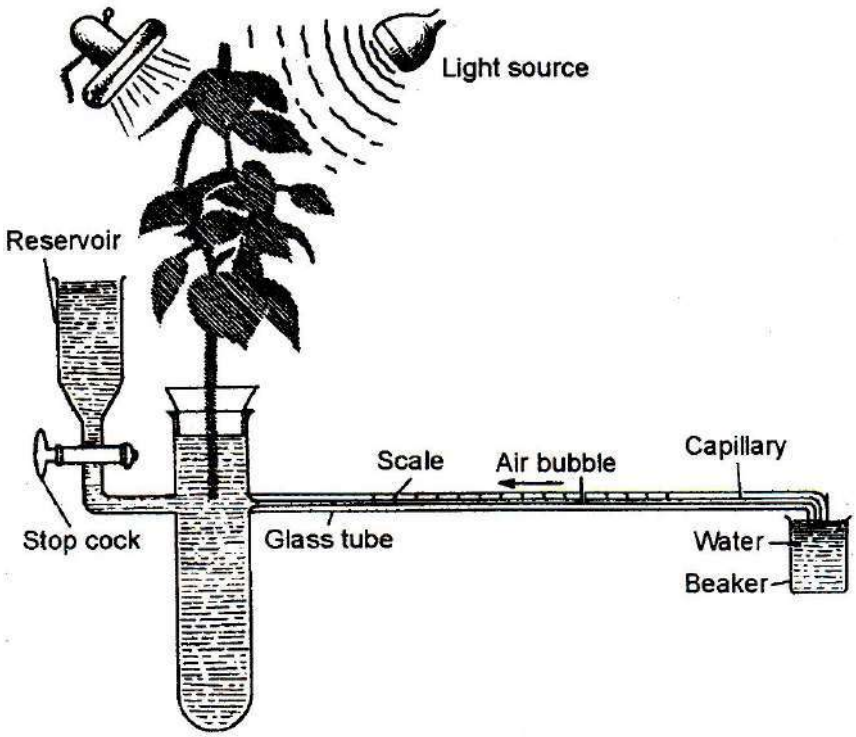
Measurement of Transpiration (By Ganong's potometer) :

Fill Ganong's Patometer completely with water. Close the hole of the capillary tube with your finger. Insert a fresh leafy shoot, cut under water, into the mouth of the wide tube by means of cork. Make the connections air tight by applying melted wax or vaseline to the joint. Place the apparatus in dry place or sunlight. Remove your finger from the free end. An air bubble will enter the graduated capillary tube

dip the free end in a beaker containing water. The air bubble will seen moving forwards.
Note the time taken for the air bubble to travel from one end to other end in tube. As soon as the air bubble reaches the other end open the stop cock of the reservior till it is pushed back to the beginning of the horizontal tube. Repeat the experiment. Note the amount of water absorption in different conditions.

$V = \pi r^2 \ell$

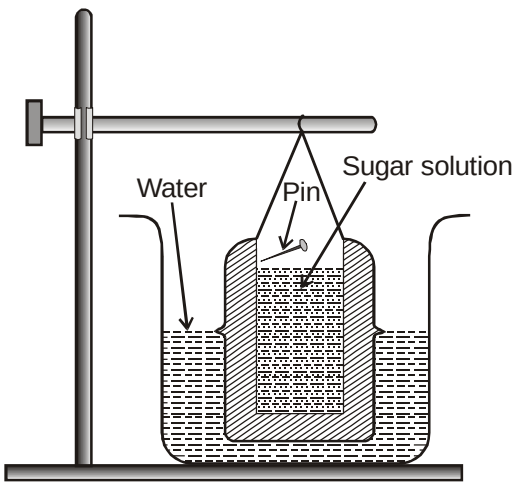
V = volume of water which absorbed/transpired water
π = 3.14
ℓ = distance of movement by air bubble



EXPERIMENT - 4

Demonstration of osmosis by Potato Osmoscope

Take a large sized potato tuber. Cut on side flat. Bore a cavity from the other side in such a way that only a thin base is left intact on the flat side. Also remove the skin near the edges of the flat end because the skin of the tuber is impermeable to water. Now place the cavity of the potato tuber by 10-20% sugar solution. Mark the level of sugar solution in the cavity with the help of pin. After some time the level of sugar solution rises in the cavity.



The rise in the level of sugar solution in the cavity of the potato tuber indicate that it has absorbed water from the petri dish. The two are separated from each other by a large number of cells.

The entry of water into sugar solution proves that (i) Sugar solution is an osmotically active solution. (ii) the cytoplasm of all the cells of the tuber that lie between the sugar solution and the water of petri dish act as a single semi-permeable membrane (iii) Water enters the sugar solution when it is separated from it by a semi-permeable membrane, the phenomenon being known as osmosis.

EXERCISE - 1

MINERAL ABSORPTION & NUTRITION

Q.1 Which of the group of elements is not essential for a normal plant ?
(1) K, Ca, Mg (2) Fe, Zn, Mn, B
(3) Pb, I, Na (4) Mg, Fe, Mo

Q.2 Hydroponics is a technique in which plants are grown in ?
(1) Green house
(2) Water saturated sand
(3) Balanced nutrient solution
(4) Purified distilled water

Q.3 For cholrophyll formation a plant needs :-
(1) Fe, Ca & light (2) Fe, Mg & Light
(3) Ca, K & light (4) Mn & Cu

Q.4 Brown heart rot of beets is due to deficiency of-
(1) B (2) P
(3) Mg (4) Mo

Q.5 Die back disease in citrus is due to deficiency of : -
(1) Mo (2) B
(3) Cu (4) Zn

Q.6 The disease related with deficiency of molybdenum is : -
(1) Whiptail disease of cauliflower
(2) Little leaf disease
(3) Reclamation disease of cereals
(4) Brown heart disease

Q.7 Protoplasmic elements are : -
(1) C, H, O, P, N, S (2) C, H, O, Fe, N
(3) N, S, Fe, P, K (4) Fe, Mg, Ca, N, P

Q.8 Which element is not considered as macronutrient ?
(1) Mg (2) Ca
(3) Mn (4) P

Q.9 The element which can not be placed along with micronutrients : -
(1) Mn (2) Mo
(3) Cu (4) Ca

Q.10 The amino acid having S in its composition is -
(1) Cystine (2) Cysteine
(3) Methionine (4) All

Q.11 Which elements are considered as balancing elements ?
(1) Ca & K (2) C & H
(3) N & S (4) Mg and Fe

Q.12 The group of mineral nutrients known as frame work elements : -
(1) N, S, P (2) C, H, O
(3) Mg, Fe, Zn (4) Zn, Mn, Cu

Q.13 Which element essential for stability of chromosome structure ?
(1) Zn (2) Ca
(3) Mo (4) Fe

Q.14 "Reclamation" and "Little leaf" disease, caused by deficiency of -
(1) Zn and Mo (2) Cu and Zn
(3) Cu and B (4) Mn and Cu

Q.15 Which element is required in comparatively least quantity for the growth of plant ?
(1) Zn (2) N
(3) P (4) Ca

Q.16 Which of the following essential element is not properly placed in the given category ?
(1) Cu (2) Zn
(3) Mg (4) Mn

Q.17 Criteria for essentiality in mineral nutrition were shown firstly by : -
(1) Arnon (2) Liebig
(3) Steward (4) Levitt

Q.18 Which mineral nutrients are called critical element for crops ?
(1) N, P, K (2) C, H, O
(3) N, S, Mg (4) K, Ca, Fe

Q.19 The mineral nutrient mainly concerning with apical meristematic activity is : -
(1) K (2) Ca
(3) N (4) S

Q.20 Little leaf disease is caused by -
(1) Zn - deficiency (2) Cu - deficiency
(3) Mo - deficiency (4) Mn - deficiency

Q.21 Which of the following does NPK denote ?
(1) Nitrogen, Potassium, Kinetin
(2) Nitrogen, Protein, Kinetin
(3) Nitrogen, Protein, Potassium
(4) Nitrogen,Phosphours, Potassium

Q.22 Plants absorb mineral salts from the soil solution through : -
(1) A semipermeable membrane into the cytoplasm
(2) Perforations at the apex of root hair cells
(3) The cell wall which is semipermeable
(4) None of these

Q.23 Mineral salts which are absorbed by the roots from the soil are in the form of : -
(1) Very dilute solution
(2) Dilute solution
(3) Concentrated solution
(4) Very concentrated solution

Q.24 By which method ions are absorbed by the plants ?
(1) Diffusion (2) DPD gradient
(3) Carrers proteins (4) Water pontential

Q.25 Hydrophytes absorb salt and water by : -
(1) Root and root hairs
(2) Leaves and root
(3) Roots and stem
(4) General epidermis

Q.26 Active and passive absorption terms were coined by : -
(1) Kramer (2) Deutrochet
(3) Priestley (4) Renner

Q.27 Which is free ion present in a cell ?
(1) P (2) K
(3) Fe (4) B

Q.28 Who give the Cytochrome pump theory ?
(1) Sachs (2) Lundegradh
(3) Bose & Renner (4) Bennet - Clark

Q.29 Who proposed the protein lecithin theory ?
(1) Sachs (2) Lundegradh
(3) Bose & Renner (4) Bennet & Clark

Q.30 Carrier protein helped in : -
(1) Active absorption of ions
(2) Passive ions absorption
(3) Water absorption
(4) Vaporization

Q.31 Active uptake of minerals depends upon :-
(1) Active water absorption
(2) Transpiration
(3) Photorespiration
(4) Dephosphorylation

Q.32 When chlorophyll is burnt, which one obtained ?
(1) Fe (2) Mg
(3) Ca (4) Mn

Q.33 Which element related with Khaira disease, of Paddy & auxin synthesis : -
(1) Fe (2) Zn
(3) B (4) Cu

Q.34 Generally plants absorbed N_2 in the form of :-
(1) NO_2^- (2) NO_3^-
(3) $N \equiv N$ (4) HNO_2

Q.35 Cobalt present in : -
(1) Vit. – A (2) Vit. – B_2
(3) Vit. – B_{12} (4) PC

Q.36 Which is essential for N_2 metabolism ?
(1) B (2) Mo
(3) Cu (4) Mg

ANSWER KEY

EXERCISE - 1

Q.1	3	Q.2	3	Q.3	2	Q.4	1	Q.5	3	Q.6	1	Q.7	1
Q.8	3	Q.9	4	Q.10	4	Q.11	1	Q.12	2	Q.13	2	Q.14	2
Q.15	1	Q.16	3	Q.17	1	Q.18	1	Q.19	2	Q.20	1	Q.21	4
Q.22	1	Q.23	1	Q.24	3	Q.25	4	Q.26	4	Q.27	2	Q.28	2
Q.29	4	Q.30	1	Q.31	4	Q.32	2	Q.33	2	Q.34	2	Q.35	3
Q.36	2												

EXERCISE - 2

Q.1 Which element is left when chlorophyll is burnt-

(1) Iron (2) Manganese

(3) Magnesium (4) Molybdenum

Q.2 Essential macroelements are-

(1) Absorbed from soil

(2) Manufactured during photosynthesis

(3) Produced by enzymes

(4) Produced by growth hormones

Q.3 What is the substrate for loading of food in the plants-

(1) IAA (2) Abscisic acid

(3) GA (4) K^+ ion

Q.4 Which of the following is not a macro-nutrient-

(1) Mn (2) Ca

(3) Mg (4) Phosphorus

Q.5 The possible resource of phosphorus ions and nitrogen ions in soil generally get depleted because they are usually found as-

(1) Positively charged ions

(2) Negatively charged ions

(3) A disproportionate mixture of negatively charged ions

(4) Particles carrying no charge

Q.6 Chlorosis, etiolation and albinism are caused by-

(1) Iron, light and certain genes

(2) Zinc, iron and magnesium

(3) Magnesium, iron, zinc, light and certain genes

(4) Magnesium, zinc and light

Q.7 Which of the following is a macro-nutrient-

(1) Ca and Mg (2) Mo

(3) Mn (4) Zn

Q.8 Phytotron is a device by which-

(1) Electrons are bombarded

(2) Protons are liberated

(3) Plants are grown in controlled environment

(4) Mutations are produced in plants

Q.9 All mineral salts are absorbed in cells as-

(1) Ions (2) Atoms

(3) Molecules (4) All the above

Q.10 Which one of the following elements plays an important role in biological nitrogen fixation-

(1) Molybdenum (2) Manganese

(3) Copper (4) Zinc

Q.11 Chlorosis of plants is caused by the deficiency of-

(1) Iron (2) Boron

(3) Copper (4) Calcium

Q.12 Which one of the following scientists used the nutrient culture solution in hydroponic cultures-

(1) Sachs (2) Webster

(3) Wallace (4) Knop

Q.13 Technique of growing plants without soil in nutrient solutions is called-

(1) Parthenogenesis (2) Hydroponics

(3) Aquaculture (4) Tissue culture

Q.14 Interveinal chlorosis of leaves is caused by the deficiency of-

(1) Nitrogen (2) Calcium

(3) Potassium (4) Magnesium

Q.15 In nature, organic compounds invariably contain-

(1) Carbon (2) Phosphorus

(3) Sulphur (4) Magnesium

Q.16 Which of the following is not macro-nutrient-

(1) C (2) P

(3) S (4) Zn

Q.17 Which of the following element is not essential for plants-

(1) Iron (2) Zinc

(3) Potassium (4) Iodine

Q.18 Which of the following is micro-element in plant-

(1) Manganese (2) Nitrogen

(3) Magnesium (4) Calcium

Q.19 Which of the following is not caused by deficiency of mineral nutrition-

(1) Necrosis (2) Chlorosis

(3) Etiolation (4) Shortening internode

Q.20 Which one is not related with plant ash ?

(1) Trace elements (2) Essential elements

(3) Nitrogen (4) Mineral elements

Q.21 Fall of immature leaf is due to the deficiency of-

(1) Sulphur (2) Phosphorus

(3) Sodium (4) Zinc

Q.22 Translocation of sugar in flowering plants occurs in the form of-

(1) Maltose (2) Glucose

(3) Sucrose (4) Starch

Q.23 Hydroponics is a-

(1) Soilless culture (2) Water less Culture

(3) Airless culture (4) None of these

Q.24 The core metal of chlorophyll is-

(1) Fe (2) Mg

(3) Ni (4) Cu

Q.25 Mass flow hypothesis was first described by-

(1) Swanson (2) Buchnan

(3) Kursanov (4) Munch

Q.26 Which of the following helps in the absorption of water and mineral salts-

(1) Mycorrhiza (2) Anbaena

(3) Nostoc (4) None of these

Q.27 Bidirectional translocation of minerals takes place in-

(1) Xylem (2) Phloem

(3) Parenchyma (4) Cambium

Q.28 Cultivation by sand culture is also called-

(1) Soilless cultivation (2) Green house effect

(3) Photorespiration (4) None of these

Q.29 Inorganic nutrients are present in the soil in the form of-

(1) Molecules (2) Atoms

(3) Electrically charged ions

(4) Parasite

Q.30 Which of the following contains copper-

(1) Quinone (2) Plastoquinone

(3) Plastocyanin (4) None of these

Q.31 Which of the following is not an essential macroelement for the growth of plants-

(1) N (2) Zn

(3) Ca (4) K

Q.32 Which of the following is the importance of molybdenum in plants metabolism-

(1) Carbon assimilation

(2) Nitrate reduction

(3) Plant breeding

(4) Chromosome contraction

Q.33 Phosphorus is a structural element in-

(1) Fat (2) Starch

(3) Nucleotide (4) Carbohydrate

Q.34 The enzyme responsible for the reduction of molecular nitrogen to the level of ammonia in the leguminous root nodule is-

(1) Nitrogenase (2) Nitrate reductase

(3) Nitrite reductase (4) Nitro-ammoniase

Q.35 Which of the following element is used up in phosphorylation-

(1) Calcium and sulphur

(2) Chlorine and maganese

(3) Iron and phosphorous

(4) Magnesium and phosphate

Q.36 The plants accept Zn as-

(1) Zn (2) Zn^{2+}

(3) ZnO (4) $ZnSO_4$

Q.37 Nodules with nitrogen fixing bacteria are present in-

(1) Cotton (2) Gram

(3) Wheat (4) Mustard

Q.38 Micro-nutrients are-

(1) Less important in nutrition than macronutrients

(2) As important nutrition as macro-nutrients

(3) May be omitted from culture media without any detrimental effect on the plant

(4) Called micro because they play only minor role in nutrition

Q.39 Nitrogen is an important constituent of-
(1) Proteins (2) Lipids
(3) Carbohydrates (4) Polyphosphates

Q.40 Legume plants are important because they-
(1) Help in NO_2 fixation
(2) Not help in NO_2 fixation
(3) Increased soil fertility
(4) All of these

Q.41 Tracer elements are-
(1) Micro elements (2) Macro-elements
(3) Radio isotopes (4) Vitamins

Q.42 Which one is Cu^{++} containing pigment-
(1) Ferredoxin (2) Plastocyanin
(3) Plastoquinone (4) Cytochrome

Q.43 Which of the following deficiency may cause leaf tip bending-
(1) Sulphur (2) Nitrogen
(3) Phosphorus (4) Calcium

Q.44 Gray space disease in oats takes place by the deficiency of-
(1) Zinc (2) Copper
(3) Potassium (4) Manganese

Q.45 The number of essential elements required for normal growth of plant is-
(1) 10 (2) 16
(3) 20 (4) 25

Q.46 Important contribution of molybdenum is-
(1) Flower growth
(2) Nitrogen fixation
(3) Chromosome condensation
(4) Carbon fixation

Q.47 Which of the following is not a micro or trace element-
(1) Boron (2) Molybdenum
(3) Manganese (4) Calcium

Q.48 Nodules with nitrogen fixing bacteria are present in roots of-
(1) Cotton (2) Gram
(3) Wheat (4) Maize

Q.49 Insectivorous plants can grow well in a soil deficient in-
(1) Calcium (2) Magnesium
(3) Nitrogen (4) Iron

Q.50 Carrier proteins are involved in-
(1) Passive transport of ions
(2) Active transport of ions
(3) Water transport
(4) Water evaporation

Q.51 Knot like bodies known as 'nodules' found in the roots of groundnut plant are produced by-
(1) Azospirillum (2) Azotobacter
(3) Pseudomonas (4) Rhizobium

Q.52 Which of the following is used as green manure-
(1) Azolla (2) Azadiracta indica
(3) Crotolarea juncea (4) Hevea brassiliansis

Q.53 Symbiotic microorganism is-
(1) Clostridium (2) Azotobacter
(3) Rhizobium (4) Chromatium

Q.54 The plants that grow on saline soils with high concentration of NaCl, $MgSO_4$ and $MgCl_2$ are called-
(1) Succulents (2) Mesophytes
(3) Xerophytes (4) Halophytes

Q.55 The major portion of the dry weight of plants comprises of-
(1) Carbon, hydrogen and oxygen
(2) Nitrogen, Phosphorus and potassium
(3) Calcium, magnesium and sulphur
(4) Carbon, nitrogen and hydrogen

Q.56 Boron in green plants assists in-
(1) Sugar transport
(2) Activation of enzymes
(3) Acting as enzyme cofactor
(4) Photosynthesis

Q.57 Active uptake of minerals by roots mainly depends on-
(1) Light
(2) Temperature
(3) Availability of CO_2
(4) Availability of oxygen

Q.58 The most abundant element present in the plants is -
(1) Carbon (2) Nitrogen
(3) Manganese (4) Iron

Q.59 A metal ion involved in stomatal regulation is-
(1) Iron (2) Potassium
(3) Zinc (4) Magnesium

Q.60 The plant ash is an indication of-

(1) Organic matter of plant

(2) Waste product

(3) Mineral salt absorbed by plants

(4) None of these

Q.61 The deficiencies of micronutrients, not only affects growth of plants but also vital functions such as photosynthetic and mitochondrial electron flow. Among the list given below, which group of three elements shall affect most both photosynthesis and mitochondrial electron transport-

(1) Co, Ni, Mo (2) Ca, K, Na

(3) Mn, Co, Ca (4) Cu, Mn, Fe

Q.62 Farmers in particular region were concerned that premature yellowing of leaves of a pulse crop might cause decrease in the yield. Which treatment could be most beneficial to obtain maximum seed yield?

(1) Application of iron and magnesium to promote synthesis of chlorophyll

(2) Frequent irrigation of the crop

(3) Treatment of the plants with cytocinins along with a small dose nitrogenous fertilizer

(4) Removal of all yellow leaves and spraying the remaining green leaves with 2,4,5-trichlorophenoxy acetic acid

Q.63 Sulphur is an important nutrient for optimum growth and productivity in-

(1) Oilseed crops (2) Pulse crops

(3) Cereals (4) Fibre crops

Q.64 A plant requires magnesium for-

(1) Protein synthesis

(2) Chlorophyll synthesis

(3) Cell wall development

(4) Holding cells together

Q.65 Which one of the following element is not an essential micronutrient for plant growth?

(1) Zn (2) Cu

(3) Ca (4) Mn

Q.66 Which is not macro nutrient element-

(1) Mn (2) Mg

(3) K (4) Ca

ANSWER KEY

EXERCISE - 2

Q.1	3	Q.2	1	Q.3	4	Q.4	1	Q.5	2	Q.6	3	Q.7	1
Q.8	3	Q.9	1	Q.10	1	Q.11	1	Q.12	4	Q.13	2	Q.14	4
Q.15	1	Q.16	4	Q.17	4	Q.18	1	Q.19	3	Q.20	3	Q.21	4
Q.22	3	Q.23	1	Q.24	2	Q.25	4	Q.26	1	Q.27	1	Q.28	1
Q.29	3	Q.30	3	Q.31	3	Q.32	2	Q.33	3	Q.34	1	Q.35	4
Q.36	2	Q.37	2	Q.38	2	Q.39	1	Q.40	3	Q.41	3	Q.42	2
Q.43	1	Q.44	4	Q.45	2	Q.46	2	Q.47	4	Q.48	2	Q.49	3
Q.50	1	Q.51	4	Q.52	3	Q.53	3	Q.54	4	Q.55	1	Q.56	1
Q.57	2	Q.58	1	Q.59	2	Q.60	3	Q.61	4	Q.62	3	Q.63	1
Q.64	2	Q.65	3	Q.66	1								

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Which of the following elements are essential of the photolysis of water : -

[Uttaranchal PMT 2004]

(1) Ca and Cl (2) Mn and Cl

(3) Zn and I (4) Cu and Fe

Q.2 Which of the following is releated with transfer of food material : **[Uttaranchal PMT 2005]**

(1) Xylem (2) Collenchyma

(3) Phloem (4) Parenchyma

Q.3 Which of the following element is most mobile in plant metabolism :

[Uttaranchal PMT 2006]

(1) Calcium (2) Phosphorus

(3) Carbon (4) Magnesium

Q.4 The process of converting ammonia to nitrate by bacteria is known as :

[Uttaranchal PMT 2006]

(1) Ammonification (2) Nitrification

(3) Nitrogen fixation (4) Denitrification

Q.5 Root nodules which are present in plants are meant for fertilizers and are found in/on :

[Uttaranchal PMT 2006]

(1) Certain leguminous plants

(2) Casurina

(3) Alanus

(4) All of the above

Q.6 Agriculturists have reported about 40-50% higher yieds of rice by applying :

[Uttaranchal PMT 2006]

(1) Azolla

(2) Cyanophycean members

(3) Mycorrhizae

(4) Thorn forest

Q.7 A nutrient element essential for the formation of micro-tubules of the mitotic spindle apparatus during cell division is :

[Uttaranchal PMT 2006]

(1) Phosphorus (2) Sulphur

(3) Clacium (4) Zinc

Q.8 Non-symbiotic N_2 fixer is :

[West Bengal JEE 2007]

(1) Anabaena (2) Rhizobium

(3) Azotobactor (4) Azolla

Q.9 The N_2 fixing bacterium associated with root nodules of legumes is known as :

[C.G. PMT 2004]

(1) Azotobacter (2) Nitrobacter

(3) Lactobacillus (4) Rhizobium

Q.10 The bacteria which convert nitrate in to molecular nitrogen is called :**[CGPMT 2004]**

(1) Nitrifying bacteria

(2) Methanobacteria

(3) Diazotrophic bacteria

(4) Denitrifying bacteria

Q.11 The bacterium capable of anaerobic N_2 Fixation is known as : **[C.G. PMT 2004]**

(1) Clostridium (2) Bacillus

(3) Azotobacter (4) Rhizobium

Q.12 Which element is essential for photolysis of water **[C.G. PMT 2004]**

(1) Nitrogen (2) Manganese

(3) Carbon (4) Oxygen

Q.13 Which of the following can utilize molecular nitrogen (N_2) as nutrient for growth

[C.G. PMT 2004]

(1) Rhizobium (2) Spirogyra

(3) Mucor (4) Methancoccus

Q.14 Sinks are related to : **[C.G. PMT 2005]**

(1) Transport of organic solutes

(2) Stomata

(3) Enzymes (4) phytochrome

Q.15 Supply ends in transport of solute are :

[C.G. PMT 2005]

(1) Green leaves and storage organs

(2) Root and stem

(3) Xylem and Pholem

(4) Hormones and enzymes

Q.16 Which of the following is a biofertilizer : **[C.G. PMT 2006]**

(1) Funaria (2) Fern

(3) Anabaena (4) Fungus

Q.17 Mo is related with : **[C.G. PMT 2006]**

(1) N_2 fixation

(2) Flower induction

(3) Chromosome contraction

(4) Carbon collection

Q.18 Which one of the following elements is present in chlorophylls : **[C.G. PMT 2006]**

(1) Manganese (2) Magnesium

(3) Copper (4) Iron

Q.19 Which one of the following bacteria has potential for nitrogen fixation : **[C.G. PMT 2006]**

(1) Nitrosomonas (2) Nitrobacter

(3) Nitrosococcus (4) Rhizobium

Q.20 For nitrogen fixation, pigment useful is : **[Jharkhand 2006]**

(1) Nitrogenase (2) Haemoglobin

(3) Myoglobin (4) Leghaemoglobin

Q.21 Which of the following is symbiotic bacteria : **[Jharkhand 2005]**

(1) Rhizobium (2) Azotobactor

(3) Clotrisdium (4) Streptomyces

Q.22 The metal ion involved in stomatal regulation is **[Bihar 2002]**

(1) Fe (2) Mg

(3) Zn (4) K

Q.23 Legume plants are important for crop production because they : **[UP CPMT 2002]**

(1) Help in NO_2 Fixation

(2) Do not help in NO_2 Fixation

(3) Increase soil fertility

(4) All of these

Q.24 Which of the following is a nitrogen fixing organism **[UP CPMT 2003]**

(1) Some BGA (2) Rhizobium

(3) Both (1) and (2) (4) Aspergillus

Q.25 Which of the following of bacteria is involved in two step conversion of NH_3 into nitrate : **[UP CPMT 2004]**

(1) Azotobacter and nitrosomonas

(2) Nitrosomoans and Nitrobacter

(3) Azotobacter and Achromobacter

(4) Pseudomonas and Nitrobacter

Q.26 A metal ion involved in stomatal regulation is : **[UP CPMT 2004]**

(1) Iron (2) Potassium

(3) Zinc (4) Magnesium

Q.27 The plant ash is an indication of : **[UP CPMT 2005]**

(1) Organic matter of plant

(2) Waste product

(3) Mineral salts absorbed by plants

(4) None of these

Q.28 Plant ash has maximum content of : **[UP CPMT 2006]**

(1) Mg (2) Fe

(3) K (4) B

Q.29 Which of the following is part of cytochrome: **[UP CPMT 2006]**

(1) Mg (2) Zn

(3) Fe (4) Ca

Q.30 Food in plants is translocated in the form of : **[UP CPMT 2006]**

(1) Glucose (2) Starch

(3) Sucrose (4) Fructose

Q.31 Which of the following is not related to N_2 fixation **[UP CPMT 2006]**

(1) Rhizobium (2) Anabaena

(3) Pseudomonas (4) Azotobacter

Q.32 Which of the following is not caused by deficiency of mineral : **[MP PMT 2007]**

(1) Chlorosis

(2) Etiolation

(3) Shortening of internodes

(4) Necrosis

Q.33 The mineral present in cell walls is : **[MP PMT 2007]**

(1) Na (2) Ca

(3) K (4) Mg

Q.34 What happened when we inoculated Rhizobium in wheat field : **[MP PMT 2007]**

(1) No increase in production (nitrogen content of soil remains same)

(2) A lot of increase in production (nitrogen content of soil increase)

(3) Fertility of soil decreases

(4) Fertilite of soil increases

Q.35 Nitrifying bacteria are able to : **[MP PMT 2007]**

(1) Convert atomospheric nitrogen into soluble form

(2) Convert ammonia to nitrate

(3) Ammonia to nitrogen

(4) Nitrate to nitrogen

Q.36 Magnesium is found in : **[MP PMT 2001]**

(1) Chlorophyll (2) Carotenoid

(3) Phycobilin (4) Cytochrome

Q.37 Which of the following is a trace element : **[MP PMT 2001]**

(1) S (2) Mg

(3) Cu (4) P

Q.38 Which one of the following organisms may respire in the absence of oxygen : **[MP PMT 2002]**

(1) Azotobacter (2) Clostridium

(3) Rhizobium (4) Lactobacillus

Q.39 Which of the following is not a trace element : **[MP PMT 2003]**

(1) Zn (2) Mn

(3) Mg (4) Cu

Q.40 Symbiotic microorganism is : **[MP PMT 2003]**

(1) Clostridium (2) Azotobacter

(3) Rhizobium (4) Chromatium

Q.41 Essential mineral nutrients are the element **[MP PMT 2005]**

(1) In the absence of which plants cannot complete their life cycle

(2) Which cannot be replaced by other element in its function

(3) The element which is directly associated with metabolism of the plant

(4) All of the above

Q.42 Stomatal movement is controlled by : **[MP PMT 2005]**

(1) Na (2) Mg

(3) K (4) P

Q.43 Which of the following enzyme fixes nitrogen **[MP PMT 2005]**

(1) Nitrate reductase (2) Nitrogenase

(3) PEP caboxylase (4) Rubisco

Q.44 The bacterium capable of anaerobic nitrogen-fixation is : **[MP PMT 2006]**

(1) Azatobacter (2) Rhizobium

(3) Bacillus (4) Clostridium

Q.45 In plant metabolism phosphorus play a major role to : **[MP PMT 2006]**

(1) Evolve oxygen during photosynthesis

(2) Create aerobic condition

(3) Generate metabolic energy

(4) Evolve carbon dioixde during respiration

Q.46 Photosynthetic food material is transported in the form of : **[MP PMT 2006]**

(1) Glusose (2) Sucrose

(3) Starch (4) Fructose

Q.47 Chlorosis is caued due to deiciency of **[MP PMT 2006]**

(1) Mg (2) Ca

(3) B (4) Mn

Q.48 The major portion of the **dry weight** of plants comprises of : - **[AIPMT-2003]**

(1) Nitrogen, phosphorus and potassium

(2) Calcium, magnesium and sulphur

(3) Carbon, nitrogen and hydrogen

(4) Carbon, hydrogen and oxygen

Q.49 Which one of the following mineral elements plays an important role in biological nitrogen fixation ? **[AIPMT-2003]**

(1) Copper (2) Manganese

(3) Zinc (4) Molybdenum

Q.50 Stomata of CAM plants : - **[AIPMT-2003]**

(1) Are always open

(2) Open during the day & close at night

(3) Open during the night & close during the day

(4) Never open

Q.51 Stomata of a plant open due to : -
[AIPMT-2003]

(1) Influx of potassium ions

(2) Efflux of potassium ions

(3) Influx of hydrogen ions

(4) Influx of calcium ions

Q.52 Plants deficient of element zinc, show its effect on the biosynthesis of plant growth hormone
[AIPMT-2003]

(1) Auxin (2) Cytokinin

(3) Ethylene (4) Abscisic acid

Q.53 In which one of the following is nitrogen not a constituent ? **[AIPMT-2003]**

(1) Idioblast

(2) Bacteriochlorophyll

(3) Invertase

(4) Pepsin

Q.54 Gray spots of Oat are caused by deficiency of-
[AIPMT-2003]

(1) Cu (2) Zn

(3) Mn (4) Fe

Q.55 The most abundant element present in the plants is - **[AIPMT-2004]**

(1) Iron (2) Carbon

(3) Nitrogen (4) Maganese

Q.56 The ability of the Venus Flytrap to capture insects is due to - **[AIPMT-2005]**

(1) Chemical stimulation by the prey

(2) A passive process requiring no special ability on the part of the plant

(3) Specialized "muscle-like" cells

(4) Rapid turgor pressure changes

Q.57 The deficiencies of micronutrients, not only affects growth of plants but also vital functions such as photosynthetic and mitochondrial electron flow. Among the list given below, which group of three elements shall affect most,both photosynthetic and mitrochondrial electron transport : **[AIPMT-2005]**

(1) Cu, Mn, Fe (2) Co, Ni, Mo

(3) Mn, Co, Ca (4) Ca, K, Na

Q.58 Potometer works on the principle of :
[AIPMT-2005]

(1) Amount of water absorbed equals the amount transpired

(2) Osmotic pressure

(3) Root pressure

(4) Potential difference between the tip of the tube and that of the plant

Q.59 Farmers in a particular region were concerned that pre-mature yellowing of leaves of a pulse crop might cause decrease in the yield. Which treatment could be most beneficial to obtain maximum seed yield **[AIPMT-2006]**

(1) Removal of all yellow leaves and spraying the remaining green leaves with 2,4,5-trichlorophenoxy acetic acid

(2) Application of iron and magnesium to promote synthesis of chlorophyll

(3) Frequent irrigation of the crop

(4) Treatment of the plants with cytokinins alongwith a small dose of nitrogenous fertilizer

Q.60 Sulphur is an important nutrient for optimum growth and productivity in **[AIPMT-2006]**

(1) Fibre crops (2) Oil seed crops

(3) Pulse crops (4) Cereals

Q.61 A plant requires magnesium for :
[AIPMT-2007]

(1) Cell wall development

(2) Holding cells together

(3) Protein synthesis

(4) Chlorophyll synthesis

Q.62 Which of the following is a flowering plant with nodules containing filamentous nitrogen-fixing microoganism ? **[AIPMT-2007]**

(1) Cicer arietinum

(2) Casuarina equisetifolia

(3) Crotalaria juncea (4) Cycas revoluta

Q.63 About 98 percent of the mass of every living organism is composed of just six elements including carbon, hydrogen, nitrogen oxygen and : **[AIPMT-2007]**

(1) Calcium and phosphorus

(2) Phosphorus and sulphur

(3) Sulphur and magnesium

(4) Magnesium and sodium

Q.64 Which one of the following elements is not an essential micronutrient for plant growth ? **[AIPMT-2007]**

(1) Ca (2) Mn

(3) Zn (4) Cu

Q.65 Carbohydrates are commonly found as starch in plant storage organs. Which of the following five properties of starch (a–e) make it useful as a storage material ? **[AIPMT-2008]**

(I) Easily translocated

(II) Chemically non-reactive

(III) Easily digested by animals

(IV) Osmotically inactive

(V) Synthesized during photosynthesis

The useful properties are-

(1) (I), (III) and (V) (2) (I) and (V)

(3) (II) and (III) (4) (II) and (IV)

Q.66 Nitrogen flxation is root nodules of Anlus is brought about by : - **[AIPMT-2008]**

(1) Frankia (2) Azorhizobium

(3) Bradyrhizobium (4) Clostridium

Q.67 Guard cells help in : - **[AIPMT-2009]**

(1) Fighting against infection

(2) Protection against grazing

(3) Transpiration (4) Guttation

Q.68 Manganese is required in : - **[AIPMT-2009]**

(1) Chlorophyll synthesis

(2) Nucleic acid synthesis

(3) Plant cell wall formation

(4) Photolysis of water during photosynthesis

Q.69 An element playing important role in nitrogen fixation is- **[AIPMT-2010 (Pre)]**

(1) Manganese (2) Zinc

(3) Molybdenum (4) Copper

Q.70 Which one of the following is not a micronutrient? **[AIPMT-2010 (Pre)]**

(1) Zinc (2) Boron

(3) Molybdenum (4) Magnesium

Q.71 The chief water conducting elements of xylem in gymnosperms are- **[AIPMT-2010 (Pre)]**

(1) Transfusion tissue (2) Tracheids

(3) Vessels (4) Fibres

Q.72 Which one of the following structures between two adjacent cells is an effective transport pathway? **[AIPMT-2010 (Pre)]**

(1) Endoplasmic reticulum

(2) Plasmalemma

(3) Plasmodesmata

(4) Plastoquinones

Q.73 One of the free-living, anaerobic nitrogen-fixer is- **[AIPMT-2010 (Pre)]**

(1) *Rhizobium*

(2) *Azotobacter*

(3) *Beijernickia*

(4) *Rhodospirillum*

Q.74 The common nitrogen-fixer in paddy field is- **[AIPMT-2010 (Pre)]**

(1) *Oscillatoria*

(2) *Frankia*

(3) *Rhizobium*

(4) *Azospirillum*

Q.75 Transport of food material in higher plants takes place thrugh : **[AIPMT-2010 (Mains)]**

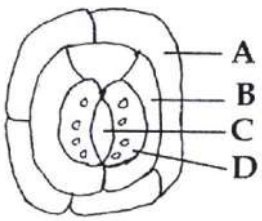
(1) Transfusion tissue

(2) Tracheids

(3) Sieve elements

(4) Companion cells

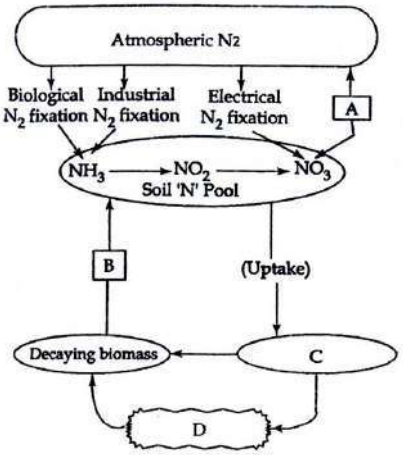
Q.76 Given below is the diagram of a stomatal apparatus. In which of the following all the four parts labelled as A, B, C and D are correctly identified? **[AIPMT-2010 (Mains)]**



	A	B	C	D
(1)	Guard cell	Stomatal aperture	Subsidiary cell	Epidermal cell
(2)	Epidermal cell	Guard cell	Stomatal aperture	Subsidiary cell
(3)	Epidermal cell	Subsidiary cell	Stomatal aperture	Guard cell
(4)	Subsidiary cell	Epidermal cell	Guard cell	Stomatal aperture

Q.77 Study the cycle shown below and select the option which gives correct words for all the four blanks A, B, C and D.

[AIPMT-2010 (Mains)]



Option :

	A	B	C	D
(1)	Dentrification	Ammonification	Plants	Animals
(2)	Nitrification	Dentrification	Animals	plants
(3)	Dentrification	Nitrification	Plants	Animals
(4)	Nitrification	Ammonification	Animals	plants

Q.78 Leguminous plants are able to fix atmospheric nitrogen through the process of symbiotic nitrogen fixation. Which one of the following statements is not correct during this process of nitrogen fixation? **[AIPMT-2010 (Mains)]**

(1) Nodules act as sites for nitrogen fixation

(2) The enzyme nitrogenase catalyses the conversion atmospheric N_2 to NH_3

(3) Nitrogenase is insensitive to oxygen

(4) Leghaemoglobin scavenges oxygen ans is pinkish in colour.

Q.79 Which one of the following is correctly matched? **[AIPMT Pre 2012]**

(1) Apoplast - Plasmodesmata

(2) Potassium - Readily immobilisation

(3) Bakane of rice seedlings - F. Skoog

(4) Passive transport of nutrients - ATP

Q.80 Which one of the following is wrong statement ? **[AIPMT Pre 2012]**

(1) Root nodule forming nitrogen fixers live as aerobes under free-living conditions.

(2) Phosphorus is a constituent of cell membranes, certain nucleic acids and all proteins.

(3) *Nitrosomnas* and *Nitrobacter* are chemoautotrophs

(4) *Anabaena* and *Nosloc* are capable of fixing nitrogen in free-living state also.

Q.81 A nitrogen-fixing microbe associated with *Azolla* in rice fields is : **[AIPMT Pre 2012]**

(1) *Anabaena* (2) *Frankia*

(3) *Tolypothrix* (4) *Spirulina*

Q.82 Best defined function of Manganese in green plants is : **[AIPMT Pre 2012]**

(1) Calvin cycle (2) Nitrogen fixation

(3) Water absorption (4) Photolysis of water

Q.83 For its activity, carboxypeptidase requires : **[AIPMT Mains 2012]**

(1) Zinc (2) Iron

(3) Niacin (4) Copper

Q.84 For its action, nitrogenase requires : **[AIPMT Mains 2012]**

(1) High input of energy

(2) Light (3) Mn^{2+}

(4) Super oxygen radicals

ANSWER KEY

EXERCISE - 3

Q.1	2	Q.2	3	Q.3	2	Q.4	2	Q.5	4	Q.6	1	Q.7	3
Q.8	3	Q.9	4	Q.10	4	Q.11	1	Q.12	2	Q.13	1	Q.14	1
Q.15	1	Q.16	3	Q.17	1	Q.18	2	Q.19	4	Q.20	4	Q.21	1
Q.22	4	Q.23	3	Q.24	3	Q.25	2	Q.26	2	Q.27	3	Q.28	1
Q.29	3	Q.30	3	Q.31	3	Q.32	2	Q.33	2	Q.34	1	Q.35	2
Q.36	1	Q.37	3	Q.38	2	Q.39	3	Q.40	3	Q.41	4	Q.42	3
Q.43	2	Q.44	4	Q.45	3	Q.46	2	Q.47	1	Q.48	4	Q.49	4
Q.50	3	Q.51	1	Q.52	1	Q.53	1	Q.54	3	Q.55	2	Q.56	4
Q.57	1	Q.58	1	Q.59	2	Q.60	2	Q.61	4	Q.62	2	Q.63	2
Q.64	1	Q.65	4	Q.66	1	Q.67	3	Q.68	4	Q.69	3	Q.70	4
Q.71	2	Q.72	3	Q.73	4	Q.74	4	Q.75	3	Q.76	3	Q.77	1
Q.78	3	Q.79	2	Q.80	2	Q.81	1	Q.82	4	Q.83	1	Q.84	1

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

PHOTOSYNTHESIS

HISTORY

- **Aristotle and Theophrastus (320 BC) :** (Humus theory) Believed that plants take their nourishment both inorganic and organic from the soil .
- **Van Helmont (1648)** : (Water theory) He worked on ***Salix plant*** & concluded that plants grow & gain weight by absorbing water from soil. He planted a twig of known weight in 200 lbs of soil & watered the plant by measured amount of rain water. After few years he weighted the plant & found that weight has increased to a large amount. But the weight of the soil was slightly reduced. He suggested that the increase in plant substances of the willow tree must have come from water alone.
- **John Woodward (1699) :** (Soil water theory) According to him plants grow or gain weight by soil & water both.
- **Stephen Hales (1727) :** He wrote a book **'vegetable staticks'** & said that green plants make food with the help of leaf.
- **Joseph Priestley (1772) :** He reported about purification of air as plants release oxygen. He performed the experiment using mice, mint plant & candle Firstly, he placed mice in a closed bell jar & observed that after sometime the mice dies or the burning candle extinguishes in the jar. Secondly, he placed a plant twig in a closed bell jar & observed that after sometime plant twig dies. But when he placed both plant & mice together, they survived because their is a balance between CO_2 & O_2. He called the air produced by candle as **'Phlogiston'** & said that plant convert it into **dephlogiston** or purify it.
- **J. Ingenhousz (1779) :** (Light theory). He told about the utility of light & said that plants purify air only in the presence of light.
- **Jean Senebier (1782) :** He concluded that green plants take CO_2 & release O_2 in presence of light.
- **Lavoisier (1783)** : He supported the work of J.Senebier. He identified **CO_2 as the impure air**.
- **N. Theodore de Saussure (1818) -** found the **utility of water**. Besides this he gave other facts also (i) CO_2 & not organic acid is absorbed. (ii) By CO_2 absorption, O_2 is released and (iii) found that red **wavelength** of light is the most effective in the light spectrum.
- **Pelletier and Caventou (1818) :** He discovered green colour & called it as **chlorophyll**. It can be separated by boiling in alcohol.
- **Liebig** (1840) found that (i) All organic substances get carbon from CO_2. (ii) He proposed the **law of effectiveness of minimal factor** in 1845.
- **Robert Mayer** (1845) found that green plants utilise **solar energy** to convert it into **chemical energy.**
- **Sachs** (1860) gave the concept of **Cardinal Points**.
- **Julius Von Sachs** (1862) mentioned the **first visible product** of photosynthesis to be **starch** and in photosynthesis, **chloroplast** as site of absorption of CO_2 and release of O_2.
- **G.G. Stocks** (1864) isolated chlorophyll-a and chlorophyll-b in pure form. He also indicated about the existence of Chl.-c.
- **Bossingault** (1864) found assimilatory coefficient O_2 / CO_2 as 1.
- **Engelmann** (1888) drew **action spectrum** of chlorophyll.
- **Pfeffer** (1897) found O_2 released from plants to be slightly more than CO_2.

- **F.F. Blackman** (1905) mentioned the occurrence of **light** and **dark**, two types of reactions. He expanded Liebig's **law of minimal factors** to **law of limiting factors**.
- **Willstater and Stahll** gave the detailed chemical structure and function of chlorophyll in "**Investigation on chlorophyll**".
- **Warburg** (1920) used single celled alga, **Chlorella** for photosynthesis.
- **Van Neil** (1931) studied bacterial phtosynthesis and drew many conclusions (1) They use H_2S (2) O_2 is not released in bacterial photosynthesis but S is released (3) In green plant, O_2 is liberated from H_2O.
- **Emerson & Arnold** (1932) reported **light reaction** occuring in two steps.
- **Hill** isolated **chloroplasts** from a plant ***Stellaria media*** and found liberation of O_2 in the absence of CO_2 and in the presence of a hydrogen acceptor and light. This is called **Hill's reaction**. This proved that O_2 is not liberated from CO_2.
- **Ruben, Kamen, Hassid** (1941) using radio active O^{18} proved that **source of oxygen is water**.
- **Emerson & Lewis** mentioned **red drop**.
- **Arnon et al,** In 1954 **photophosphorylation** was discovered.
- **Emerson** (1957) proposed **Emerson's enhancement effect**.
- **Calvin** (1955) found CO_2 fixation as a cyclic process. It is called by the names of **C_3 cycle**, **(Calvin cycle)**. He was awarded the Noble prize for his work in 1961.
- **Kortschak** et al (1965) found the **first product of CO_2 fixation** in tropical plants, a **4-C compound**. It is called **C_4 path**.
- **Hatch & Slack** (1967) discovered **C_4 cycle**.
- **Dowton & Treguan** established relationship between C_4 cycle and Kranz anatomy. Kranz in Kranz anatomy means a **ring**. Cells are found in **two well defined rings** in leaves with **Kranz anatomy.**
- **Huber, Michel and Dissenhofer** (1985) crystallized photosynthetic centre of **Rhodobacter bacterium** and its chemical structure. They were awarded the Nobel prize for this in 1988.

INTRODUCTION

- The most significant physio biochemical process on which the existence of life on earth is dependent is the process of **photosynthesis**
- Every living organism directly or indirectly derives its energy in form of 'food' by this process.
- "Photosynthesis is a photo-biochemical process **(anabolic & endergonic)** in which compounds (carbohydrates) are synthesised from the inorganic **raw material (H_2O & CO_2)** in presence of light and pigments. O_2 is evolved as a by product".
- **Light energy is conserved into chemical energy by photosynthesis.**

$$6CO_2 + 12H_2O \xrightarrow[\text{Light}]{\text{Pigment}} C_6H_{12}O_6 + 6O_2 \uparrow + 6H_2O$$

Oxidation/light reaction

Reduction/dark reaction

- 90% of total photosynthesis is carried out by **aquatic plants** (85% algae) & 10% by land plants.
- First true & oxygenic photosynthesis started in **cyanobacteria**. (BGA)
- In the **Cuscuta & fungi** photosynthesis is absent. **Euglena** is photosynthetic organism & link between animal & plants.
- Roots of **Tinospora & Trapa** are assimilatory or photosynthetic.

✸ **Significance of photosynthesis-**

- Photosynthesis is vital process for life on planet earth as it is the only process, that links the physical and biological world by conservation of solar energy into organic matter, which make bulk of the dry matter of any organism.
- Presence of O_2 in the atmosphere is also an outcome of photosynthesis. This oxygen is helpful to living organisms in two ways.

(1) Oxidative break down of organic food matter (respiration).

(2) Making ozone (O_3), in outer layer of atmosphere, which helps in stopping the highly destructive U.V. rays.

PHOTOSYNTHETIC REQUIREMENTS

✸ **Carbondioxide/CO_2 :**

- It comes from atmosphere (0.03%/300-350 PPM conc.)
- Gaseous exchange in plants mainly occurs through stomata. Also by general body surface and lenticels.
- It's assimilation occur into glucose during dark reaction by utilization of assimilatory power. i.e., ATP & $NADPH_2$ (Reducing Power)
- Reduction of CO_2 occurs during dark reaction by $NADPH_2$ (Reducing power)
- CO_2 acceptor in plants are and .
- Addition of CO_2 is called carboxylation. It is catalysed by enzymes **Rubisco** & **PEPcase**.
- Present level of atmospheric CO_2 is limiting factor for C_3 & CAM plants, not for C_4 plants.

✸ **Water :**

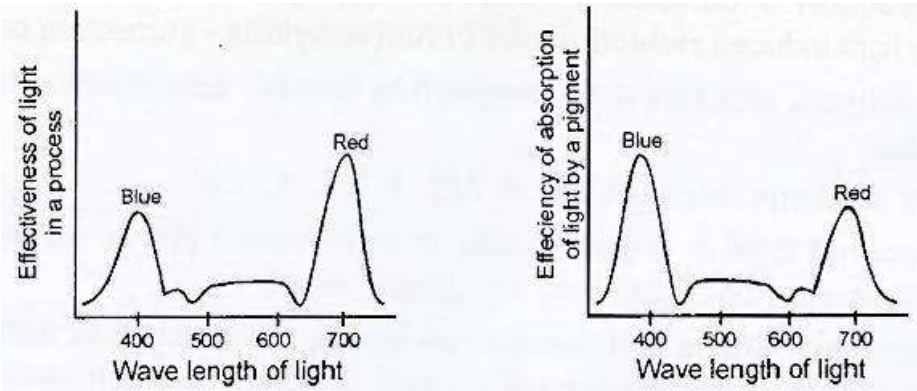
- Comes from soil.
- Absorbed by roots/root hairs and transported by water counducting tissue xylem.
- Only 1% of total water absorbed is utilized in photosynthesis.
- Oxidation of H_2O take place during ligtht reaction of photosynthesis as it provide H^+ & e^-.
- (Source of H^+ & e^-). H^+ & e^- donated by H_2O are transfered by NADP ($NADP+ H^+ + e^- \rightarrow NADPH_2$) to CO_2. So $NADPH_2$ do the reduction of CO_2 and called as **reducing power.**
- Light plays important role in oxidation of water so it is called as **photolysis of water** (R.Hill)
- O_2 released from water was first stated by C.B.Van neil and experimentally proved by Ruben, Kamen, Hassid (use of O^{18})
- Bacterial photosynthesis is non oxygenic as H_2O is not utilized as source of H^+ & e^-. First oxygenic photosynthesis by cyanobacteria as utilized H_2O as doner of H^+ & e^-.

✸ **Sunlight :**

- All kind of light wavelengths are present in sunlight **(Polychromatic & Continuous)** and available for photosynthesis but it depends on the type of pigment content of photosynthetic organism. Most of photosynthetic organism used **visible light** in their photosynthesis **(PAR-400-700nm)**.

UV	Visible	IR
Used by red algae	(400-700nm) PAR used by most of photosynthetic organisms	Used by photosynthetic bacteria

- Only 1% of total absorbed light is utilized in photosynthesis.
- Helps in oxidation of H_2O/Photolysis of water during light reaction. So directly involved in light reaction and indirectly in dark reaction.
- The only source of energy for all living organisms. It is avilable for all organisms specially chemohetrotrophs as conserved into chemical energy by photosynthesis.
- **Action spectrum -** Graph plotted between effectiveness of light in particular process against the wavelength of light. Action spectrum of photosynthesis is **Red** & **Blue.** Given by Englemann **(Experiment on Cladophora)**.
- **Absorption spectrum -** Graph plotted between the effeiciency of absorption of light during a process by pigment against the wavelength of light.
- Absorption spectrum of chlorophyll 'a' is **Blue** & **Red.**



- Rate of photosynthesis is higher in Red wavelength of light, but **highest in white light** (Full spectrum), than monochromatic light.

✸ **Chloroplast :**

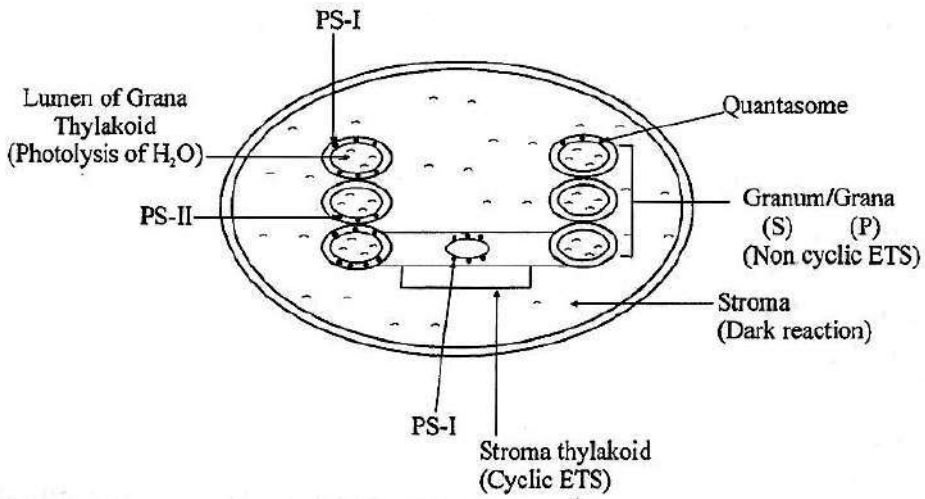


Fig.: Chloroplast

- **Chloroplast** is the main site of photosynthesis
- Inside chloroplast, **thylakoids** plays the leading role in photosynthesis
- Cyanobacteria & other photosynthetic bacteria lack chloroplast. They have pigments located on thylakoids like structure called **chlorosome**/**carboxysome**/**lamelisome**/**chromatophores** which exist freely in the cytoplasm.

✸ **Photosynthetic pigments :**

- Eukaryote & Prokaryote both possess different types of photosynthetic pigments.
- These pigments are organic substances which absorb light of specific wavelength in the visible region of spectrum.
- Being fat soluble these pigments are located in **lipid part of thylakoid**.
- Mainly there are 3 types of photosynthetic pigments-chlorophyll,carotenoid & phycobilin.

✸ **Chlorophyll -** Green colour pigments

- **Arnoff & Allen** distinguished 9 types - chlorophyll a, b, c, e, bacteriochlorophyll a, b; bacteriovirdin or chlorobium chlorophyll.
- **Biosynthesis of chlorophyll :**

(a) In plants **glycine + succinyl Co-A** start synthesis of chlorophyll. They are **first precursor** for chlorophyll synthesis.

(b) After a series of reaction a compound **Protochlorophyllide** is formed. It is pale in colour Protochlorophyllide by light induced **reduction** gives **chlorophyllide** - immediate precursor of chlorophyll.

(c) To chlorophyllide, phytol gets attached & **chlorophyll** is formed. Esterification of chlorophyllide leads to chlorophyll formation.

(d) Chlorophyll synthesis in plants require light, N, Mg, S, Fe, K, Ca.

(e) For formation of chlorophyll **light is required only in angiosperm** plants, others can form chlorophyll even in absence of light **eg :** Gymnosperm, Bryophyta, Algae.

(f) **Exception in Angiosperm - Citrus** & **Nelumbo can forms chlorophyll in dark**. If Angiosperm plant is kept in dark starting from germination it will be pale in colour & undifferentiated. Such plants are termed as **etiolated** & the process as **etiolation**.

(g) **Chlorosis -** It is due to **deficiency** of minerals or even by **viral attack**.

- **Structure :** The detailed structure was elucidated by **Willstatter & Stahll (1913, 1918)**.
- All chlorophylls are basically similar in structure, all have 2 parts - **Porphyrin head** & **phytol tail**.
- **Porphyrin head** is squarish, having 4 pyrrole rings attached with each other by methane bridges. Each ring has 4 C & 1 N.
- All 4 rings are linked to Mg in the centre

Note : Chl-C does not has phytol chain

Chlorobium chlorophyll is a derivative of bacterio chlorophyll.

Chl - a = $C_{55}H_{72}O_5N_4$ Mg

Chl - b = $C_{55}H_{70}O_6N_4Mg$

Chl - c = $C_{25}H_{32}O_5N_4Mg$

Chl - d = $C_{54}H_{70}N_4Mg$

✸ **Carotenoids :**

- Yellow, brown, red, orange colour pigments.
- Light is not required for their synthesis.
- They protect Chlorophyll from destruction due to photo-oxidation & hence called **protective pigments**.
- They acts as **accessory pigments** as they trap light energy.
- They also occur in chromoplast of flower & fruits & made them attractive for animals & thus help in pollination.
- Etiolated plants have colour of carotenoids. Deciduous or temperate forest called as **colourful forests**.
- **Carotenoids are of 2 types :**

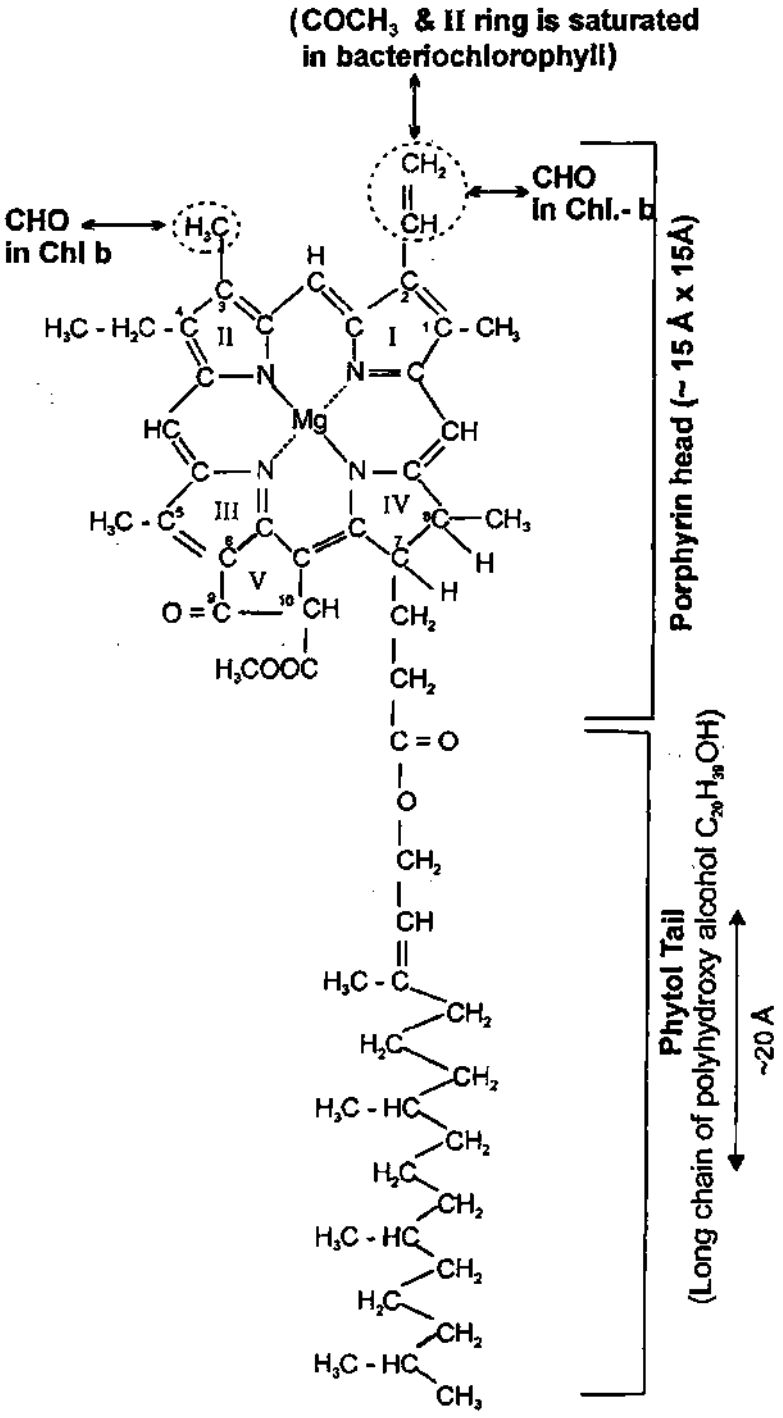
(A) ***Carotenes***

- They are hydrocarbons having formula $\mathbf{C_{40}H_{56}}$.
- Basic carotene is **lycopene** which is found in tomato, chilly, rose & purple bacteria.

- These are isomers of lycopene which are **orange yellow** in colour.
- There are **3 main isomers of carotenes** α, β, γ. **β-carotene** is the most common and generally present in **chloroplast**.
- In animals , **β-carotene** is converted into **vitamin A** and plants form **abscisic acid (ABA)**.

(B) ***Xanthophylls*** **(*Carotenols*)**

- **Yellow**, **brown** in colour
- They are **oxygen derivative of carotenes** (oxygen 1 - 8 %)
- In animals in corpus leutum **lutins** are present.
- Other eg are zeaxanthin, violaxanthin, cryptoxanthin, flavoxanthin, fucoxanthin (brown colour).



STRUCTURE OF CHLOROPHYLL–a

✵ **Phycobilins :**

- Found in red, blue green algae & cryptomonads
- They are of 3 types :

  Phycocyanin (blue), **Phycoerythrin** (red) & **Allophycocyanin** (green)
- Cryptomonads lack allophycocyanin, red & blue green algae has all the three types.
- Phycobilin are conjugated to proteins therefore called **phycobiliproteins** or biliproteins
- These pigments are closely associated with thylakoids in form of granules or microbodies, hence called as **phycobilisomes**.
- Phycobilisome of higher plants is **phytochrome** (no relation with photosynthesis). But used in stomatal movement, photomorphogenesis, photoperiodism.
- Structure : Here **4 pyrrole rings** are linked to each other in linear array.

Arrangement of photosynthetic pigments, Photosynthetic unit or pigment system or light harvesting particles :

- Photosynthetic pigments do not remain in scattered form in thylakoid instead they arrange themselves in **groups or clusters.**

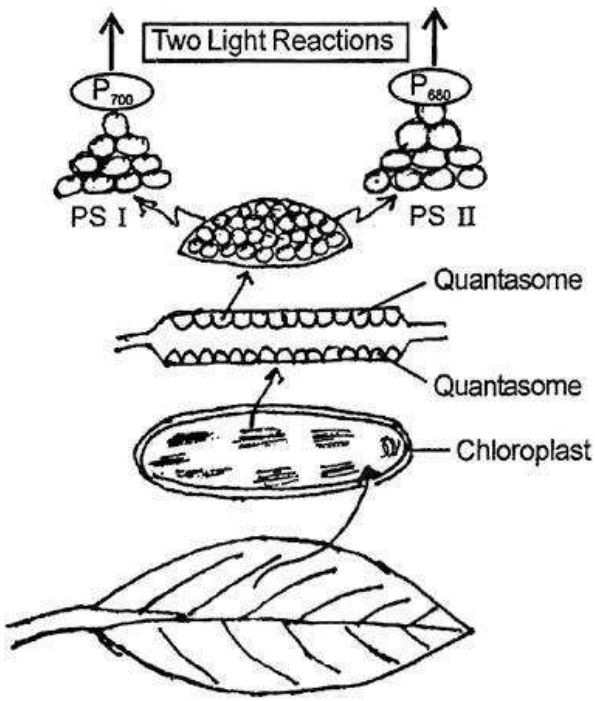


Fig : Arrangement of photosynthetic pigments

- The no. of pigment molecules required to produce a desired photochemical reaction, together constitute a **single photosynthetic unit or quantasome**.
- One unit consist of approx. **230 chlorophyll molecule** along with accessary pigments or harvesting pigments.
- In each group or unit there is a special molecule which on absorption of specific wavelength produces a desired photochemical event. This molecule is called as **"Reaction centre"** molecule.
- All the other molecules serves as secondary centres which transmits their energy to the reaction centre.These are called as **harvesting pigments** or **antenna pigments** which help in trapping energy.
- **Park & Biggins** (1964) noticed the distinct morphological structures on thylakoid membranes & named them as **quantasome**.

- Carotenoids help in **photolysis of water**. During light reaction carotenoids convert elemental oxygen to molecular oxygen. This occurs in 2 steps :

  (a) Carotenoids receive elemental oxygen (2 O) & convert it into colourless compound **epoxide**.

  (b) Epoxide with help of enzyme **deepoxidase** liberates oxygen in **molecular** form + carotenoids (colourful again)

$$2[O] + \text{Carotenoid} \longrightarrow \text{Epoxide} \quad O_2 + \text{Carotenoids}$$

TWO PIGMENT SYSTEMS / LIGHT HARVESTING COMPLEX

(Photosystem-I or PS/LHC-I & Photosystem II or PS/LHC-II)

- In green plants, PS-I contains a single molecule of reaction centre - P_{700} or Chl-a_{700} , Chl-b, 200-400, 50 carotenoids, 2 Fe containing proteins i.e. Fe-S proteins. It works on more than 680 or 700 nm of light.
- PS-II contains, a single molecule of reaction centre - P_{680} or Chl-a_{680}, lesser no. of Chl-b, i.e. 200 molecules, 50 carotenoids, quinone, Mn^{2+} , Cl^{-} & water oxidising enzyme. It works on less than 680 nm to 680 nm.
- PS-I is located on both **stroma thylakoids** and **grana thylakoids** while PS-II is located only on **grana thylakoids**.
- Light energy absorbed by pigments in the two systems is trapped by P_{700} & P_{680} forms of Chl-a which further take part in photochemical reaction.
- PS-I is involved in both **cyclic and non-cyclic photophosphorylation** while PS-II is involved in **only non-cyclic photophosphorylation**.

IMPORTANT SCIENTIFIC CONTRIBUTION

- According to **Van Niel,** oxygen comes from water in photosynthesis.

$$6CO_2 + 12H_2S \longrightarrow C_6H_{12}O_6 + 12S + 6H_2O$$

- **Ruben, Hassid** and **Kamen (1941) :-** Used $\mathbf{O^{18}}$ to show experimentally that O_2 in photosynthesis comes from water.

$$6CO_2^{16} + 12H_2O^{18} \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6^{16} + 6O_2 + 6O_2^{18}$$

- **Existence of two steps in Photosynthesis :**

- **Blackman** discovered dark reaction (By study of $\mathbf{Q_{10}}$ value or temperature coefficient). Experiment on Chlorella.

  Calvin and **Benson** gave cyclic pathway for this, thus dark reaction is called as **Calvin cycle** or **C_3-cycle.**

- Q_{10} (Temperature coefficient) for **light reaction is one,** while Q_{10} for **dark reaction is between 2-3.** (By Vont Hoff).
- Q_{10} means the doubling of rate of reaction, which involves chemicals, on 10ºC rise in temperature in it's optimum range.
- Experimental evidences for Blackman findings were given by **Wardburg (1920)**. He carried out **intermittent light experiment of Chlorella.** (by using flash light)

- The rate of photosynthesis has been found greater in **intermittent light**.(i.e., light given after intervals of dark periods) than in continuous light.
- This is due to the fact that light reactions are faster than the dark reaction.
  In continuous light product of light reactions (**ATP** and **$NADPH_2$**) are not consumed at the same rate as in subsequent dark reaction. Thus dark reaction is rate limiting step of photosynthesis.
- Photosynthesis - (i) Light reaction / Hill reaction (ii) Dark reaction / Blackman reaction
- **Hill Reaction -** Experiment on isolated chloroplast (**Stelaria** plant) study of light reaction, which is called as **Hill Reaction**.
  O_2 gas liberated from **photolysis of H_2O,** only in the presence of suitable e^- acceptor. **(DCPIP** (Dichlorophenol Indophenol-a dye), **ferricyanide, $NADP^+$— Hill reagents**)

$$\frac{1}{2}O_2 \longleftarrow \overset{\text{Light}}{\boxed{H_2O}} \swarrow\!\!\searrow \begin{matrix} 2H^+ \\ 2e^- \end{matrix} + NADP^+ \longrightarrow NADPH_2$$

- **Emerson & Arnold -** Worked on **Chlorella** and gave the concept of **two photosystem** or two pigment systems.
  When they gave monochromatic light, longer than 680 nm wavelength, then quantum yield is suddenly dropped down, this event is called as **red drop**.
- When Emerson gave light, shorter and greater than 680 nm (combined light) then photosynthetic, activity increases, this is called as **Emerson effect** or **enhancement effect**.
  (i) 680 nm↑ ⇒ PS-I (Cyclic process) **red drop appears**.
  (ii) 680 nm↓ + 680↑ nm (Mixed light) ⇒ Both cyclic and non cyclic ETS operates. **(Emerson effect)**

✵ **Quantum requirement-**

The number of light Quanta or photons required for the evolution of 1 mol. of O_2 in photosynthesis = 8

✵ **Quantum Yield-**

The number of oxygen molecule evolved by one quantum of light in photosynthesis is called as **Quantum yield.** Emerson calculated that the quantum requirement is 8. Hence the quantum yield is 1/8 = 0.125 or 12.5%.

- **Arnon's experiment (Chlorella) -**

Discovered cyclic and non-cyclic ETS or photophosphorylation (ADP + iP $\xrightarrow[\text{Chl.}]{\text{light}}$ ATP.)

MECHANISM OF PHOTOSYNTHESIS

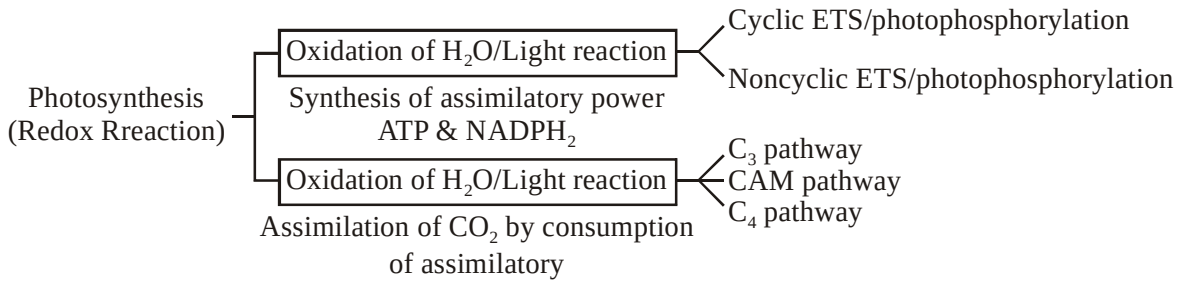
- Photosynthesis is basically an **oxidation - reduction reaction** occurring between water & CO_2.
- Removal of H^+ and e^- from water is oxidation of water & joining of H^+ and e^- with CO_2 is reduction of CO_2. **Photochemical reduction of CO_2** is called photosynthesis.
- Photosynthesis is divided in 2 main steps - **Light reaction & Dark reaction.**

$$6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Oxidation/light reactoin

Reduction/dark reactoin

UNDERSTANDING PHOTOSYNTHESIS :



Light reaction / Hill reaction / Photochemical reaction / Generation of assimilatory powers ($NADPH_2$ + ATPs) / Photophase.

- During the light reaction, the primary function of the two pigment systems/photosystems is interact with each other to trap light energy and convert it into the chemical energy (ATP). These reactions are cyclic and non cyclic types.
- Antenna or accessory pigments receive radient energy and transfer it among themselves. This transfer of energy is known as **resonance transfer.** Then antenna molecules excited and transfer their energy to the chlorophyll 'a' molecules of **reaction centre**.

  It is known as **inductive resonance**. Finally chl. 'a' molcules converts the **light energy into electrical energy** by bringing about **electric charge separations**.

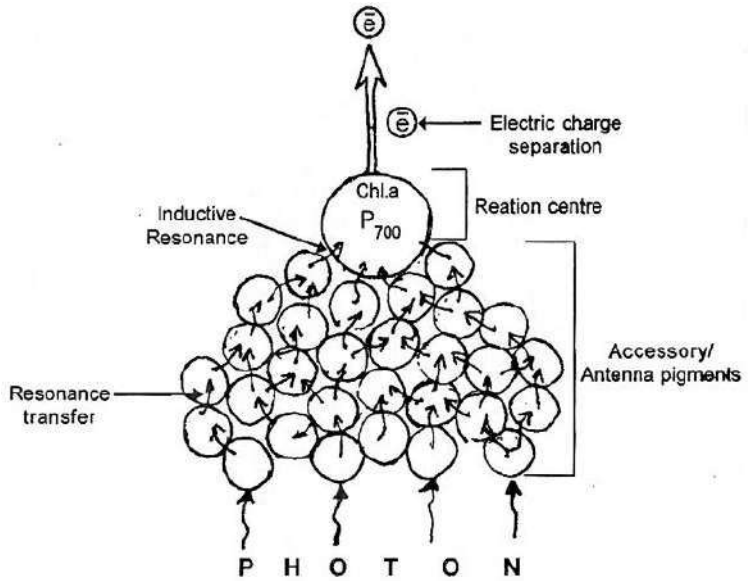
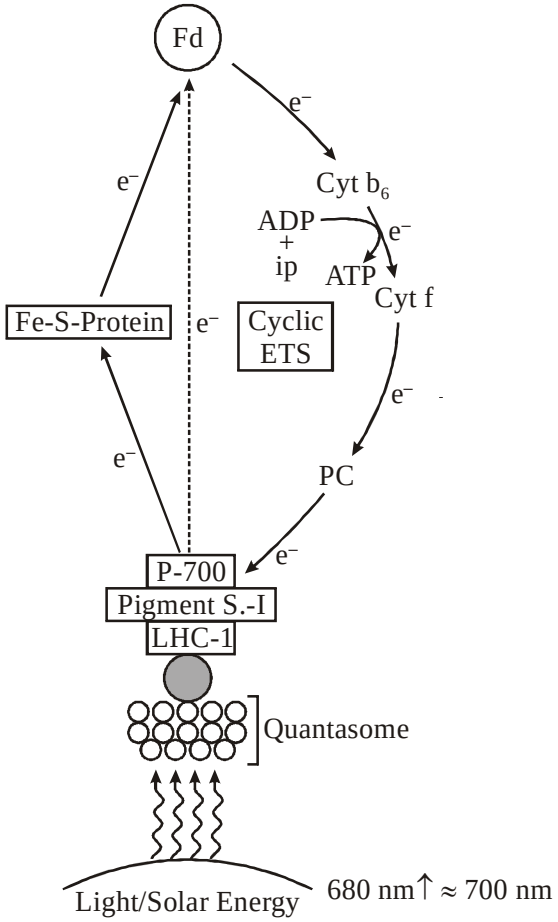


Fig : Pigment System / Light Harvesting Complex (LHC)

✸ Cyclic photophosphorylation/ETS :

- In this pathway only **PS-I is involved.** It occurs naturally only on stroma thylakoid but experimentally can occurs on both stroma and grana thlakoids.
- Reaction centre of PS-I activated by wavelength of light more than 680 nm or equal to 700 nm.
- In this pathway the electron released from the photosystem is received back after moving through electron carriers.
- In cyclic pathway only ATP is formed, by photophosphorylation.
- In this type of ETS first of all the reaction centre of PS-I i.e. P_{700} gets excited releasing an electron which is accepted by first electron carrier **ferrodoxin (Fd)**.

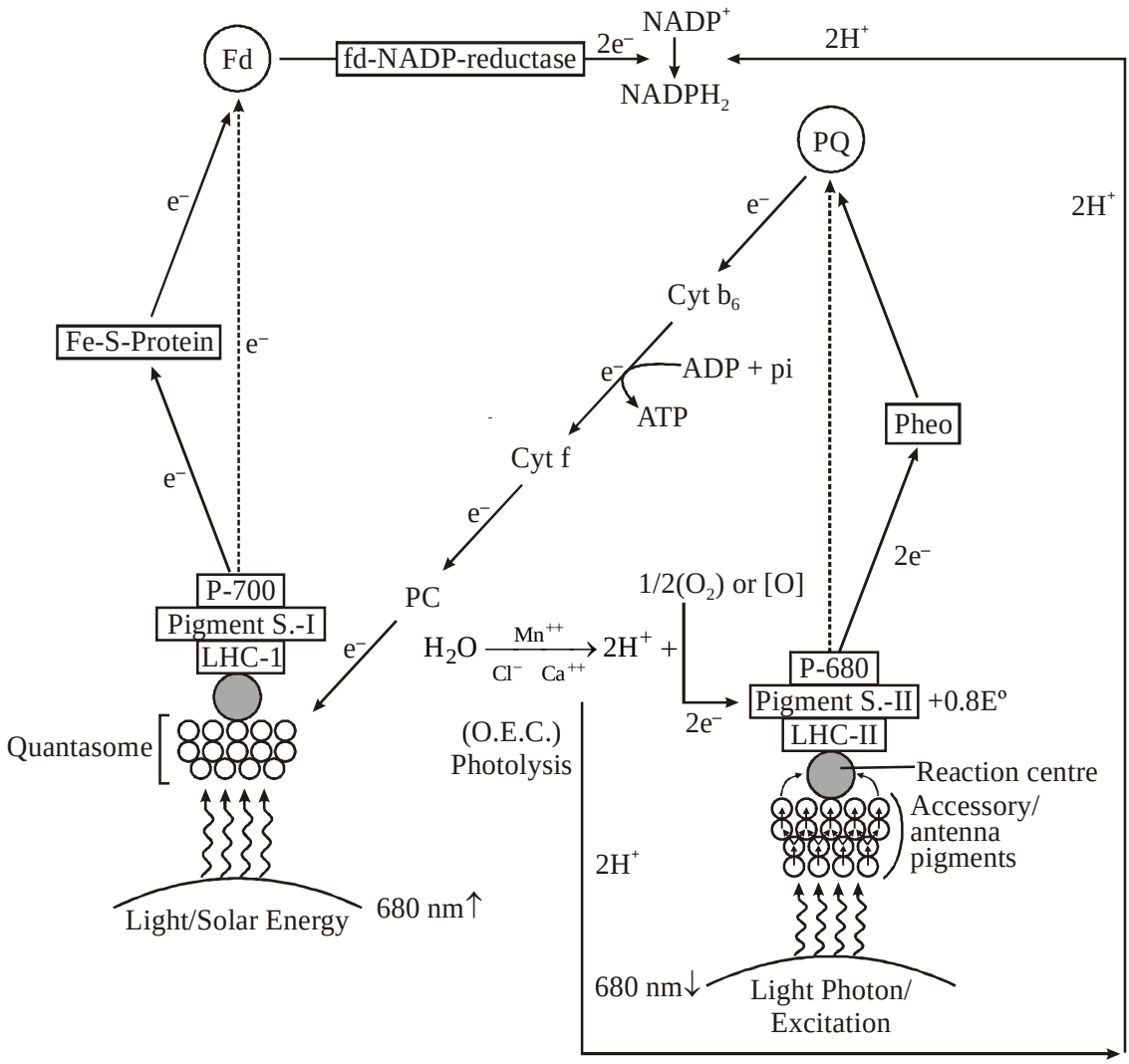
- From reduced Fd the electron is transferred to **cytochrome complex**, (Cyt-b_6 - Cyt-f) & then through **plastocyanin (PC)** is received back by oxidized P_{700} thereby causing its reduction.
- Only 2 ATP are synthesized between Fd - Cyt b_6 and Cyt b_6 - Cyt-f
- No photolysis of H_2O, O_2 evolution and $NADPH_2$ production.
- Primary e^- acceptor of PS-I is a **Fe-S -protein**.
- **Plastocyanin** is **copper** containing, blue colour carrier of cyclic ETS.



Cyclic Photophosphorylation

✸ **Non-cyclic photophosphorylation / ETS : Z-scheme (Hill & Bendall)**

- In this pathway the electron released from the photosystems is not received back after moving through electron carriers
- **PS-I & PS-II** both are involved in this pathway. It occurs only on grana thylakoids.
- In this ETS ATP, O_2 & $NADPH_2$ are formed.
- In this pathway first of all, the reaction centre of PS-II i.e. P_{680} liberates electron after absorption of quanta of light energy & becomes oxidised.
- This oxidised P_{680} chlorophyll gets reduced by receiving electron obtained from photolysis of water.
- The order of sequence of electron carriers through which electron passes is as follows.
- The high energy electron liberated from Ch-a_{680} is first of all accepted by the primary acceptor **Pheophytin (Chlorophyll without Mg)** & through it, e^- is transferred to electron transport system containing **PQ** (plastoquinone), **Cytochrome complex** (Cyto-b_6 Cyto-f) & **Plastocyanin (PC)** .
- Simultaneously, P_{700} the reaction centre of PS-I absorbs light energy (Photons) and gets **excited** thus liberates an e^-.



Non-cyclic Photophosphorelation / Z-scheme

- P_{700} which after liberating an e^- gets oxidised is reduced by an e^- transferred by **plastocyanin**.
- The e^- liberated by P_{700} is accepted by a **Fe - S - Protein** & from here e^- is transferred to Fd & then to $NADP^+$.
- $NADP^+$ is reduced to $NADPH_2$ after receiving e^- from Fd and H^+ obtained by spliting of water; in presence of an enzyme **ferredoxin – NADP reductase**.

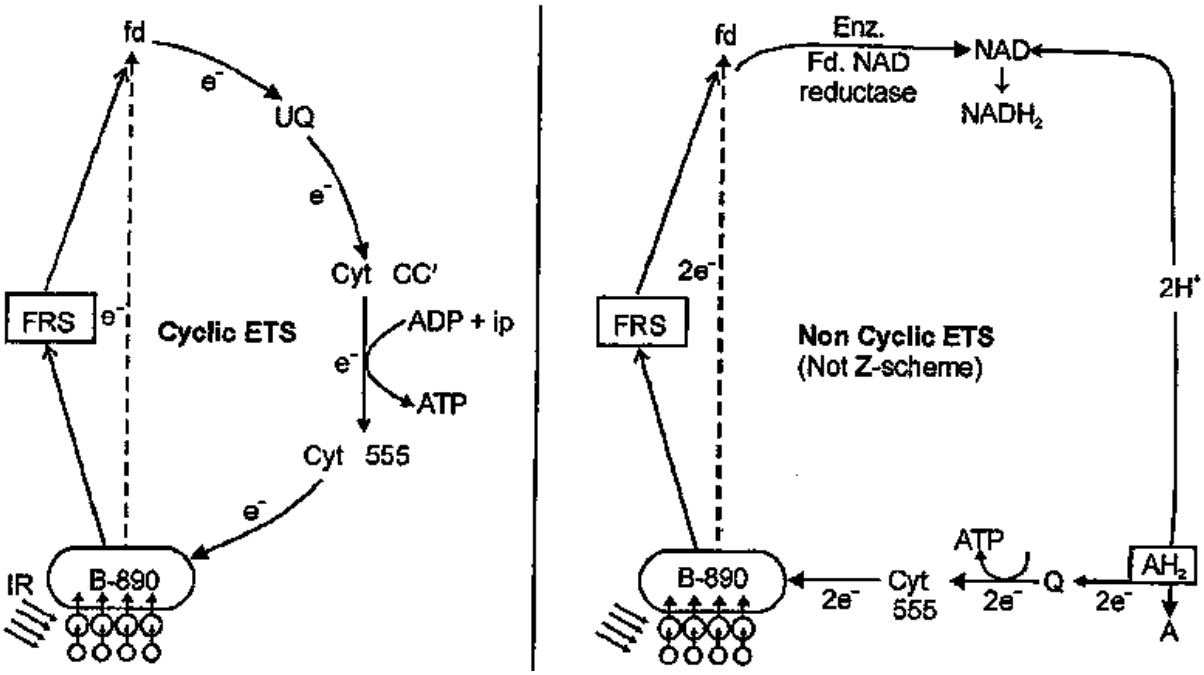
$$Fd_{(red)} + NADP^+ + H^+ \rightarrow NADPH_2 + Fd_{(Oxi)}$$

- 1 ATP is formed in between Cyt-b_6 and Cyt-f.
- In this pathway first e^- donor is water.
- During non cyclic ETS 1 ATP, 1 $NADPH_2$ is formed inolving photolysis of one H_2O molecule with release of O_2 or [O].
- 4 quanta of light are utilized in ejection of $2e^-$ at two times (PS-I and PS-II) during non cyclic ETS, Photolyse one H_2O molecule and release O_2 or [O]. So 8 quanta utilized in evolution of 1 molecule of O_2.

BACTERIAL PHOTOSYNTHESIS / LIGHT REACTION

- Certain bacteria are capable for photosynthesis Eg.: **Chlorobium** (Green Sulphur), **Chromatium** (Purpule Sulphur), **Rhodospirillium, Rhodopseudomonas** (Purple non sulphur).
- Cyclic photophosphorylation is an important method in bacterial photosynthesis.
- Absorption of **Infrared** spectrum takes place during bacterial photosynthesis thus **no red drop**.

- Bacteria has only one pigment system, PS-I (PS-II is absent).
- Pigment system of bacteria denoted by PS-I - **B-890**
- Evolution of **O_2 is not related to** bacterial photosynthesis, because water is not H^+ & e^- donor (H_2S)
- Only one ATP is produced in each turn of cyclic photophosphorylation, in bacteria.
- Bacterial light reaction occurs at chromatophores/carboxysome/lamillisome while dark reaction occurs at cytoplasm.
- Synthesis of ATP and $NADPH_2$ (Reducing Power) Occurs at cytoplasm.
- **Olson** 1970 gave a non cyclic scheme in bacterial photosynthesis.
- $6CO_2 + 12H_2S \xrightarrow[\text{Pigment in chromotophores}]{\text{IR light}} C_6H_{12}O_6 + 6H_2O + 12S.$



DARK REACTION / BLACKMAN'S REACTION / BIOSYNTHESIS PHASE

- It occurs in **'Stroma'** part of chloroplast. This reaction is **not directly controlled by light**
- This reaction is sensitive towards **temperature** & regulated by **enzymes**.
- This reaction is also called as **biosynthetic phase** or **CO_2 fixation phase** as the ATP & $NADPH_2$ formed in the light reaction are utilized for the formation of carbohydrates.
- Dark reaction in photosynthetic plants shows diversity as C_3 path, C_4 path and CAM path. This diversity is based on four important components of dark reaction.

	CO_2 acceptor	Carboxylase enzyme	1st carboxylation reaction product	Assimilatory power utilized in 1 Glucose mol. synthesis
C_3 Plants	RUBP (5C)	Rubisco	PGA(3C)	18 ATP & 12 $NADPH_2$
C_4 Plants	PEP (3C) (Primary acceptor) & RUBP (5C)	PEP case (work during day time) & Rubisco	OAA (4C)	30 ATP & 12 $NADPH_2$
CAM Plants	PEP (3C) (Primary acceptor) & RUBP (5C)	PEP case (work during night time) & Rubisco	OAA (4C)	30 ATP & 12 $NADPH_2$

- The final CO_2 assimilation into glucose in all photosynthetic plants take place by C_3 cycle, as it is the ultimate pathway of glucose synthesis operated in C_3, C_4 and CAM Plants.
- In Dark reaction, the assimilation and reduction of CO_2 takes place in the following steps :-

"C_3 cycle or Calvin Benson cycle or Photosynthetic Carbon Reduction cycle (PCR) or Reductive Pentose Phosphate Pathway (RPPP) or pentose phosphate reduction (PPR) cycle."

- The sequence & reactions of this cycle was given by **Calvin & Benson** (1948). In 1961 **Calvin got Nobel prize** for his work. They used green algae ***Chlorella*** and ***Scenedesmus*** for their experiments.
- They used radioactive $^{14}CO_2$ to find the sequence & intermediates of the reaction
- The plants in which this cycle is found are called **C_3 plants**.
- This cycle is completed in 3 phases–

(A) Carboxylation phase :

- The absorption or fixation of CO_2 takes place in this phase
- CO_2 is fixed by the primary acceptor **"Ribulose 1,5-di phosphate or RUBP"** which is a 5 carbon (5C) sugar.
- For the formation of 1 molecule of hexose sugar 6 mol. CO_2 combines with 6 RUBP to form 6C unstable compound which further break down to form 12 mol. 3C compound **phosphoglyceric acid** (PGA). This reaction is catalyzed by enzyme **RUBP carboxylase** or **RUBISCO** or **carboxydismutase**.
- RUBISCO is the **most abundant protein** found on earth. It is 16% of the protein present in chloroplast.

$$6CO_2 + 6RUBP \rightarrow 12\ PGA\ (3C)$$

(B) Glycolytic reversal :

- PGA formed is reduced to **phosphoglyceraldehyde** (PGAL)
- This phase is **reversal of glycolysis**.
- PGAL formation occurs in 2 steps firstly, PGA is phosphorylated by ATP to form 1,3-diphosphoglyceric acid in presence of kinase. Secondly, 1, 3- di PGA is reduced to phosphoglyceraldehyde (PGAL) with the help of $NADPH_2$. Now PGAL is converted to **Dihydroxy acetone phosphate** (DHAP) in presence of enzyme **triose phosphate isomerase**.
- Now DHAP & PGAL condenses to form fructose 1,6-diphosphate (F-1,6-dip) by **aldolase**, from this 1-phosphate is removed to form fructose-6-phosphate (F-6-P) by **Phosphatase**.
- F-6-P is the intermediate compound to form glucose, starch, sucrose.

$$\text{F-6-P} \xrightarrow{\text{Mutase}} \text{F-1-P} \xrightarrow{\text{isomerase}} \text{Glucose-1-P} \xrightarrow[\text{iP}]{} \text{Glucose}$$

$$\text{F-6-P} + \text{G-1-P} \longrightarrow \text{Sucrose}$$

(C) Regeneration of RUDP or RUBP :

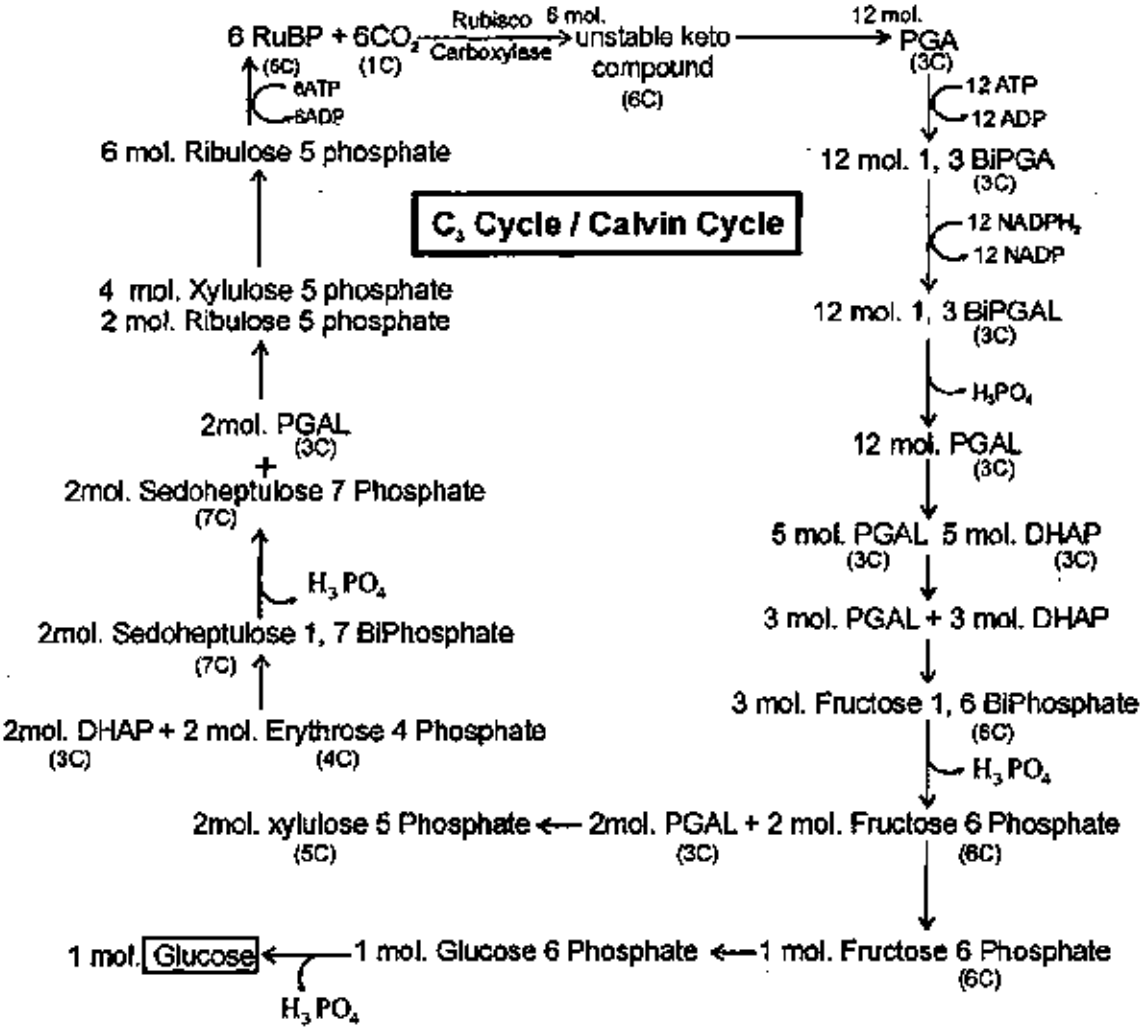
It occurs in the following sequence :

- $2\ \text{Fructose-6-P} + 2\text{PGAL} \xrightarrow{\text{Transketolase}} 2\ \text{Erythrose-4-P} + 2\ \text{Xylulose-5-P}$
- $2\ \text{Erythrose-4-P} + \text{DHAP} \xrightarrow{\text{Aldolase}} 2\ \text{Sedoheptulose-1,7-di-P} \xrightarrow[-2\text{P}]{\text{Phosphate}} 2\ \text{Sedoheptulose-7-P}$
- $2\text{Sedoheptulose-7-P} + 2\text{PGAL} \xrightarrow{\text{Transketolase}} 2\text{Ribose-5-P} + 2\ \text{Xylulose-5-P}$
- $2\ \text{Ribose-5-P} \xrightarrow{\text{isomerase}} 2\ \text{Ribulose-5-P}$
- $4\ \text{Xylulose-5-P} \xrightarrow{\text{epimerase}} 4\ \text{Ribulose-5-P} \xrightarrow[6\text{ATP}]{} 6\text{RuBP}$ (6ADP)

✸ **Net Dark reaction :**

$$6CO_2 + 18ATP + 12\ NADPH_2 \longrightarrow C_6H_{12}O_6 + 6H_2O + 18ADP + 12NADP^+$$

- Examples of C_3 plants– Pumpkin, Sunflower, Mango & mostly dicot plants, also in monocots.
- At **high O_2 concentration** RUBISCO function as **oxygenase enzyme** rather than carboxylase enzyme.



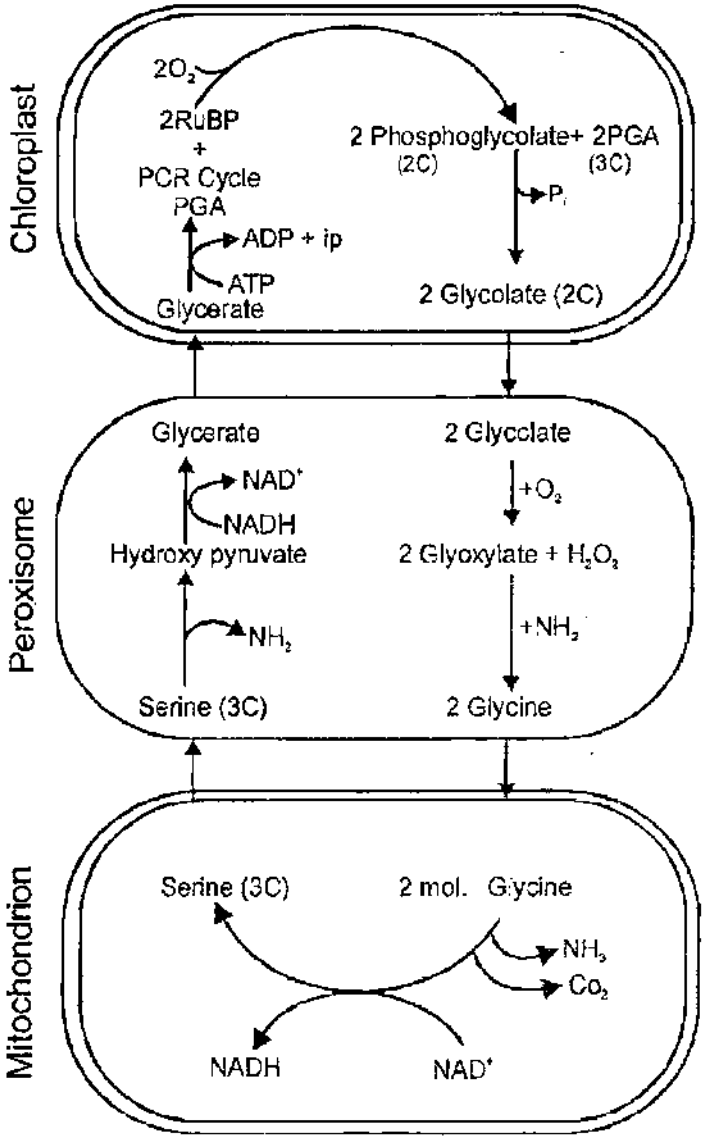
Photosynthetic carbon oxidation cycle / C_2 Cycle / Photorespiration / Glycolate - Metabolism

- Term was given by **'Krotkov'.**
- First of all **Krotkov** et. al indicated that more CO_2 evolves during day time in C_3 plants.
- **Decker** & **Tio** discovered photorespiration and clarified that **C_2-Cycle** or **glycolate pathway** operates during day time in C_3-plants & **Rubisco acts as oxygenase** at **higher concentration of O_2** and **low CO_2 concentration in the** C_3-green cells.
- The light dependent uptake of O_2 & release of CO_2 in C_3 photosynthetic cell is called **photo-respiration.**
- Photorespiration is not linked with ATP generation (in place ATP are consumed) as ordinary **dark respiration.** It is harmful or wasteful process linked with C_3 cycle.
- It occurs in **chloroplast, peroxisome** & **mitochondria (three cell organelle reaction).**

$$\underset{(5C)}{6RuBP} + \underset{(1C)}{6CO_2} \xrightarrow{\text{Rubisco}} \underset{(3C)}{12\ PGA} \longrightarrow \begin{cases} \text{Glucose} \\ 6RuBP \end{cases}$$

$$\underset{(5C)}{8RuBP} + 8O_2 \xrightarrow[\text{Low } CO_2\text{. High } O_2 \text{ con. High temp.}]{\text{RuBP – Oxygenase}} \underset{(3C)}{12\ PGA} \longrightarrow \underset{(2C)}{\begin{cases} \text{Glucose} \\ 6RuBP \end{cases}}$$

- During photorespiration, 75 percent of the carbon lost by the oxygenation RUBP is recovered. Because two molecules of glycine (2C + 2C = 4C) form one molecule of serin (3C). During this one carbon releases in form of CO_2 in mitochondria thus 25 percent carbon is lost.
- The **actual loss of carbon in form of CO_2** is **10%.**
- This serine molecule changes into PGA via different reactions of C_2 cycle.



Photorespiration / Photosynthetic carbon oxidation cycle.

- H_2O_2 (Peroxisome) and NH_3 (Mitochondria) produced in photorespiration.
- Glycine (Peroxisome) and serine (Mitochondria) are also formed in photorespiration.
- Scientists are trying to change C_3 species into C_4 species.
- It is assumed that in C_3 plants, if photorespiration does not occur, then increases O_2 conc. which oxidise (Photooxidation or Solarization) the different protoplasmic parts of photosynthetic cell at high light intensity.

C_4 CYCLE OR HATCH - SLACK CYCLE

- **Kortschak & Hartt** (1965) using radioactive $^{14}CO_2$ identified that in sugarcane the first stable product was not 3-C compound but was 4-C compound i.e. **oxaloacetic acid** (OAA).
- In 1967 **Hatch & Slack** (Australia) discovered the sequence of CO_2 fixation and reduction in C_4 plants.

- This cycle is found in many tropical & subtropical monocots eg : Maize, Sorghum etc.
- In dicots also many such plants are known eg : Amaranthus, Chenopodium, Atriplex, Euphorbia etc. In some families of dicots Compositae, Portulacaceae, Nyctaginaceae.
- There are 13 families (of these, Graminae, Cyperaceae are releated to monocots) which have C_4 plants. 11 genera are such that they have C_3 as well C_4 both types of species eg : *Atriplex patula* (C_3). *Atriplex rosea* (C_4).
- In C_4 plants photorespiration does not takes place.
- C_4 plants are generally **xerophytes**. C_4 plants leaves are anatomically different from C_3 plants.
- In the leaves of C_4 plants vascular bundles are surrounded by bundle sheath of larger parenchymatous or chlorenchymatous cells, which are further surrounded by mesophyll cells.
- The chloroplast in cells of bundle sheath are larger more in number & lack grana. Thylakoids are found scattered in these chloroplasts.
- Bundle sheath cells are **thick walled**, **multilayered** and **without intercellular spaces**.
- The chloroplast in mesophyll cells are smaller less in number & contain grana.
- The cells of mesophyll and bundle sheath are connected through **plasmodesmata**.

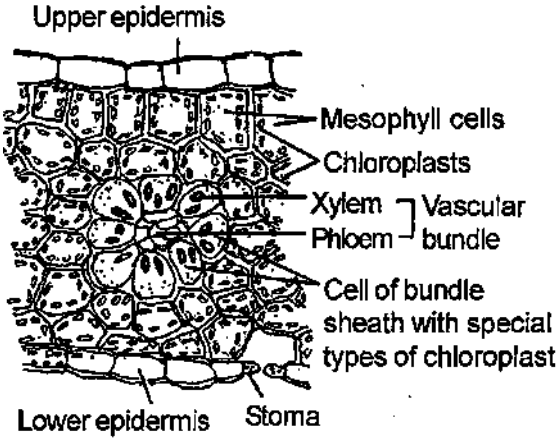
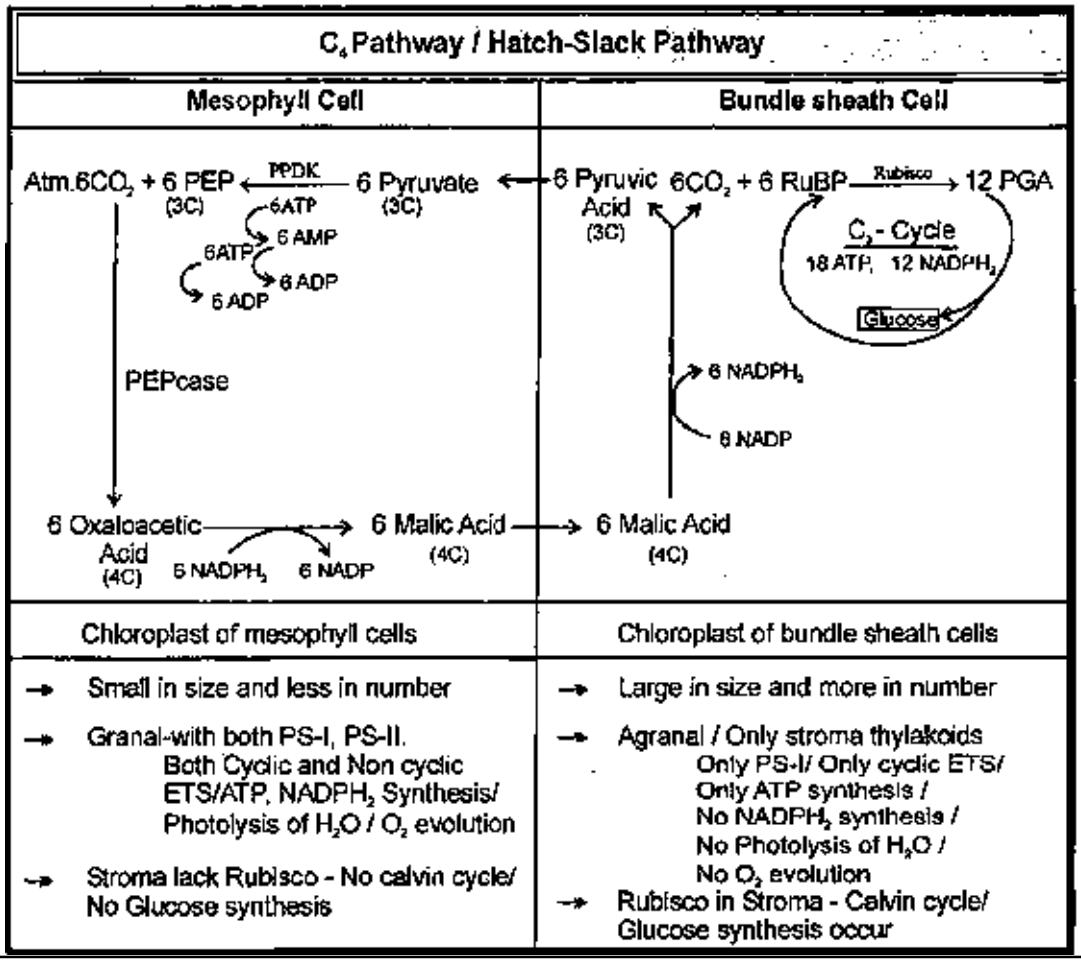


Fig : Krantz Anatomy

- The anatomy of leaf of C_4 plants is also called as **'kranz anatomy'** as the cells of bundle sheath are present in concentric layers around the vascular bundles which look like a **crown**, **ring** or **halo**.



✸ **Diversity in C_4 plants :**

Chollet and Ogren (1975) - Recognised three categories of C_4 plants.

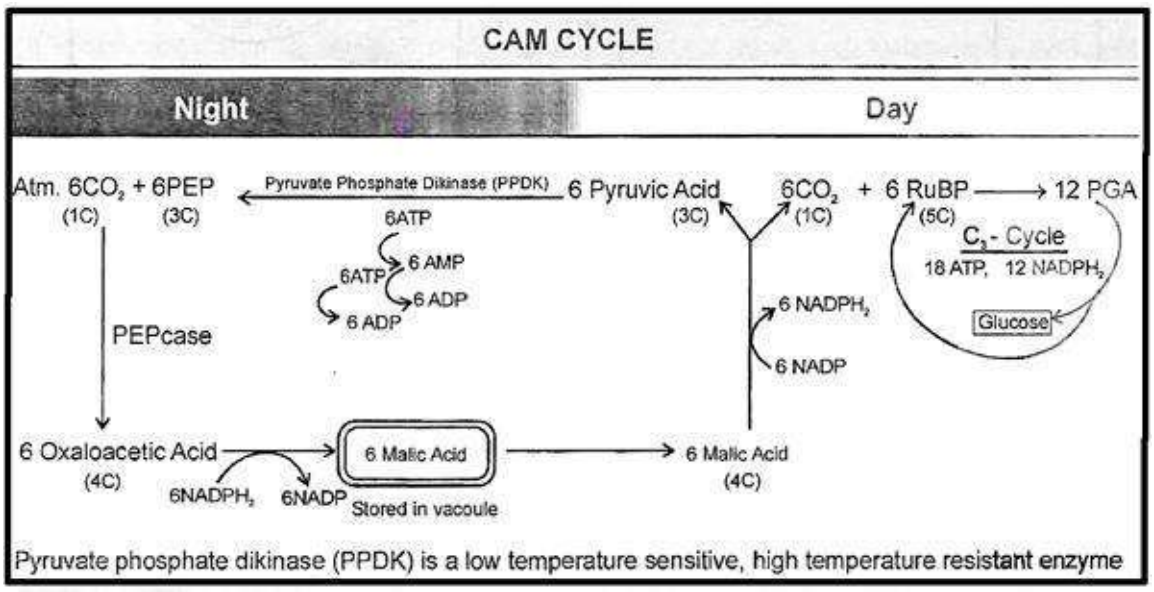
- **Maize and Sugarcane type :** In this category malate transported to bundle sheath cells and its decarboxylation given CO_2 for C_3 cycle.
- **Panicum and Chloris type :** In this category malate transported into bundle sheath cells, but this changes into **oxaloacetate,** which gives CO_2 for C_3 cycle.
- **Atriplex type :** In this category the **aspartate transported** into bundle sheath cells. where it changes into **malate**, which provides CO_2 for C_3 cycle.

✸ **Speacial features of C_4 plants / Significance of C_4 pathway :**

- To escape the conditions of water scarcity C_4 plants perform C_3 cycle in bundle sheath cells just beneath xylem which provides water for C_3 cycle.
- PEP carboxylase enzyme is abundantly present in C_4 plants. This enzyme is capable of using internal CO_2 i.e. CO_2 evolved in respiration. Thus C_4 plants has two sources of CO_2 one is from atmosphere & other from respiration.
- C_4 plants are **most efficient or most productive** plant at present CO_2 concentration.
- Present level of atmospheric **CO_2 is generally not limiting factor** for C_4 plants.
- C_4 plants posses **low CO_2 compensation points**. (8-10 ppm)
- C_4 plant would **not show CO_2 fertilization effect**, if CO_2 concentration is increases. Because high avilability of CO_2 by PEPcase and it's effective transfer in bundle sheath cells and no photorespiration due to Kranz anatomy..

Crassulacean Acid Metabolism (CAM) :

- This biochemical process is found in **succulent xerophytes**.



- **Oleary** and **Rouhani** discovered CAM-process in ***Sedum tefilium*** **leaf** members of **Crassulaceae** family. Succulent xerophytic plants. e.g., - **Kalanchoe, Bryophyllum, Sedum, Kleinia, Opuntia, Agave, Aloe, Euphorbia species, Pineapple, Welwistchia** (Gymnosperm) etc. Some members of cataceae, orchidacae, vitaceae.
- Primary acceptor of CO_2 is **PEP** (Phosphoenol pyruvate) and oxaloacetic acid is the first product of carboxylation reaction.

- In CAM plants stomata are of **scotoactive type,** so initial CO_2 fixation is found in night but light reactions operates at day time. Final CO_2 fixation (C_3 cycle) occurs in day time. PEPcase induces carboxylation reaction in night.
- **PEP carboxylase & Rubisco** present in mesophyll cells. **(No Kranz-anatomy)**
- In CAM plants 30 ATP and 12 $NADPH_2$ are required as assimilatory power for 1 glucose synthesis.
- CAM plants exhibits ecophysiological adaptation with **xeric habitat**.
- During whole night these plants absorb CO_2 from air & convert it in malic acid& store it in cell sap.
- During day time malic acid by process of **oxidative decarboxylation** liberate CO_2 and this CO_2 is converted to carbohydrates by C_3 cycle.
- C_4 & C_3 cycle occurs at different time.
- **Kranz anatomy** is **absent in CAM plants**.
- High O_2 concentration can **inhibits photosynthesis**
- Photorespiration is less.
- Transpiration is very less.
- Even at high temperature CO_2 is fixed.
- **First compound formed** is **OAA**. **Stable product** is **malic acid.**
- Leaves of CAM plants have thick cuticle.

FACTORS AFFECTING PHOTOSYNTHESIS

✸ **Concept of Cardinal Points :**

- **Sachs** in 1860 proposed the concept of **"Cardinal points"** for any factor affecting the physiological reaction.
- There are 3 main values or cardinal points for any factor -**Minimum** - below it no physiological reaction occurs, **Optimum** - at this point the reaction occurs at the maximum rate, **Maximum** - beyond this point the activity stops.

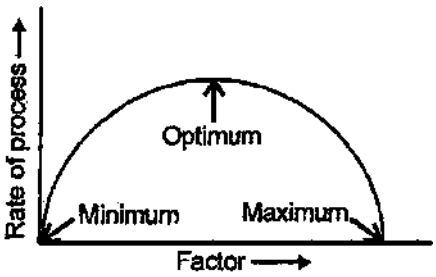


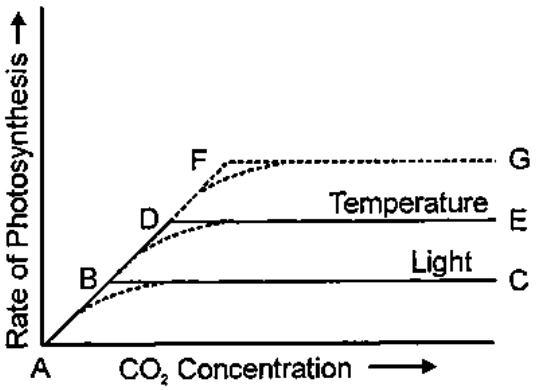
Fig : Three Cardinal points

✸ **Law of minimum : By J. Liebig**

- Given by Liebig "When a vital process is affected by several environmental factors, the rate of process will increase on increase in value of factor present in minimum amount.

✸ **Blackman's law of limiting factor :**

- When a physiological reaction is at it's maximum rate and being affected by a numbers of factors, then the rate is dependent on that factor which is minimum in amount, this factor is called as **limiting factor**.
- By increasing the value of limiting factor, rate of the reaction directly increases.
- Blackmann's law is a modified **Liebig's law of minimum**.
- Concentration of **CO_2 is always a limiting factor** (it is 300 ppm or 0.03%).



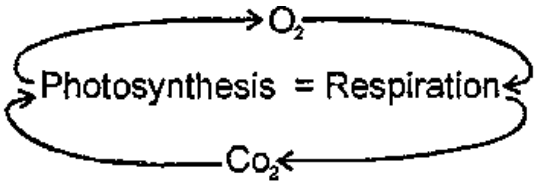
- During cloudy days light becomes limiting factor.
- For aquatic plants CO_2 is not a limiting factor, they use dissolved CO_2 in water. Bicarbonates in water is the main source of CO_2 for them.

1. EXTERNAL FACTORS :

(A) Light : Light affects photosynthesis in three ways -

(a) Compensation Point :

- The point at which rate of photosynthesis is equals to rate of respiration.
- Any environmental factor which can start or stop the photosynthesis can be responsible for compensation point.
- It attain at minimum and maximum value of factor.



- No gaseous exchange at compensation point.
- Net primary productivity (NPP) become zero.
- Growth stopped.
- Three type of compensation point-

– **Light Compensation Point :** High for heliophytes low for sciophytes.

Sciophytes posses large surface area of leaves and large number of phtosynthetic units or quantasomes per unit area of leaves ***vice versa*** in heliophytes.

– **Temperature Compensation Point :** High for C_4 and CAM Plant : 12 - 15ºC or 55ºC and Low for C_3 plants : 2 - 3ºC or 48ºC

C_4 and CAM plants are xerophytes and adapted to hot and dry climate while C_3 plants are adapted to cold climate.

– **CO_2 Compensation Point :** Not naturally attained. High for C_3 plants (40-60 PPM) while low for C_4 plants. (0 - 10 PPM)

(b) Light intensity :

- Photosynthesis increases upto a limit by increasing light intensity, then becomes constant, beyond that it decreases. Decreasing light intensity decreases photosynthesis.
- At certain intensity, air exchange from the photosynthetic zone of the plant stops. This intensity is called **light compensation point**. In evening and morning this point is reached.
- The compensation point in sciophytes or Heliophobus is established at 10-100 ft candle but in heliophytes or Heliophilous, it is 100-200 ft. candle.
- Solarisation effect is due to **photo-inhibition** or **photo-oxidation**. Due to light effect, transpiration increases and the cells of leaves becomes less hydrated, so stomata closes. Inhibition of photosynthesis in this way is called **photo-inhibition**. Decrease in photosynthesis due to destruction of chlorophyll by oxidation in strong light in the presence of O_2 is called **photo-oxidation**.

(c) Light quality :

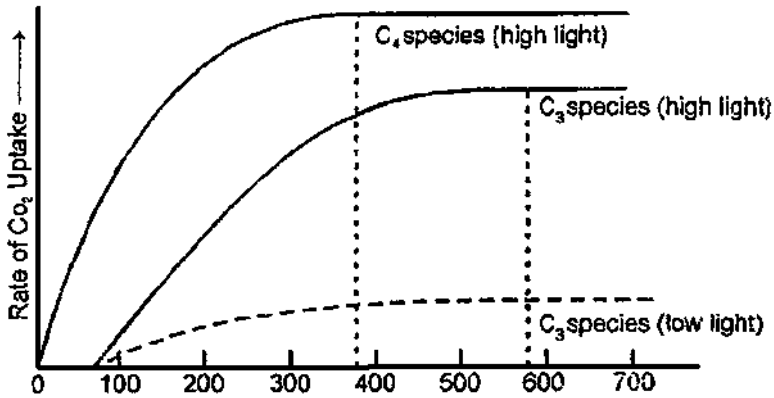
- Most plants photosynthesize in visible light ; Generally **maximum photosynthesis** occurs in **red** and **minimum** in **green light**.

(B) Temperature :

- Generally photosynthesis does not occur at 0ºC due to inactivation of enzymes. It is maximum at 25-30ºC (In C4 plants at 35-40ºC). At 50-55ºC, generally **photosynthesis stops** because of **denaturation of enzymes.**
- Upto optimum point, $\mathbf{Q_{-10}}$ **value is 2 or 3.**
- In most plants, photosynthesis has been found to start between 0ºC to 5ºC. But in lichens, it has been found to occur at -20ºC and in some conifers even at -35ºC.
- Certain succulents can photosynthesize at 55º and a few algae even at 75ºC.
- C_3 plants exhibit photosynthetic capacity at low temperature while C_4 plants do so at higher temperature.

(C) Carbon dioxide :

- Generally in the environment, 0.03% CO_2 is found.
- On lowering of CO_2 concentration, at one point $\mathbf{CO_2}$ **compensation point** is established. The CO_2 concentration at which rate of CO_2 fixation and CO_2 liberation is same is called CO_2 compensation point.
- In C_3 plants CO_2 compensation point is higher (50-100 ppm) than C_4 plants(0-10 ppm) as they do not have photorespiration.
- Higher concentration of CO_2 has **toxic effect on plants** and photosynthesis is lowered.



(D) Oxygen :

- In C_3 plants, increasing the O_2 lowers the photosynthesis. This effect is called **Warburg's effect**. Which is due to photorespiration.
- With increase in O_2, photo-respiration increases and Photo-oxidation may occur.
- The **inhibitory effect** of O_2 is **lacking in C_4 plants**.(Photorespiration)

(E) Water :

- As medium for enzyme activity during dark reaction.
- As reactent during light reaction.

(F) Minerals :

- **Mg** is the mineral which is **structural component** of **chlorophyll.**
- Fe, N, S, K are essential for synthesis of chlorophyll.
- **Mn** is essential for **photolysis of water**.
- P is required for the formation of ATP.

(G) Pollutants :

- Smoke and dust particles reduce the intensity of light. Ozone, Nitrogen oxides, Hydrogen fluorides affect cell organelles and enzymes and thus reduce photosynthesis.

(H) Inhibitors :

- **DCMU** (**Diuron/**Dichlorophenyl Dimethyl Urea), **CMU** (Monuron), **PAN, Atrazine, Simazine, Bromocil, Isosil -** Inhibit the photosynthesis by blocking PS-II. They stop e^- flow between P-680 & PQ.
- In cyclic ETS diquat, paraquat (Viologen dyes) inhibit e^- flow between P-680 & PQ.
- In these chemicals are used as herbicides, which mostly block ETS.

2. INTERNAL FACTORS :

(A) Chlorophyll :

- Chlorophyll is essential for absorption of light. Part of leaf without chlorophyll (in variegated leaves) does not have starch.
- **Willstater** and **Stahll** described the relationship between chlorophyll and assimilation number according to **photosynthetic number** or **assimilatory number**. The amount of CO_2 absorbed in grams by 1 gm chlorophyll in 1 hr is called **photosynthetic number**. They found this number varied in different species.
- Generally, **chlorophyll is not the limiting factor. Carotenoids prevent photo-oxidation**.

(B) Age :

- Rate of photosynthesis increase from young leaves to maturity. After that it lowers down.

(C) Anatomy of leaf :

- Diffusion of CO_2 availability and distribution of light to leaf, transport of photosynthetic products etc. are affected by anatomy of leaf. Thus, photosynthesis is also affected.

(D) Hydration of protoplasm :

- Photosynthesis is lowered when hydration of protoplasm becomes less.

(E) Accumulation of photosynthetic end products :

- Accumulation of photosynthetic products in green cells lowers photosynthesis.

HETEROTROPHIC PLANTS NUTRITION

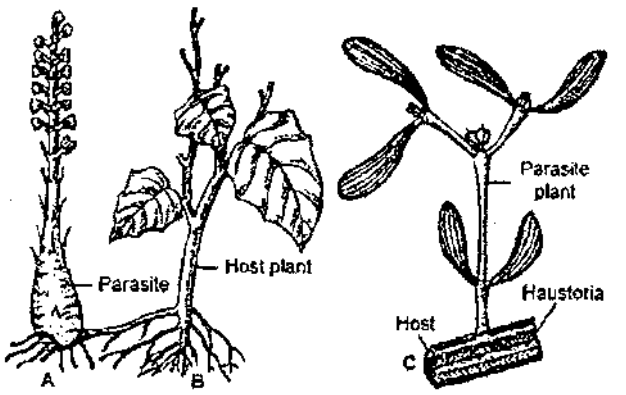
1. HETEROTROPHS - Heterotrophic plants are of following types -

(A) Parasites :

- **Total stem parasites :** ***Cascuta*** or dodar (totally depend)
- **Partial stem parasites :** ***Loranthus***, ***Viscum*** (depend on host for H_2O & minerals)
- **Total root parasites :** Members of Rafflesiaceae, Balanophoraceae and Orobancheae (totally depend on host).
- **Partial root parasites :** ***Santalum album*** **&** ***Striga*****.**

(B) Insectivorous plants :

These are green plants but of insectivorous habits which develop, due to deficiency of nitrogen, because they grow on N_2-deficient place (Swampy places).

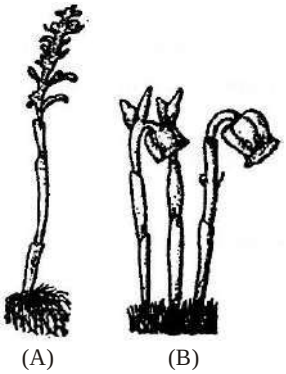


Parasitic plants-*Orobanche*
(A) A flowering plant growing on the root of *bringal*
(B) *Viscum*-Plant attached to the host stem
(C) Part of host stem is cut open to show the haustorium

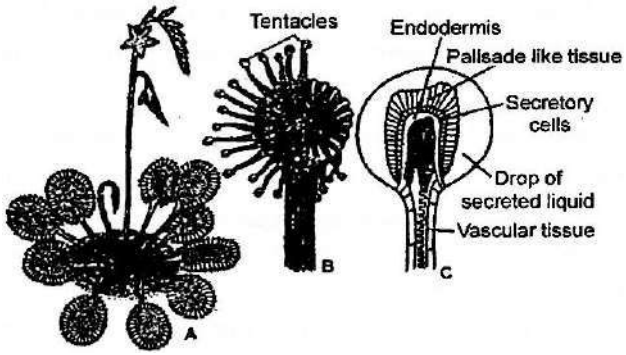
- ***Nepenthes*** or pitcher plant - Found on north eastern parts of India (Endangerd).
- ***Utricularia*** or bladderwort - Hydrophyte and pullution indicator.
- ***Drosera*** or Sundew
- ***Pinguicula*** or butterwort.
- ***Dionaea*** or venus fly trap.
- ***Saracenia*** or pitcher plant with symbiotic bacteria.
- ***Aldrovanda*** (Water flea trap)
- ***Genlisea*** (Lobster pot trap)

(C) Saprophytes :

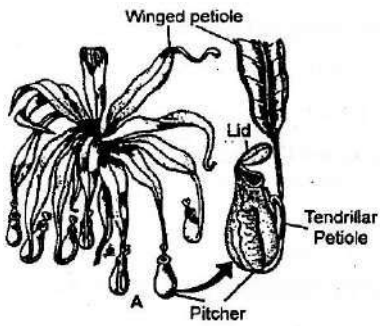
- Non green plants, which depend on dead organic matter - ***Monotrapa*** (Indian Pipe) ***Noettia*** (Birds eye nest) (***Dischidia*** is a pitcher plant but not insectivorous).



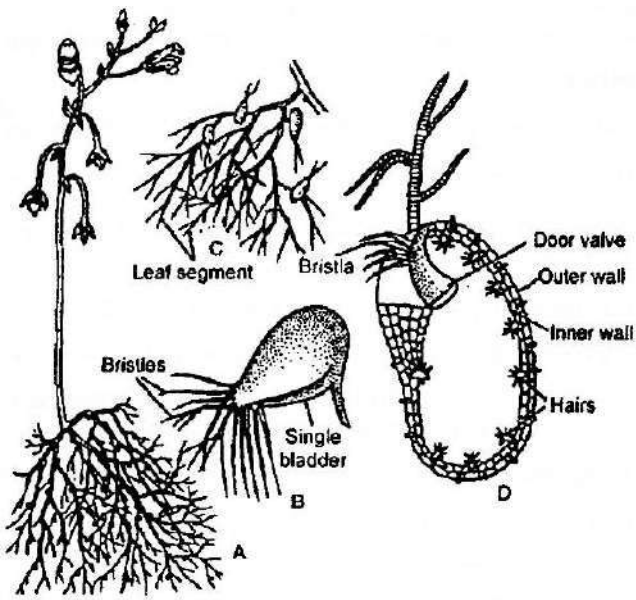
Saprophytic Plants
(A) Neottia (Birds nest plant)
(B) Monotrapa (Indian pipe)



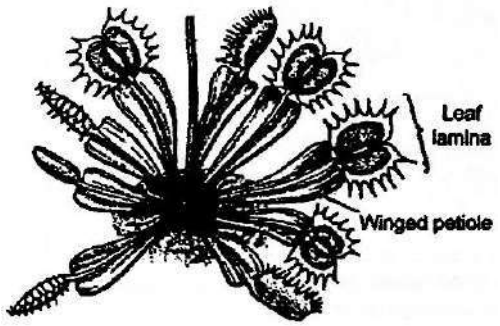
Insectivorous Plants - Drosera
(A) Complete plant (B) One leaf (C) One glandular tentacle



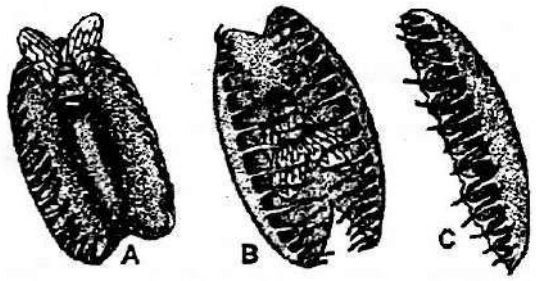
Insectivorous plant - Nepenthes
(Pitcher plant)
(A) A pitcher plant with pithcer



Insectivorous plant - Utricularia - (Bladderwort)
(A) Complete plant (B) One bladder
(C) Part of leaf with bladers (D) Internal structure of bladder



Insectivorous plant - Dionaea (Venus fly trap)



Insectivorous plant - Dionaea : Different stages in the capture of the insect

SPECIAL POINTS

- Photosynthesis is an **endergonic, anabolic, oxidation-reduction process.**
- A particle of light containing energy is called a **photon** or **quantum**.
- **Quantasomes** were discovered by **Park and Biggins** (1964). They are also called **photosynthetic units**.
- Rate of Photosynthesis is higher than that of respiration during day time and the ratio of O_2 produced to that of consumed is 10 : 1.
- **Moll's half leaf experiment** is used to show that CO_2 is less **essential for photosynthesis**.
- **Wilmott's bubbler** is used for the measurement of the rate of photosynthesis.
- During photosynthesis, 264 gms of CO_2 and 216 gms. of water are utilized to produce 108 gms of water, 192 gms of O_2 and 180 gms of glucose.
- Photosynthesis involves oxidation of water and reduction of CO_2.
- Ferric compounds (Ferricyanide & ferric oxalate), quinone and 2,6-dichloroindophenol used as hydrogen acceptors in Hill's experiments are called **Hill's Reagents**.
- **DCMU**(Dichlorophenyl dimethyl urea), a **herbicide**, is a **strong inhibitor** of non cyclic photophosphorylation and O_2 evolution in photosynthesis.
- **Manganese** and **chloride ions** are required for evolution of O_2 in photosynthesis.
- In 1971, Rubisco was crystallised from tobacco leaves in **Wildman's laboratory**.
- Rubisco is **most abundant protein** of the world.
- Due to the affinity to O_2, **Carotenoids** assist in photolysis of water by taking up O_2.
- **Chl-a** is called the **key molecule** due to its ability to **initiate** light reaction.
- In photosynthesis, the quanta of light required to release one molecule of O_2 is called **quantum requirement**. It is 8 quanta.
- Chlorophyll pigment soluble in organic solvents like acetone, ether etc. (anthocyanin is non photosynthetic water soluble pigment, which present in vacuole).
- Photolysis of water occurs at +0.8 E^o
- In cyanobacteria (BGA), photosynthesis occurs on **chlorosomes** or **lamellisome** or **carboxysome.**
- PS-I is strong reductant as PS-I has good ability to reduce $NADP^+$, while PS-II is a strong oxidant, because it has extrem power of oxidation & photolysis of water molecule.
- **Efficiency of photosynthesis-**

– One quantum of red light = 47.6 Kcal (One red photon or quantum = 47.6 Kcal)
– One glucose = 686 Kcal. (1 CH_2O = 114.3 Kcal)
– 8 Quantum × 47.6 Kcal = 381 Kcal energy require for fixation of one CO_2.

Thus, $\frac{114.3}{381} \times 100 = 30\%$

DIFFERENCES

Photorespiration	Dark Respiration
(i) Occurs in chloroplast, peroxisome and mitochondria.	(i) Occurs in cytoplasm, mitochondria.
(ii) Wasteful process.	(ii) Useful process.
(iii) NH_3 & CO_2, H_2O_2 are produced	(iii) CO_2, H_2O &ATP genetrated.
(iv) In green cells of C_3-plants.	(iv) In all living cells.
(v) Occurs during day time only.	(v) All time.

Cyclic photophosphorylation	Non-cyclic photophosphorylation
(i) Only PS-I involved in cyclic process.	(i) Both PS-II & PS-I works in non cyclic process.
(ii) The e^- expelled from chl-700 is cycled back.	(ii) The e^- expelled from reaction centre is not cycled · back. Its loss is compensated by e-form H_2O.
(iii) Photolysis of water and evolution of 02 does not take place.	(iii) Photolysis of water and evolution of 02 takes place.
(iv) Phosphorylation at two places.	(iv) Phosphorylation at one site.
(v) NADP+ is not reduced.	(v) $NADP^+$ is reduced to NADPH.
(vi) Activated by 680 NMt light.	(vi) Activated by 680 NM ↓

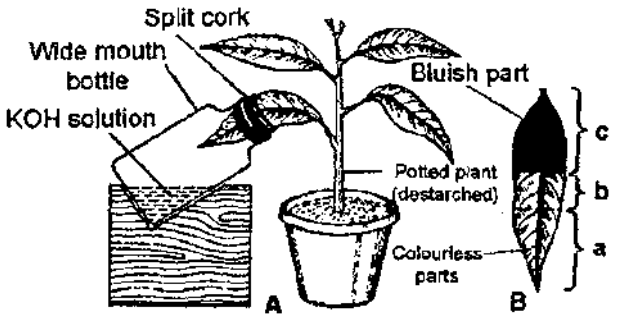
C_3-pathway	C_4-pathway	CAM-pathway
(1) 1st stable compound is 3-C PGA	(1) 1st stable compound is 4C O.A.A.	(1) First formed compound is O.A.A.
(2) 18 ATP & 12 $ADPH_2$ used for 1 glucose formation	(2) 30 ATP & 12 $NADPH_2$ used for 1 glucose formation	(2) 30 ATP and 12 $NADPH_2$ used for production of 1 glucose
(3) Kranz anatomy absent	(3) Krenz anatomy present	(3) Kranz anatomy absent
(4) Presence of photorespiration	(4) Absence of photorespiration	(4) Photorespiration may present
(5) One type of carboxylase enzyme, Rubisco only	(5) Two type of carboxylase enzyme Rubisco & PEPcase.	(5) Two type of carboxylase enzyme Rubisco & PEPcase
(6) CO_2 acceptor - RUBP	(6) Primary CO_2 acceptor PEP & RUBP is secondary acceptor	(6) Primary CO_2 acceptor is PEP & RUBP is secondary acceptor
(7) Transpiration ratio (TR) 500-1000	(7) TR - 200 - 300	(7) TR - 50 - 100

IMPORTANT EXPERIMENTS

EXPERIMENT - 1

CO_2 Necessary for photosynthesis molls half leaf experiment :

Destarch a potted plant by keeping it in dark for 2-3 days till its leaves do not show positive starch test. Insert one half of a leaf in wide mouthed bottle containing a few c.c. of KOH solution by means of a split cork. Make the connection air tight the leaf hald present inside the bottel is unable to get carbon dioxide as the same gets carbon dioxide as the same gets absorbed by potassium hydroxide solution.



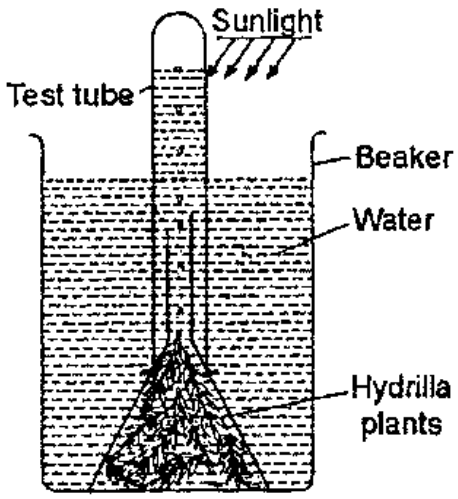
Place the apparatus in sun light for few hours. Remove the leaf under study & test for starch. It will be seen that the inner half of the leaf which was devoid of CO_2 supply does not turn blue, while the outer half shows positive starch test. This experiment shows positive starch test. This experiment shows that photosynthesis does not occurs in the absence of CO_2.

EXPERIMENT - 2

Experiment that prove O_2 gas is evolved during photosynthesis.

Place an aquatic plant like Hydrilla at the bottom of a large waterfilled beaker with the cut end of the stem pointing towards the upperside. Cover the plant by inverting over it a short stemmed funnel. Pour water into beaker till it has covered the stem of the funnel completely. Dissolve a bit of sodium bicarbonate in it.

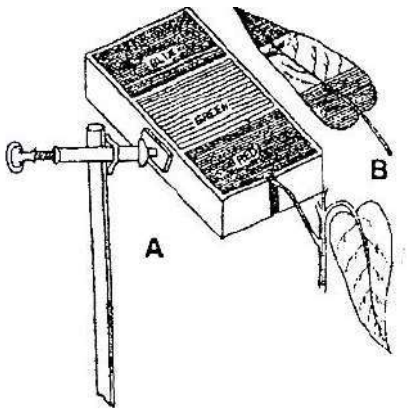
Invert a test tube full of water over the funnel and place the apparatus in bright sunlight. Soon gas bubbles will be seen coming out of the plants and get collected in test tune. When sufficient gas has been collected, remove the test tube and introduce a glowing splinter which will burn brightly showing that the gas evolved is oxygen.



EXPERIMENT - 3

Light is necessary for photosynthesis (By Ganong's light screen)

Fit Ganong's light screen to one of the leaves of a destarched plant. Place the plant in sunlight. The leaf receive the light only through the stencil. After a few hour pick up the leaf under examination and test for starch with iodine solution the area manufactures starch get blue and thus perform photosynthesis which has received light.

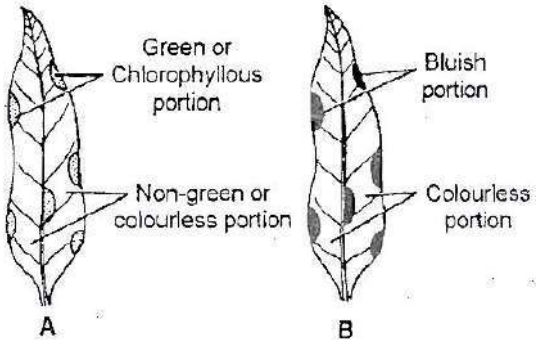


EXPERIMENT - 4

Chlorophyll is essential for photosynthesis (By experiement of varigated leaf)

Pick up a variegated leaf from coleus, pathos plant.

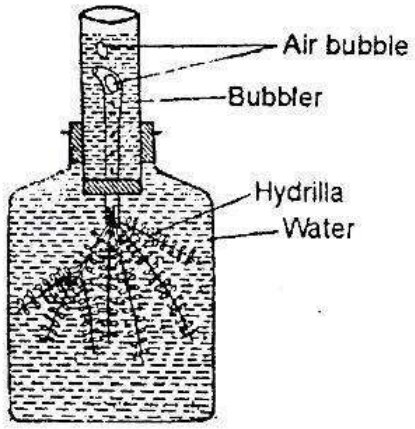
Which has received light for a few hours. Take a piece of rice paper and place it over the surface of variegated leaf. Mark out the green and non green areas by means of a pencil. 'Kill the leaf in boiling water and remove its chlorophyll by immersing it in warm spirit. Wash and test for starch. Only those parts of the leaf will give positive test which were originally green or with chlorophyll.



EXPERIMENT - 5

Measurement of photosynthesis by the rate of evolution of oxygen (By Wilmott Bubbler)

Take as fresh shoot of Hydrilla plant remove its apical 10 cm long portion by giving an oblique cut while keeping it submerged in water. Place it in a test tube 3/4th full of water with the cut end upwards as such or gently tied to a glass rod for support. And some sodium bicarbonate in the water of test tube. Give a fresh oblique cut to the shoot end & place the test tube in sunlight. Bubbles of oxygen gas are seen coming out of the cut end of hydrilla plant count the no. of bubbles per minute. Rate of reaction increases by adding in H_2O.



EXERCISE - 1

Q.1 Bio-Chemical phase in photosynthesis was first discovered by
(1) Calvin (2) Blackman
(3) Arnon (4) Hill

Q.2 In chlorophyll molecule "Mg' is situated in
(1) Centre of porphyrin ring
(2) Corner of porphyrin
(3) In phytol tail (4) In isocyclic ring

Q.3 The accepted size of chlorophyll molecule is
(1) Head ; 15 × 10 Aº & Tail; 25Aº
(2) Head : 20 × 20 Aº & Tail : 25Aº
(3) Head : 10 × 10 Aº & Tail : 15Aº
(4) Head : 15 × 15 Aº & Tail : 20 Aº

Q.4 The photosynthetic pigment "chlorophylls" are soluble in
(1) Water (2) Inorganic solvent
(3) Organic solvent
(4) Water & organic solvent

Q.5 Which of the following chlorophyll is lack of phytoltail ?
(1) Chl'a' (2) Chl.'b'
(3) Chl.'c' (4) Chl.'e'

Q.6 Photosythetic pigment phycobilin are not associated with : -
(1) PS II (2) Cyanobacteria
(3) PS I (4) All the above

Q.7 Percentage of chlorophyll in a normal chloroplast
(1) 5 - 10% (2) 40 - 50%
(3) 65 - 75% (4) 90 - 95%

Q.8 The correct formula for carotene is
(1) $C_{40}H_{56}$ (2) $C_{40}H_{50}$
(3) $C_{40}H_{56}O_2$ (4) $C_{41}H_{56}O_3$

Q.9 Normally phycobillins occurs in
(1) Red alage (2) Blue green algae
(3) Rhodophyceae (4) All of the above

Q.10 Which of the following protein is most abundant on the earth ?
(1) Catalase (2) Rubisco
(3) Amylase (4) None of these

Q.11 Porphyrin is occurs in
(1) Chlorophyll (2) Hameoglobin
(3) Cytochrome (4) All the above

Q.12 Universal photosynthetic chlorophyll is
(1) Chl-'a' (2) Chl 'b'
(3) Chl - 'c' (4) Chl- 'e'

Q.13 Which of the following is the site of photolysis of water ?
(1) Stroma of chloroplast
(2) Cristae of chloroplast
(3) Ribosome of chloroplast
(4) Lumen of thylakoid sacs

Q.14 Which one of the following is precursor of protochlorophyll ?
(1) Acethyl COA (2) Succinyl COA
(3) Oxlaoacetic acid (4) α-ketoglutarate

LIGHT REACTIONS OR PHOTOPHOSPHORYLATION

Q.15 The first step in photosynthesis is
(1) Joining of three carbon atoms to from glucose
(2) Formation of ATP
(3) Ionization of water
(4) Excitement of an electron of chlorophyll by a photon of light

Q.16 The ultimate gain of light reaction is : -
(1) ATP & $NADPH_2$ (2) $NADPH_2$
(3) only ATP (4) Only O_2

Q.17 Photophosphorylation is the process in which
(1) CO_2 and O_2 unite
(2) Phosphoglyceric acid is produced
(3) Aspartic acid is formed
(4) Light energy is converted in to chemical energy by production ATP

Q.18 Alage and other submerged plants bount in water during day time and sink at night, becuase
(1) They come upto enjoy some time
(2) They lose weight at night
(3) They become bouyant due to accumulation of O_2 as a result of photosynthesis
(4) They become light due to food material accumulation

Q.19 Which one of the following concerns with photophosphorylation :

(1) ADP + AMP $\xrightarrow{\text{Lightenergy}}$ ATP

(2) ADP + Inorganic PO_4 $\xrightarrow{\text{Lightenergy}}$ ATP

(3) ADP + Inorganic PO_4 $\longrightarrow$ ATP

(4) AMP + Inorganic PO_4 $\longrightarrow$ ATP

Q.20 Which occurs during the light reaction of photosynthesis

(1) Chlorophyll is produced

(2) Water splits to form $2H^+$ & O_2

(3) CO_2 is given off as a waste

(4) Sugar is formed from CO_2 and water

Q.21 The function of ATP in photosynthesis is the transfer of energy from the

(1) Dark reaction to the light reaction

(2) Light reaction to the dark reaction

(3) Chloroplasts to mitochondria

(4) Mitochondira to chloroplasts

Q.22 In photosynthesis, hydrogen is transferred from the light reaction to dark reactions by :-

(1) DPN (2) DNA

(3) ATP (4) NADP

Q.23 Which of the following element is a component of ferredoxin : -

(1) Copper (2) Manganese

(3) Zinc (4) Iron

Q.24 During photochemical reaction of photosythesis-

(1) liberation of O_2 takes place

(2) Formation of ATP and $NADPH_2$ take place

(3) Liberation of O_2, formation of ATP, and $NADPH_2$ takes place

(4) Assimilation of CO_2 takes place

Q.25 Splitting of water in photosynthesis is called:

(1) Dark reaction (2) Photolysis

(3) Electron transfer (4) Phototropism

Q.26 The chief product of hill reaction are : -

(1) ATP and $NADPH_2$ in chloroplast

(2) ATP and $NADPH_2$ in mitochondria

(3) Only oxygen

(4) A reduced substance $NADPH_2$, ATP and O_2 in chloroplast

Q.27 ADP + iP = ATP in grana is called : -

(1) Phosphorylation

(2) Oxidative phosphorylation

(3) Photophosphorylation

(4) Photolysis

Q.28 Which of the following is excited molecule during photosynthesis : -

(1) Chlorophyll (2) Oxygen

(3) Carbondioxide (4) Water

Q.29 $NADPH_2$ is also called : -

(1) Real power

(2) Oxidising agent

(3) Power house of energy

(4) Reducing power

Q.30 During ionisation of H_2O, H^+ is captured by

(1) Chlorophyll (2) NADP

(3) O_2 (4) Cytochrome

Q.31 At the time of ionization of H_2O, which initially captures the electron

(1) Chlorophyll (2) NADP

(3) OH^- (4) Cytochrome

Q.32 In cylic photophosphorylation which one of the following is formed

(1) NADP & ATP (2) ATP

(3) $NADH_2$ and O_2

(4) $NADPH_2$, ATP and O_2

Q.33 Fixation of 1 CO_2 requires : -

(1) $6NADPH_2$ & 3ATP

(2) $2NADP.H_2$ & 3ATP

(3) $4NADP.H_2$ & 3ATP

(4) $5NADP.H_2$ & 3ATP

Q.34 Photooxidation of water in photosynthesis is in association of

(1) Cythochrome b_6

(2) Pigment system-I

(3) Pigment system-II

(4) Plastocyanin

Q.35 During ATP synthesis electron pass through

(1) Water (2) Cytochromes

(3) O_2 (4) CO_2

Q.36 Which pigment system utlimately donates e^- for the reduction of NADP.

(1) PS II (2) PS I

(3) CO_2 (4) Plastoquinone

Q.37 Respiration and photosynthesis both require

(1) Green cells (2) Sunlights

(3) Cytochromes (4) Organic fuel

Q.38 Photosynthesis is an oxidaton reduction process, the materials that is oxdised is :

(1) CO_2 (2) NADP

(3) H_2O (4) PGA

Q.39 Element which helps in electron transport in the process of photosynthesis is

(1) Zinc (2) Molybdenum

(3) Boron (4) Mangnese

Q.40 Photo-oxidation of chlorophyll is called

(1) Intensification (2) Chlorosis

(3) Solarization (4) Defoliation

Q.41 The by product of photosynthesis is

(1) CO_2 (2) Oxygen

(3) Energy (4) Sugar

Q.42 The electron ejected by P_{680} in light reaction is initially accepted by

(1) Plastoquinone (2) ATP

(3) Ferredoxin (4) P-700

Q.43 Decreased rate of photosynthesis at high concentration of O_2 is referred to as

(1) Pasteur effect (2) Emerson effect

(3) Warburg effect

(4) Richmond lang effeect

Q.44 Which element are presents in OEC (Oxygen evolving complex)

(1) Mn^{++} (2) Cl^-

(3) Ca^{++} (4) All

Q.45 Which one is Cu^{++} containing protein complex : -

(1) Ferridoxin (2) Plastocyanin

(3) Plastoquitnone (4) Cytochrome

Q.46 Pigment system-I is concerned with

(1) Photolysis

(2) Cyclic photophosphorylation

(3) Non-cylic photophosphorylation

(4) Oxidative phosphorylation

Q.47 The important role of PS-II in photosynthesis is

(1) To cause photolysis of water

(2) To release energy

(3) To trap & assimilate CO_2

(4) To reduce NAD to $NAD.H_2$

Q.48 The first electron carrier molecule from P_{700} to $NADP^+$ is believed to be

(1) Cytochrome

(2) Cu protein/Plastcyanin

(3) FeS protein/Ferredoxin

(4) Fe-Mg protein

Q.49 In plants, hill reaction occurs

(1) All the time

(2) Only in day time

(3) Only when the plants are grown in cold climate of hills

(4) When the plant carries out up hill task of salt absorption and food translocation

Q.50 Pigment system-II occur

(1) Grana (2) Stroma

(3) Matrix (4) Oxysomes

Q.51 The excess energy of e^- (in ETS) is used in the systhesis of :-

(1) ATP from ADP & –ip

(2) $NADPH_2$ from NADP

(3) Organic compounds

(4) ADP from ATP

Q.52 During photosynthesis

(1) Water is reduced & CO_2 is oxidized

(2) CO_2 is reduced & water is oxidized

(3) Both CO_2 & water get reduced

(4) Both CO_2 & water get oxidized

Q.53 Photolysis is related to

(1) Clavin cycle (2) H.S.K. cycle

(3) Cylic photophosphorylation

(4) Non cyclic flow of electrons

Q.54 Connecting link between light phase and dark phase of photosynthesis

(1) Only ATP (2) Only $NADH_2$

(3) Only $NADPH_2$ (4) Both (1) and (3)

Q.55 When the two pigment systems absorb light in what direction does the energy flow between them

(1) PS-I → PS-II (2) PS-II → PS-I

(3) PS-II-PS-I (4) None of the above

Q.56 Which photosynthetic pigment converts nascent oxygen to molecular oxygen : -

(1) Chlorophyll-a (2) Carotenoids

(3) Phycobilins (4) Chlorophyll-b

Q.57 Hill reaction occurs in : -

(1) High altitude plants

(2) Total darkness

(3) Presence of ferricyanide

(4) Absence of water

Q.58 Which cofactor is necessary for photolysis of water

(1) Mg (2) Mn

(3) Fe (4) Cu

Q.59 Who proposed Z-scheme of light reaction

(1) Arnon (2) Calvin and Bensen

(3) Emmerson and Arnon

(4) Blackman

Q.60 Detail study of pigment systems made by

(1) Robert Hill (2) H.P. Nanda

(3) Govindji (4) Emmerson

Q.61 Which of the following absorb light energy for photosynthesis : -

(1) Chlorophyll (2) Water molecule

(3) O_2 (4) RUBP

DARK REACTIONS (C_3-PLANTS, C_4-PLANTS CAM-PLANTS)

Q.62 In photosynthesis CO_2 combines with

(1) RUDP/RUBP (2) ATP

(3) ADP (4) PGA

Q.63 During the dark reactions of photosynthesis :-

(1) Water splits

(2) CO_2 is reduced to organic compounds

(3) Chlorophyll is activated

(4) C_6-sugar is broken into three carbon sugars

Q.64 The first stable product of photosynthesis in C-3 plants is : -

(1) 3-phosphoglyceric acid

(2) Dihydroxyacetone phosphate

(3) Fructose-1, 6-diphosphate

(4) Ribulose-1, 5-dil phosphate

Q.65 The enzyme that fixes atmospheric CO_2 in C_4 plants is : -

(1) PEP carboxylase (2) Hexokinase

(3) RUBP oxygenase (4) Hydrogenase

Q.66 During photosynthesis when PGA is changed into phosphoglyceraldehyde which of the following reaction occur : -

(1) Oxidation (2) Reduction

(3) Electrolysis (4) Hydrolysis

Q.67 Which one of the following is a C_4 plant :-

(1) Papaya (2) Potato

(3) Maize (4) Pea

Q.68 Carbon refixation in C_4 plants occurs in chloroplasts of :-

(1) Palisade tissue (2) Sprongy Mesophyll

(3) Bundle sheath cells

(4) Gaurd cells

Q.69 Tropical plants like sugarcane show high efficiency of CO_2 fixation because of : -

(1) Calvin cycle (2) Hatch-Slack cycle

(3) Cyclic photophosphorylation

(4) TCA Cycle

Q.70 "Kranz" type of Anatomy is found in : -

(1) C_4 plant (2) C_3 plant

(3) Succulents (4) None of the above

Q.71 Carbon dioxide acceptor in C_4 plants is : -

(1) Phosphoenol pyruvic acid (PEP)

(2) Ribulose-1, 5-dil phosphate

(3) NADP

(4) Ribulose-5- phosphate

Q.72 What is the first stable intermediate product of photosynthesis : -

(1) Glucose (2) Formaldehyde

(3) Phosphoglyceric acid

(4) PGAL

Q.73 All the reactions from the reduction of CO_2 to the formation of sugar are included in :-
(1) Light reaction (2) Photolysis
(3) Dark reaction (4) Hill reaction

Q.74 Ribulosediphosphate carboxylase enzyme, catalyse the carboxylation reaction between
(1) CO_2 and ribulose-1, 5-diphosphate
(2) Oxalloacetic acid and acetyl Co-A
(3) PGA and dihydroxyacetone phosphate
(4) Ribulosediphosphate and phosphate glycerldehyde

Q.75 Which of the following is C-4 plants
(1) Maize (2) Atriplex
(3) Sugarcane (4) All of the above

Q.76 "Kranz Anatomy" is found in
(1) Flower (2) Seed
(3) Leaves (4) Stem

Q.77 C-4 plants are adapted to
(1) Hot and dry climate
(2) Temperate climate
(3) Cold and dry climate
(4) Hot and Humid climate

Q.78 C-4 plants are found among
(1) Only gramineae
(2) Only monocot
(3) Only dicot
(4) Monocots as well as dicots

Q.79 In case of C-4 pathway, in the first step is
(1) CO_2 combines with RUDP
(2) CO_2 combines with PGA
(3) CO_2 combines with PEP
(4) CO_2 combines with RMP

Q.80 The enzyme which catalyzes the photosynthetic C_4 cycle is
(1) RUDP carboxylase
(2) PEP carboxylase
(3) Carbonic anhydrase
(4) None of these

Q.81 The family in which many plants are C_4 type
(1) Malvaceae (2) Solanaceae
(3) Crucifereae (4) Graminae

Q.82 In dark reaction, first reaction is the
(1) Carboxylation (2) Decarboxylation
(3) Dehydrogenation (4) Deamination

Q.83 Number of ATP molecules required for regeneration phase of RUBP during synthesis of 1 glucose molecule.
(1) 6 (2) 12
(3) 18 (4) 30

Q.84 Which of the following is likely to be the first substance that a green plant makes in photosynthesis : -
(1) A simple sugar (2) Starch
(3) Fats (4) Proteins

Q.85 Isotopes employed to study the process of photosynthesis reaction.
(1) S^{35} and P^{32} (2) C^{14} and O^{18}
(3) N^{14} and Co^{60} (4) N^{14} and O^{18}

Q.86 Chloroplast is present in bundle sheath cells of
(1) C_3-plants (2) C_4 plants
(3) CAM plants
(4) Photorespiring plants

Q.87 CO_2 is accepted by RUBP in C_4 plants in
(1) Mesophyll cells
(2) Bundle sheath cells
(3) Stomatal gaurd cells
(4) Epidermal cells

Q.88 How many type of photosynthetic cells occur in C_4 plant is
(1) One type (2) Two type
(3) Four type (4) Eight type

Q.89 Bundle sheath chloroplast of C_4 plant are :-
(1) Large & agranal (2) Large & granal
(3) Small & agranal (4) Small & granal

Q.90 Most efficient photosynthesis & presence of bundle sheath chloroplast are characteristics of
(1) C_3 - plants (2) C_2 plants
(3) C_4 plants (4) CAM plants

Q.91 In C_4 pathway the fixation of CO_2 by PEPCase occurs in
(1) Palisade tissue (2) Mesophyll
(3) Bundle sheath (4) Gaurd cell

Q.92 Sythesis of fructose in C_4 pathway occurs in the chloroplast of
(1) Spongy mesophyll
(2) Bundle sheath cells
(3) Gaurd cells
(4) Palisade tissue

Q.93 C_2 and C_3 cycles predominantly operates in
(1) Cytoplasm and mitochondria
(2) Mitochondria and peroxysome
(3) Peroxisome and stroma
(4) Stroma and grana of chloroplast

Q.94 In addition to the 12 molecules of $NADP.H_2$ the energy required for the synthesis of one mole of hexose by C_3 and C_4 pathway is
(1) 18 molecules of ATP
(2) 30 molecules of ATP
(3) 18 & 30 molecules of ATP respectively
(4) 30 & 18 molecules of ATP respectively

Q.95 How many molecules of water are needed by a green plant to produce one molecule of hexose/reduce 6 molecules of CO_2
(1) 6 (2) 12
(3) 24 (4) 1

Q.96 How much energy in terms of ATP equivalents is consumed in the photosynthetic production of a mole of hexose
(1) 36 ATP e (2) 38 ATP e
(3) 40 ATP e (4) 54 ATP e

Q.97 How many molecules of water would be consumed to support one calvin cycles
(1) One (2) Two
(3) Four (4) Six

Q.98 How many calvin cycles would generate one molecules of glucose/hexose
(1) One cycles (2) Three cycles
(3) Six cycles (4) Twelve cycles

Q.99 CAM - plants are mainly
(1) Succulent xerophyte
(2) Hydrophtytes
(3) Epihytes
(4) None of the above

Q.100 Hatch and Slack pathway occurs in
(1) Amaranthus (2) Atriplex-rosea
(3) Saccharum (4) All of the above

Q.101 The first stable product of calvin cycle and HSK-cycle are
(1) 4-C and 3-C compounds
(2) 4-C and 6-C compounds
(3) 3-C and 4-C compounds
(4) 5-C and 4-C compounds

Q.102 Which one is the first seven carbon compound in the C_3 cycle
(1) SHP (2) DHAP
(3) SHDP (4) FDP

Q.103 Which compound is four carbon compound in the C_3 cycle
(1) Erythrose-P (2) DHAP
(3) PGAL (4) OAA

Q.104 Term-Apoplast & symplast first used by : -
(1) Clark (2) Munch
(3) Dixon (4) Lundegardh

Q.105 In Photosyntheisis energy from light reaction to dark reaction is transferred in the form of : -
(1) ADP (2) ATP
(3) RUDP (4) Chlorophyll

Q.106 The rate of photosynthesis does not depend upon
(1) Light duration (2) Light intensity
(3) Light quality (colour)
(4) Temperature

Q.107 Optimum temperature of photosynthesis is :-
(1) 10 – 15ºC (2) 20 - 25ºC
(3) 20 - 35ºC (4) 35 - 50ºC

Q.108 Which one of the following have high CO_2 compensation point :-
(1) C_2 plants (2) C_3 plants
(3) C_4 plants (4) Alpine herbs

Q.109 Solarisation is a process in which : -
(1) Sugar are formed with the help of solar energy
(2) Chlorophyll is formed
(3) Destruction of chlorophyll and ultimate death of protoplasmic components
(4) Mobilization of light energy

Q.110 Accumlation of food in assimilatory cells results in

(1) Increase in the rate of photosynthesis

(2) Decrease in the rate of photosynthesis

(3) No effect

(4) May increase or decrease

Q.111 The principle of limiting factor was given by:-

(1) Hill (2) F.F. Blackman

(3) Will statter ans stoll

(4) Calvin

Q.112 Etiolated plants are formed due to lack of

(1) Light (2) Hg

(3) Fe (4) Mg

Q.113 During day light hours, the rate of photosynthesis is higher than that of respiration and the ratio of oxygen produced to that of consumed is

(1) 10 : 1 (2) 5 : 1

(3) 1 : 1 (4) 50 : 1

Q.114 Substrate for photorespiration is

(1) Serine (2) Glycolate

(3) Indole acetic acid (4) Malic acid

Q.115 Generally atmo. CO_2 is not limiting for hydrophytes

(1) Mesophytes plants fix H_2S in their photosynthesis

(2) These plants obtain CO_2 from water in the form of HCO^-_3

(3) Glucose is not required for their respiration

(4) All the above

Q.116 What is called "warburg's effect" on photosynthesis

(1) Low rate of process due to O_2 supply

(2) Low rate of the prcoess due to CO_2 supply

(3) Both (1) & (2)

(4) None of the above

Q.117 Photorespiration is favoured by

(1) Low light intensity

(2) Low O_2 and high

(3) Low temperature

(4) High O_2 and Low CO_2

Q.118 Bacterial photosynthesis involves

(1) PS - I only

(2) PS-II only

(3) Both PS-I & PS-II

(4) None of the above

Q.119 Photorespiration occurs in

(1) Mitochondria (2) Chloroplast

(3) Peroxisome (4) Cytoplasm

Q.120 What is C_2 - Cycle

(1) Glycolate cycle (2) Clavin cycle

(3) Kreb's cycle (4) TCA - cycle

Q.121 Drocera is photosyntheic plant but still captures insects why ?

(1) Grown in N_2 rich soil

(2) Grown in N_2 deficient soil

(3) It is connnecting plant between plants and animals

(4) Insects helps in its pollination

Q.122 Plants which exhibit photorespiration are :

(1) C_4 plants (2) C_3 plants

(3) CAM plants (4) Alpine plants

Q.123 Glycolate accumulates in chloroplast at

(1) Low temp. (2) Low CO_2

(3) Bright illumination (4) High CO_2

Q.124 Which of the following plants are Low CO_2 compensation plants

(1) C_3 - plants (2) C_4-plants

(3) C_2 - plants (4) Alpine plants

Q.125 In photorespiring plants the atmospheric CO_2 is fixed via-

(1) HSK-cycle (2) Kreb's cycle

(3) Calvin cycle (4) Glycolate cycle

Q.126 Compensation point means

(1) When the rate of photosynthesis is equal to rate of respiration

(2) When there is neither photosynthesis nor respiration

(3) When the entire food manufactured in photosynthesis remains unutilized

(4) When availabilty of water equalise with necessity of water

Q.127 At the compensation point there will not be
(1) Any photosynthesis
(2) Any gaesous exchange between the plant and its environment
(3) Any respirationin in plants
(4) Loss in weight of the plant in dark

Q.128 What does not occur in photorespiration
(1) Utilization of O_2 (2) Production of CO_2
(3) Synthesis of ATP (4) All the above

Q.129 DCMU is an inhibitor of
(1) PS-I (2) PS-II
(3) Calvin cycle (4) Kreb's cycle

Q.130 Which of the following plants can carry out photosynthesis even at –20ºC/below freezing point :
(1) Palms (2) Marine algae
(3) Diatoms (4) Lichens

Q.131 Photorespiration occur during
(1) Respiration (2) Photosynthesis
(3) Transpiration (4) Translocation

Q.132 Photorespiration is discovered by
(1) Decker & Tio (2) Van sachs
(3) Rouhani (4) O-leri

Q.133 Photorespiration is favoured by
(1) High light intensity
(2) High temperature
(3) High O_2 concentration
(4) All of the above

Q.134 Photorespiration does not occurs in
(1) C-4 plants (2) C-3 plants
(3) C-2 plants (4) None of these

Q.135 What is the value of temperature coefficient (Q_{10}) for dark reaction
(1) 1 (2) 2 or 3
(3) Both (4) None of the above

Q.136 Main factor which limits the rate of photosynthesis on a clear day is
(1) Chlorophyll (2) Light
(3) CO_2 (4) Water

Q.137 Photosynthetic bacteria differ from green plants in
(1) Nature of their pigments
(2) Type of electron donors
(3) Photosynthetic process being non oxygenic
(4) All of the above

Q.138 What is meant by photolysis of water ?
(1) Breakdown of water by light
(2) Breakdown of water by chloroplast
(3) Breakdown of water by illuminated chloro plast
(4) Break down of illuminated water in the presence of H acceptors

Q.139 Who gave the detailed structure of chlorophyll?
(1) Arnoff and Allen
(2) Willstatter and Stahl
(3) Hill and Scarisbrik
(4) Woodward

Q.140 Granum is formed from –
(1) Thylakoids (2) Pigments
(3) Thylakoids with pigments
(4) Stroma and thylakoids

Q.141 Which is called the universal molecule ?
(1) Chlorophyll–a (2) Chlorophyll–b
(3) β–Carotene (4) None of the above

Q.142 Which of these is a molecule of bacteriochlorophyll –a ?
(1) $C_{55}H_{72}O_5N_4Mg$ (2) $C_{55}H_{70}O_6N_4Mg$
(3) $C_{55}H_{74}O_6N_4Mg$ (4) $C_{55}H_{72}O_6N_4Mg$

Q.143 Who protects chlorophyll against photo–oxidation ?
(1) Carotenes (2) Xanthophylls
(3) (1) and (2) above mentioned
(4) Biliproteins

Q.144 Generally phycobilins are found in –
(1) Algae
(2) Red & Blue–green algae
(3) Higher plants (4) Bacteria

Q.145 Which molecules are found in pigment system I (PS–I) ?
(1) Only ChL–a
(2) Chl–a and Phycobilin
(3) Chl–a but also Chl–b and carotenoids
(4) Chl–b and rest accessory pigments

Q.146 Of which pigment system, P–700 is the trap centre ?
(1) PS–I (2) PS–II
(3) Both of above (4) None of the above

Q.147 Which of these is found in PS–I ?
(1) FRS, Cyt.f. Cyt.b–6
(2) Mn, Cyt.b. 559, Cyt.f
(3) Plastoquinone, Plastocyanin
(4) All of the above

Q.148 It is found in stroma lamellae –
(1) PS–I (2) PS–II
(3) PS–I & PS–II both
(4) None of the above

Q.149 Which ion is required for photolysis of water?
(1) Mg^{++} (2) Fe^{++}
(3) Mn^{++} (4) Ca^{++}

Q.150 From which source charged molecule of P–680 gets the electron ?
(1) From P–700 (2) From water
(3) From $NADPH_2$ (4) None of the above

Q.151 Glucose is formed –
(1) On Grana (2) In Stroma
(3) Both of above (4) None of the above

Q.152 Which accepts CO_2 during CO_2 fixation in C_3 cycle ?
(1) RUDP (2) Pep
(3) Both of above (4) RUMP

Q.153 What is the first stable product in C_3 Cycle?
(1) PGA (2) OAA
(3) PGAL (4) DiHAP

Q.154 C_4 cycle is found in –
(1) Monocots (2) Dicots
(3) Both of above (4) Gymnosperms

Q.155 In how many families of plants, C_4 cycle is known ?
(1) 7 families (2) 13 families
(3) 17 families (4) 27 families

Q.156 It is not found in C_4 plants –
(1) Photosynthesis (2) Photorespiration
(3) Phototropism (4) C-4 cycle

Q.157 Which of these can photosynthesize effectively at high temperature and low CO_2 conc ?
(1) C_3 plant (2) C_4 plant
(3) Both of above (4) None of these

Q.158 Who gave the three cardinal points theory for physiological reactions ?
(1) Sachs (2) Leibig
(3) Blackman (4) Warburg

Q.159 The cardinal points affecting physiological reactions are –
(1) One (2) Two
(3) Three (4) Four

Q.160 What is the value called after which if it increases than the reaction stops ?
(1) Minimum value (2) Maximum value
(3) Optimum value (4) None of the above

Q.161 At a certain brightness of light, gaseous exchange from photosynthetic region stops. This brightness is called –
(1) CO_2 compensation point
(2) Light saturation point
(3) Light compensation point
(4) CO_2 saturation point

Q.162 Carbon dioxide is necessary of photosynthesis. The chemical used to remove this gas most effectively from entering a control apparatus is-
(1) Distilled water
(2) Sodium carbonate
(3) Calcium oxide
(4) Potassium hydroxide solution

Q.163 Assimilatory powers produced during photosynthesis are –
(1) RuDP and RuMP(2) H_2O and O_2
(3) ATP and $NADPH_2$
(4) $C_6H_{12}O_6$ and PGAL

Q.164 Hill reaction was demonstrated in the –
(1) Absence of CO_2
(2) Presence of carbon dioxide
(3) Presence of a suitable electron acceptor
(4) None of these

Q.165 Match the names of scientists given under column I with their important contributions given under column II ; choose the answer which gives correct combination of the alphabets :

Column I (Scientists)	**Column II (Contributions)**
A. Peter Mitchell	p. Steps of dark reaction of photosynthesis
B. J.W. Gibbs	Photosynthetic phosphorylation
C. Danial Aron	r. Concept of free energy
D. Melvin Calvin	s. Chemiosmotic hypothesis
	t. Mass flow hypothesis

(1) A = s, B = r, C = q, D = p
(2) A = r, B = s, C = p, D = q
(3) A = s, B = t, C = r, D = q
(4) A = s, B = r, C = p, D = q

Q.166 The name Melvin Calvin is associated with–

(1) Synthesis of ATP during photosynthesis

(2) Release of water during photosynthesis

(3) Carbon fixation during photosynthesis

(4) Capature light energy during photosynthesis

Q.167 Considering all plants the process of photosynthesis can occur –

(1) In roots

(2) In shoots

(3) Any cell of the plant

(4) Chlorophyll rich cells of the plant

Q.168 In the initial fixation of CO_2 in C_3 plants

(1) CO_2 reacts with PGA

(2) CO_2 react with PEPA

(3) CO_2 reacts with RuBP

(4) CO_2 rects with RuMP

Q.169 That in photosynthesis there are two pigment systems and two phtosystems was discovered by –

(1) Hill (2) Emerson

(3) Blackman (4) Arnon

Q.170 Emerson found red drop in wavelength –

(1) 660 nm (2) 670 nm

(3) 680 nm (4) 680-700 nm

Q.171 Of the total amount of water absorbed by the plant, its actual percentage used during photosynthesis is –

(1) 50% (2) 90%

(3) hardly 1% (4) 25%

Q.172 Which plant was used by Robert Hill in Hill's reaction ?

(1) Chlorella (2) Tradescantia

(3) Spinach (4) Stellaria

ANSWER KEY

EXERCISE - 1

Q.1	2	Q.2	1	Q.3	4	Q.4	3	Q.5	3	Q.6	3	Q.7	1
Q.8	1	Q.9	4	Q.10	2	Q.11	4	Q.12	1	Q.13	4	Q.14	2
Q.15	4	Q.16	1	Q.17	4	Q.18	3	Q.19	2	Q.20	2	Q.21	2
Q.22	4	Q.23	4	Q.24	3	Q.25	2	Q.26	4	Q.27	3	Q.28	1
Q.29	4	Q.30	2	Q.31	1	Q.32	2	Q.33	2	Q.34	3	Q.35	2
Q.36	2	Q.37	3	Q.38	3	Q.39	4	Q.40	3	Q.41	2	Q.42	1
Q.43	3	Q.44	4	Q.45	2	Q.46	2	Q.47	1	Q.48	3	Q.49	2
Q.50	1	Q.51	1	Q.52	2	Q.53	4	Q.54	4	Q.55	2	Q.56	2
Q.57	3	Q.58	2	Q.59	1	Q.60	3	Q.61	1	Q.62	1	Q.63	2
Q.64	1	Q.65	1	Q.66	2	Q.67	3	Q.68	3	Q.69	2	Q.70	1
Q.71	1	Q.72	3	Q.73	3	Q.74	1	Q.75	4	Q.76	3	Q.77	1
Q.78	4	Q.79	3	Q.80	2	Q.81	4	Q.82	1	Q.83	1	Q.84	1
Q.85	2	Q.86	2	Q.87	2	Q.88	2	Q.89	1	Q.90	3	Q.91	2
Q.92	2	Q.93	3	Q.94	3	Q.95	2	Q.96	4	Q.97	2	Q.98	3
Q.99	1	Q.100	4	Q.101	3	Q.102	3	Q.103	1	Q.104	2	Q.105	2
Q.106	1	Q.107	3	Q.108	2	Q.109	3	Q.110	2	Q.111	2	Q.112	1
Q.113	1	Q.114	2	Q.115	2	Q.116	1	Q.117	4	Q.118	1	Q.119	3
Q.120	1	Q.121	2	Q.122	2	Q.123	2	Q.124	2	Q.125	3	Q.126	1
Q.127	2	Q.128	3	Q.129	2	Q.130	4	Q.131	2	Q.132	1	Q.133	4
Q.134	1	Q.135	2	Q.136	3	Q.137	4	Q.138	3	Q.139	2	Q.140	3
Q.141	1	Q.142	3	Q.143	3	Q.144	2	Q.145	3	Q.146	1	Q.147	1
Q.148	1	Q.149	3	Q.150	2	Q.151	2	Q.152	1	Q.153	1	Q.154	3
Q.155	2	Q.156	2	Q.157	2	Q.158	1	Q.159	3	Q.160	2	Q.161	3
Q.162	4	Q.163	3	Q.164	3	Q.165	1	Q.166	3	Q.167	4	Q.168	3
Q.169	2	Q.170	4	Q.171	3	Q.172	4						

EXERCISE - 2

Q.1 Oxygen which is liberated during photosynthesis comes from-
(1) Carbon di oxide (2) Water
(3) Chlorophyll
(4) Phosphoglyceric acid

Q.2 Nine-tenth of the world photosynthesis is carried out by-
(1) Shrubs (2) Herbs
(3) Trees (4) Algae

Q.3 The process of taking in CO_2 by plants and releasing O_2 is termed as-
(1) Transpiration (2) Respiration
(3) Photosynthesis (4) Endosmosis

Q.4 In plants during the process of photosynthesis-
(1) CO_2 is taken in (2) O_2 is taken in
(3) CO_2 is taken out
(4) O_2 is taken in and CO_2 is given out

Q.5 Our present day view regarding photosynthesis is that-
(1) Converts light energy into chemical energy
(2) Creates useful energy
(3) Fixes CO_2 into carbohydrates
(4) Reverse the action of respiration

Q.6 In which of the following process, the light energy is converted into chemical energy-
(1) Digestive action (2) Respiration
(3) Photosynthesis (4) Fermentation

Q.7 The dark reaction in photosynthesis is called so because-
(1) It can only occur in dark
(2) It does not require light
(3) None of these
(4) Both (1) and (2)

Q.8 During photosynthesis the oxygen in glucose comes from-
(1) Water (2) Carbon di oxide
(3) O_2 in air
(4) Both from water and CO_2

Q.9 The law of limiting factor for photosynthesis was given by-
(1) R. Hill (2) Krebs
(3) Calvin (4) Blackman

Q.10 The percentage of light energy utilized by higher plants, in the process of photosynthesis is -
(1) 100% (2) 10%
(3) 50% (4) 1-2%

Q.11 Photosynthesis is most active in-
(1) Sun light (2) Yellow light
(3) Red light (4) Green lights

Q.12 Beside water and light which is more essential as a raw material for food formation-
(1) CO_2 (2) O_2
(3) NADP (4) Mineral salts

Q.13 The concentration of CO_2 in the atmosphere is approximately-
(1) 0.003% (2) 0.03%
(3) 0.30% (4) 3.00%

Q.14 If the CO_2 content of the atmosphere is as high as 300 parts per million-
(1) All plants would be killed
(2) The plants would not grow properly
(3) Plants would grow for some time and then die
(4) The plants would thrive wells

Q.15 R.Hill used a dye for his famous Hill-reaction-
(1) Dichlorophenol indophenol DCPIP
(2) Sulphur green
(3) Methylene blue
(4) Eosine

Q.16 The isotope of carbon used extensively for studies in photosynthesis-
(1) C^{13} (2) C^{14}
(3) C^{15} (4) C^{16}

Q.17 Which is the evidence to show that oxygen released in photosynthesis comes from water-
(1) Isotopic oxygen (O^{18}) supplied as H_2O appears in the O_2 released in photosynthesis
(2) Activated chloroplast in water released O_2 if supplied potassium ferrocyanide or some other reducing agent in the absence of CO_2
(3) Photosynthesis bacteria use H_2S and CO_2 to make carbohydrates, H_2O and sulphur
(4) All of the above

Q.18 The path of CO_2 in the dark reaction of photosynthesis was successfully traced by the use of the following-

(1) $O_2{}^{18}$ (2) $C^{14}O_2$

(3) P^{32} (4) X-rays

Q.19 Discovery of Emerson effect has already shown the existence of-

(1) Two distinct photosystems

(2) Light and dark reactions of photosynthesis

(3) Photophosphorylation

(4) Photorespiration

Q.20 The colour of light not utilized during photosynthesis is-

(1) Violet (2) Green

(3) Red (4) Blue

Q.21 During the process of photosynthesis the raw materials used are-

(1) Glucose (2) Chlorophyll

(3) Starch (4) CO_2 and H_2O

Q.22 Products of photosynthesis are :-

(1) Carbon dioxide and food material

(2) Cabohydrates and oxygen

(3) Carbon dioxide and oxygen

(4) Formaldehyde and nitrogen

Q.23 Usually the process of photosynthesis is :

(1) Slower than respiration

(2) Faster than respiration

(3) Equal to respiration

(4) Any of the above is possible

Q.24 Name the scientist, who first pointed out that plants purify foul air by bell jar experiment.

(1) Willstatter (2) Robert Hooke

(3) Priestley (4) Iean Senebier

Q.25 Of the total amount of water absored by the plant, its actual percentage used during photosynthesis is : -

(1) 50% (2) 90%

(3) 1% (4) 25%

Q.26 It is only the green part of the plant, which takes part in

(1) Respiration (2) Transpiration

(3) Photosynthesis (4) Osmosis

Q.27 Moll's experiment explains that

(1) Carbon dioxide is essential for photosynthesis

(2) Chlorophyll and water are necessary for photosynthesis

(3) Light and water are essential for photosynthesis

(4) All the above are correct

Q.28 The chemical composition of pigments chlorophylls and carotenoids for the first time was given by :-

(1) Willstatter and Stoll

(2) Mayer and Anderson

(3) Robert Mayer

(4) Senebier

Q.29 Which of the following is not a significance of photosynthesis ?

(1) Glucose synthesis for most of consumer

(2) Increase in green house effect

(3) Provides O_2 for syntheesis of ozone umbrella

(4) Provides O_2 for cell respiration

Q.30 Oxygen during photosynthesis comes from water was proved by O^{18} experiment : -

(1) Ruben and Kamen

(2) Hill

(3) Warburg

(4) Blackman

Q.31 Name of the scientist who pointed out the importance of different wavelengths of light using a green algae and aerobic bacteria :-

(1) Priestley (2) Ingen-Housz

(3) K.V. Thimann (4) Engleman

Q.32 Conversion of light energy into chemical energy within the plant body was first stated by?

(1) Mayer and Anderson

(2) Calvin

(3) Robert Mayer

(4) Willstatter and Stoll

Q.33 Photosynthesis includes

(1) Light phase

(2) Dark phase

(3) Light and dark phase

(4) None of the above

Q.34 The rate of photosynthesis decreases if the wavelength of visible light exceeds 680 nm. This was shown by which scientist & what is its R ?

(1) Black man - Law of limiting factors

(2) Calvin & Benson - Photooxidation

(3) Emerson & Arnold - Red drop

(4) Ruben & Kamen - Photolysis

Q.35 Which of the following category of photosynthetic plants posses minimum transpiration ratio (TR).

(1) C_3-Plants (2) C_4-Plants

(3) CAM-Plants (4) All the above

Q.36 The most effective wavelength of visible light in photosynthesis in the region of which of the following ?

(1) Green (2) Yellow

(3) Red (4) Violet

Q.37 Photosynthesis is mainly responsible for the existence of

(1) Animals of this earth

(2) Plants on this earth

(3) Both plants and animals

(4) None of the above

Q.38 Which step of non cyclis photophosphorylation is blocked by DCMU ?

(1) Flow of e^- between PS I to Fd

(2) Flow of e^- between cyto b_6 to cyto. f

(3) Flow of e– between PC to PS I

(4) Flow of e– between PS II to PQ

Q.39 The radiant energy is tored in the form of chemical energy in -

(1) NADP (2) Stored food

(3) RNA (4) DNA

Q.40 How many quanta are required to reduce one molecule of CO_2 and produce one molecule of O_2 in green plant photosynthesis ?

(1) 1 (2) 8

(3) 16 (4) 32

Q.41 Photosynthesis is

(1) Oxidative, exergonic, catabolic

(2) Redox-reaction, endergonic, anabolic

(3) Reductive, exergonic, anabolic

(4) Reductive, endergonic, catabolic

Q.42 The significance of light & chlorophyll in photosynthesis was discovered by

(1) Priestley (2) Ingenhousz

(3) Englemann (4) Blackkan

Q.43 What is photosynthetic quotient ?

(1) O_2/CO_2 (2) CO_2/O_2

(3) O_2/Strach (4) Water/starch

Q.44 What is the common value of PQ (Photosynthetic quotient) of a leaf ?

(1) > 1 (2) < 1

(3) One (4) Zero

Q.45 Which of the following carries out non-oxygenic photosynthesis ?

(1) Caynobacteria (2) Crab grass

(3) Bacteria (4) Wheat plant

Q.46 What is the unique process which has supported life on this planet ?

(1) N_2 fixation (2) Photosynthesis

(3) Protein synthesis (4) Respiration

Q.47 Wavelength of light responsible for Emerson's enhancement effect : -

(1) only 680 nm↑

(2) only 680 nm↓

(3) infra red wavelength

(4) Both 680 nm↑ and 680 nm↓

Q.48 The "red - drop" phenomenon is due to the disruption of the photo chemical activity of

(1) PS - I

(2) PS-I & PS-II both

(3) PS - II

(4) Carotenoids

Q.49 True for photosynthesis : -

(1) Oxidation of CO_2 and reduction of H_2O

(2) Process which connects the biotic and abiotic world

(3) Exergonic process

(4) Oxidation of Glucose

Q.50 Which of the following order is correct about the rate of photosynthesis ?

(1) Blue > yellow > orange > red

(2) Blue > red > yellow > orange

(3) Red > blue > yellow > orange

(4) Yellow > orange > blue > red

Q.51 Who discoverd chlorophyll ?
(1) Schimper (2) Errera
(3) Coventou (4) Sachs

Q.52 Who discovered carotenoid ?
(1) Schimper (2) Willstatter
(3) Wakenroder (4) Warburg

Q.53 The process of photosynthesis takes place in
(1) Roots only
(2) Shoot only
(3) All the cells of plant
(4) Chlorophyll containing cells only

Q.54 Leaves appear green because
(1) They absorb green light
(2) They reflect green light
(3) They absorb & reflect green light
(4) They absorb & reflect white light

Q.55 First of all which organism creates oxidsing atmosphere on earth ?
(1) Cyanobacteria (2) Photosynthesis
(3) Ferns (4) Dicots

Q.56 During photosynthesis, oxygen is evolved from :-
(1) H_2S (2) H_2O
(3) CO_2 (4) HCO_3

Q.57 The process of photo-phosphorylation take place in -
(1) Chloroplast (2) Ribosomes
(3) Mitochondria (4) Cell-wall

Q.58 PS I occurs in
(1) Appressed part of granal thylakoids
(2) Appressed and non appressed part of grana thylakoids
(3) Stroma
(4) Stroma thylakoids and non-appressed part of grana thylakoids

Q.59 Photophosphorylation means synthesis of
(1) ATP from ADP (2) NADP
(3) ADP from ATP (4) PGA

Q.60 Which one of the following pigment does not occur in the chloroplast ?
(1) Carotene (2) Xanthophyll
(3) Chlorophyll 'b' (4) Anthocyanin

Q.61 Start of manufacture of chlorophyll in a plant seedling is stimulated by
(1) Gibberellins (2) Indole acetic acid
(3) Kinin (4) light

Q.62 Chlorophyll contains
(1) Fe (2) Mg
(3) K (4) Mn

Q.63 Which pigment is water soluble ?
(1) Chlorophyll (2) Carotene
(3) Anthocyanin (4) Xanthophyll

Q.64 Chloroplasts fix :
(1) Carbon dioxide (2) Oxygen
(3) Nitrogen (4) Hydrogen

Q.65 ATP formation during photosynthesis is termed-
(1) Phosphorylation
(2) Photophosphorylation
(3) Oxidative phosphorylation
(4) Photolysis

Q.66 The main site for dark reaction of photosynthesis is
(1) Stroma (2) Grana
(3) Intergrana (4) Mitochondria

Q.67 What will be left if chlorophyll is burnt ?
(1) Magnesium (2) Manganese
(3) Iron (4) Sulphur

Q.68 Chlorophyll is present : -
(1) In the grana of chloroplasts
(2) On the surface of chloroplasts
(3) Dispersed through out the chloroplasts
(4) In the stroma of chloroplasts

Q.69 Bacteriochlorophyll differs from chlorophyll 'a' in having : -
(1) One pyrrole nucleus with one hydrogen
(2) One pyrrole nucleus with two hydrogen
(3) One pyrrole nucleus with three hydrogen
(4) One pyrrole nucleus with four hydrogen

Q.70 Solar energy is converted into ATP in
(1) Mitochondria (2) Chloroplast
(3) Ribosome (4) Peroxisome

Q.71 In blue-green alage photosynthesis takes place in -
(1) Cloroplasts (2) Lamellisome
(3) Heterocysts (4) Carotene

Q.72 Conditions necessary for photosynthesis are :-
(1) Light and suitable temperature
(2) Chlorophyll and water
(3) Carbon dioxide
(4) All of the above

Q.73 Photosynthesis is maximum during : -
(1) Continuous weak light
(2) Continuous strong light
(3) Intermittent light
(4) None of the above

Q.74 Process of photophosphorylation was first given by
(1) Hill (2) Willstatter & Stoll
(3) Arnon (4) Park & Biggins

Q.75 Which colour of light gives maximum adsorption peak by chlorophyll"a" ?
(1) Blue light (2) Green light
(3) Violet light (4) Red light

Q.76 Which scientists are related with light reaction & what its site ?
(1) Arnon & Hill, Grana
(2) Ruben & Kamen, Stroma
(3) Willstatter, Stoll, inner membrane of chloroplast
(4) Calvin & Benson, outer membrane of chloroplast

Q.77 Presence of carotenes in chloroplast help in
(1) ATP synthesis
(2) Transferring radiant energy into chemical energy
(3) Protecting chlorophyll molecules from photooxidation
(4) Absorption of longer wavelength of light

Q.78 Ribulose bisphosphate carboxylase oxygenase (Rubisco) is located in
(1) Golgibodies (2) Peroxisome
(3) Chloroplast (4) Mitochondria

Q.79 Which of the following photosynthetic bacteria have both PS-I & PS-II ?
(1) Purple sulphur bacteria
(2) Cyanobacteria
(3) Purple non sulphur
(4) Gree sulphur bacteria

Q.80 The site of oxygen evolution and photosynthetic phosphorylation in chloroplast is : -
(1) Grana
(2) Matrix
(3) Surface of chloroplast
(4) Inner wall of chloroplast

Q.81 The formula of chlorophyll 'a' is
(1) $C_{35}H_{72}O_5N_4Mg$ (2) $C_{55}H_{70}O_3N_4Mg$
(3) $C_{55}H_{72}O_5N_4Mg$ (4) $C_{51}H_{70}O_6N_4Mg$

Q.82 The number of pigment molecules in quantasome is :
(1) 250 - 400 (2) 300 - 900
(3) 500 - 600 (4) 50 - 100

Q.83 The main difference between chlorophyll 'a' and 'b' is :
(1) Chlorophyll 'a' is a linear chain compound and 'b' is branched chain
(2) Chlorophyll 'a' has no Mg^+ ion in centre of molecule
(3) In chlorophyll 'a' three is $-CH_3$ group whereas in 'b' it is –CHO group
(4) All of the above

Q.84 For chorophyll formation in plants elements needed are
(1) Sodium and copper
(2) Calcium and potassium
(3) Iron and magnesium
(4) Iron and calcium

Q.85 Which one is the precursor of chlorophyll ?
(1) Tryptophan
(2) Protochlorophyll
(3) Bacterio chlorophyll
(4) Bacterioviridin

Q.86 The role of chlorophyll in photosynthesis is
(1) Absorption of CO_2
(2) Absorption of light
(3) Absorption of light and photochemical decomposition of water
(4) Absorption of water

Q.87 Chloroplast contains maximum quantity of
(1) Pyruvic carboxylase
(2) Hexokinase
(3) RUDP carboxylase
(4) None of these

Q.88 Chlorophyll 'a' is found in
(1) All O_2 releasing photosynthetic forms
(2) Only higher plants
(3) Higher plants that photosynthesize
(4) All photosynthetic eukaryotes

Q.89 In angiosperms, synthesis of chlorophyll occurs in presence of : -
(1) Phytochrome (2) Light
(3) Cytochrome (4) None of the above

Q.90 In pigment system-I active chlorophyll occurs in presence of : -
(1) P-600 (2) P-680
(3) P-700 (4) P-720

Q.91 Chlorophyll 'e' is generally present in
(1) Thallophytes (2) Rhodophytes
(3) Mycophytes (4) Xanthophytes

Q.92 In pigment system-II the trapping centre of light energy is -
(1) P-700 (2) P-680
(3) Carotene (4) Xanthopyll

Q.93 Basic structure of all chlorophyll comprises of
(1) Cytochrome sytem
(2) Flavoprotiens
(3) Porphyrin system
(4) Plastocyanin

Q.94 The chemical fomula of bacteriochlorophyll is
(1) $C_{55}H_{70}O_4N_4Mg$ (2) $C_{55}H_{72}O_5N_4Mg$
(3) $C_{55}H_{70}O_5N_4Mg$ (4) $C_{55}H_{74}O_6N_4Mg$

Q.95 What is the by product of bacterial photosynthesis ?
(1) O_2 (2) H_2S
(3) S (4) H_2S

Q.96 Photosynthetic bacteria do not contain
(1) PS - I (2) PS - II
(3) PS- I or PS-II (4) Quantasome

Q.97 In photosynthetic bacteria the photosynthesis takes place in
(1) Chloroplast (2) Chromoplast
(3) Chromatophores (4) Mesosomes

Q.98 What is the role of light in plants ?
(1) Necessary for photosynthesis
(2) Controls growth & Movement
(3) Controls distribution of hormones & flowering
(4) All of the above

Q.99 Photosynthetic units are referred as
(1) Quantasome (2) Oxysome
(3) Phycobilisome (4) F_1-particles

Q.100 Rubisco constitutes
(1) 4% of the chloroplast protein
(2) 11% of the chloroplast protien
(3) 16% of the chloroplast protien
(4) 25% of the chloroplast protein

ANSWER KEY

EXERCISE - 2

Q.1	2	Q.2	4	Q.3	3	Q.4	1	Q.5	1	Q.6	3	Q.7	2
Q.8	2	Q.9	4	Q.10	4	Q.11	1	Q.12	1	Q.13	2	Q.14	4
Q.15	1	Q.16	2	Q.17	4	Q.18	2	Q.19	1	Q.20	2	Q.21	4
Q.22	2	Q.23	2	Q.24	3	Q.25	3	Q.26	3	Q.27	1	Q.28	1
Q.29	2	Q.30	1	Q.31	4	Q.32	3	Q.33	3	Q.34	3	Q.35	3
Q.36	3	Q.37	3	Q.38	4	Q.39	2	Q.40	2	Q.41	2	Q.42	2
Q.43	1	Q.44	3	Q.45	3	Q.46	2	Q.47	4	Q.48	3	Q.49	2
Q.50	3	Q.51	3	Q.52	3	Q.53	4	Q.54	2	Q.55	1	Q.56	2
Q.57	1	Q.58	4	Q.59	1	Q.60	4	Q.61	4	Q.62	2	Q.63	3
Q.64	1	Q.65	2	Q.66	1	Q.67	1	Q.68	1	Q.69	2	Q.70	2
Q.71	2	Q.72	4	Q.73	3	Q.74	3	Q.75	1	Q.76	1	Q.77	3
Q.78	3	Q.79	2	Q.80	1	Q.81	3	Q.82	1	Q.83	3	Q.84	3
Q.85	2	Q.86	3	Q.87	3	Q.88	1	Q.89	2	Q.90	3	Q.91	4
Q.92	2	Q.93	3	Q.94	4	Q.95	3	Q.96	2	Q.97	3	Q.98	4
Q.99	1	Q.100	3										

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Photochemical reactions in the chloroplasts are directly involved in - **[Uttaranchal 2004]**

(1) Fixation of carbondioxide

(2) Synthesis of glucose and starch

(3) Formation of phosphoglyceric acid

(4) Photolysis of water and phosphorylation of ADP to ATP

Q.2 Which of the following elements are essential for the photolysis of water - **[Uttaranchal 2004]**

(1) Ca and Cl (2) Mn and Cl

(3) Zn and I (4) Cu and Fe

Q.3 Which of the following is involved in transfer of electrons in photosynthesis - **[Uttaranchal 2005]**

(1) Phytochrome (2) Cytochrome

(3) Photohormone (4) Desmosome

Q.4 Substrate for photorespiration is - **[Uttaranchal 2005]**

(1) Glycolate (2) Glucose

(3) Lipid (4) Sucrose

Q.5 In aquaria, green plants are grown for : **[Uttaranchal 2005]**

(1) Co_2 production (2) Strarch production

(3) O_2 Production (4) Increase beauty

Q.6 A structure known as peroxisomes is associated with - **[Uttaranchal 2006]**

(1) Photosynthesis (2) Respiration

(3) Photorespiration (4) Photophosphorylation

Q.7 In the mesophyll cells of CAM plants, CO_2 fixation during day occur through - **[Uttaranchal 2006]**

(1) RuBP-oxygenase (2) PEP-carboxylase

(3) RuBP-carboxylase

(4) Both RuBP carboxylase and PEP carboxylase

Q.8 The first electron acceptor in photosystem-I of cyclic photophosphorylation is - **[Uttaranchal 2006]**

(1) Cytochrome (2) Plastocyanin

(3) Ferredoxin (4) Plastoquinone

Q.9 Kranz anatomy is found in leaves of : **[West Bengal 2007]**

(1) C_3 plants (2) C_4 plants

(3) Both C_3 and C_4 plants

(4) None of these

Q.10 In bacterial photosynthesis - **[West Bengal 2007]**

(1) PS I is present (2) PS II is present

(3) Both PS I and PS II present

(4) None of these are present

Q.11 Which chlorophyll molecule does not have a phytol tail - **[West Bengal 2007]**

(1) chl a (2) chl b

(3) chl c (4) chl d

Q.12 Calvin, used algae in his experiment, for tracing out the path of carbon, the algae used were- **[West Bengal 2007]**

(1) Chlorella and Chlamydomonas

(2) Chlorella and Scenedesmus

(3) Chlorococcum and Chorella

(4) Chlorococuum and Scenedemus

Q.13 Which element is essential for photolysis of water: **[C.G. PMT 2004]**

(1) Nitrogen (2) Chlorine

(3) Carbon (4) Oxygen

Q.14 In C_4 plants, initial CO_2 fixation takes place in the chloroplasts of : **[C.G. PMT 2004]**

(1) Guard cells (2) Mesophyll cells

(3) Spongy tissue (4) Bundle sheath

Q.15 Which one of the following elements is required for photosynthetic oxygen evolution? **[C.G. PMT 2007]**

(1) Copper (2) Iron

(3) Manganese (4) Zinc

Q.16 Agranal chloroplasts occurs in -
[C.G. PMT 2005]
(1) Succulent (2) C_3 plants
(3) C_4 plants (4) Hydrophytes

Q.17 The wavelength of light most absorbed by chlorophyll-'a' during photosynthesis is :
[C.G. PMT 2005]
(1) 400 nm (2) 550 nm
(3) 660 nm (4) 700 nm

Q.18 Which are related with photorespiration :
[C.G. PMT 2005]
(1) Spherosome (2) Lysosomes
(3) Glyoxysomes (4) Peroxisomes

Q.19 Which of the following is a C_4 plant :
[C.G. PMT 2006]
(1) Sugarcane (2) Mango
(3) Apple (4) Tomato

Q.20 The first stable compound formed in photosynthesis of C_3 plants is :
[C.G. PMT 2006]
(1) Phosphoglyceric acid
(2) Starch
(3) Pyruvic acid
(4) Ribulose diphosphate

Q.21 Ferridoxine is component of :
[C.G. PMT 2006]
(1) PS-I (2) PS-II
(3) Hill reaction (4) P_{680}

Q.22 Correct percentage of CO_2 in atmosphere is:
[C.G. PMT 2006]
(1) 003% (2) 03%
(3) 1% (4) 11 %

Q.23 Isotopes used in photosynthesis were :
[C.G. PMT 2006]
(1) C^{11} and P^{32} (2) C^{15} and P^{32}
(3) C^{16} and P^{15} (4) C^{14} and O^{18}

Q.24 P_{680} is related with : **[C.G. PMT 2006]**
(1) PS-I (2) PS-II
(3) Hill reaction (4) None

Q.25 NADP reduces to $NADPH_2$ in :
[C.G. PMT 2006]
(1) PS-I (2) PS-II
(3) Calvin cycle (4) Non cyclic ETS

Q.26 Hills reaction completes in :
[C.G. PMT 2006]
(1) Light (2) Dark
(3) Both (4) None

Q.27 Who described C4 pathway for first time ?
[Jharkhand- 2006]
(1) Hatch and Slack (2) Robert Hill
(3) Hens Kerbs (4) Melvin Kelvin

Q.28 In photosynthesis, for synthesis of one mole of glucose number of ATP and $NADPH_2$ required is : **[Jharkhand- 2006]**
(1) 12 and 18 (2) 18 and 12
(3) 6 and 12 (4) 18 and 18

Q.29 The first acceptor of CO_2 in C_4 plant is -
[Jharkhand- 2005]
(1) Pyruvic acid
(2) Phosphoenol pyruvic and
(3) Acetic acid (4) Oxaloacetic acid

Q.30 Insectivorous plants usually survive in -
[Jharkhand- 2005]
(1) water rich soil
(2) N_2 deficient soil
(3) N_2 rich soil
(4) Sugar deficient medium

Q.31 In the process of photosynthesis water molecule breaks in : **[Jharkhand- 2005]**
(1) Red drop (2) Photolysis
(3) Phosphorylation
(4) Carbon assimilation

Q.32 Who proved that oxygen evolved in photosynthesis comes from water :
[Jharkhand- 2004]
(1) Calvin (2) Mayer
(3) Blackman
(4) Ruben,Hassid and Kamen

Q.33 The process in which water is split during photosynthesis is : **[Jharkhand- 2004]**

(1) Plasmolysis (2) Photolysis

(3) hydrolysis (4) haemolysis

Q.34 Which the following is used during discovery of calvin cycle ? **[Jharkhand- 2004]**

(1) Spirogyra (2) Volvox

(3) Chlamydomonas (4) Chlorella

Q.35 Which of the following is maximum in chloroplast ? **[Bihar- 2005]**

(1) RuBP caroxylase (2) Hexokinase

(3) Phosphatase (4) Nuclease

Q.36 O_2 released in the process of photosynthesis, comes from : **[Bihar- 2004]**

(1) CO_2 (2) water

(3) sugar (4) pyruvic acid

Q.37 The first carbon-dioxide acceptor in C_4 plants is : **[Bihar- 2003]**

(1) Phosphoenol pyruvate

(2) Oxalo acetic acid

(3) Phosphoglyceric acid

(4) Ribulose 1, 5-diphosphate

Q.38 The C_4 plants are different from the C_3 plants with reference to the : **[Bihar- 2003]**

(1) type of pigments involved in photosynthesis

(2) the number of NADPH that are consumed

(3) end product

(4) the substance that accepts CO_2 in carbon assimilation and first stable product

Q.39 Calvin cycle occurs in : **[Bihar- 2003]**

(1) Cytoplasm (2) Chloroplasts

(3) Mitochondria (4) Glyoxysomes

Q.40 Oxygen which is liberated during photosynthesis comes from : **[Bihar- 2002]**

(1) CO_2 (2) H_2O

(3) Phosphoglyceric (4) Chlorophyll

Q.41 Which one is produced during cyclic photo phosphorylation ? **[Bihar- 2001]**

(1) ATP and $NADPH_2$

(2) ATP only

(3) ATP and O_2 (4) $NADPH_2$

Q.42 A student sets up an experiment on photosynthesis as follows : **[Bihar- 2006]**

He takes soda water in a glass tumbler and add a chlorophyll into the contents and keeps the tumbler exposed to sunlight hoping that he has provided necessary ingredients for photosynthesis to proceed (viz. CO_2 H_2O, chlorophyll and light). What do you think what happen after, say a few hours of exposers of light ?

(1) Photosynthesis will take place and glucose will be produced

(2) Photosynthesis will take place and starch will be produced which turn the mixture turbid

(3) Photosynthesis will not take place because CO_2 dissolved in soda water escapes into the atmosphere

(4) Photosynthesis will not take place because intact chloroplasts are needed for the process

Q.43 The first reaction in photorespiration is : **[UP CPMT- 2001]**

(1) carboxylation (2) decarboxylation

(3) oxygenation (4) phosphorylation

Q.44 The law of limitting factor, in photosynthesis, was given by : **[UP CPMT- 2001]**

(1) R. Hill (2) Calvin

(3) Blackman (4) Amon

Q.45 Carbon dioxide acceptor in C_3 plants is - **[UP CPMT- 2001]**

(1) PEP (2) RuDP

(3) PGA (4) NADP

Q.46 Insectivorous plants grow in soils which are deficient in : **[UP CPMT- 2001]**

(1) Nitrogen (2) Calcium

(3) Magnesium (4) Carbohydrate

Q.47 Quantasomes are found in : **[UP CPMT- 2002]**

(1) Mitochondria (2) Chloroplast

(3) Lysosome

(4) Endoplasmic reticulum

Q.48 During photosynthesis : **[UP CPMT- 2002]**

(1) O_2 evolved come from CO_2

(2) ATP is formed

(3) ATP is not formed

(4) Water is required as medium but it does not take part in photosynthesis

Q.49 Cu is present in - **[UP CPMT- 2003]**

(1) Plasmalemma (2) Plastoquinone

(3) Plastocyanin (4) Ferredoxin

Q.50 In which of the following oxygen does not evolve during photosynthesis ? **[UP CPMT- 2003]**

(1) Photosynthetic red algae

(2) Photosynthetic green algae

(3) Photosynthetic blue-green algae

(4) Photosynthetic bacteria

Q.51 In the process of photosynthesis : **[UP CPMT- 2003]**

(1) O_2 is taken and CO_2 is evolved

(2) O_2 is taken and CO_2 is not evolved

(3) CO_2 is taken and O_2 is evolved

(4) CO_2 is taken and NO_2 is evolved

Q.52 Cuscuta is a : **[UP CPMT- 2003]**

(1) Parasitic plant (2) Symbiotic plant

(3) Predator (4) Decomposer

Q.53 In photosynthesis there is - **[UP CPMT- 2003]**

(1) Reduction of H_2O

(2) Oxidation of H_2O

(3) Oxidation of CO_2

(4) Oxidation of NO_2

Q.54 In case of C_4 plants the acceptor of CO_2 is: **[UP CPMT- 2004]**

(1) Phosphoglyceraldehyde

(2) Ribulose monophosphate

(3) Phosphoenol pyruvate

(4) Ribulose diphosphate

Q.55 The first step in light reaction of photosynthesis- **[UP CPMT- 2004]**

(1) Formation of ATP

(2) Ionization of water

(3) Attachment of CO_2 to a pentose sugar

(4) Excitement of electron of chlorophyll by a photon of light

Q.56 Sugarcane show high efficiency of CO_2 fixation because of : **[UP CPMT- 2004]**

(1) Calvin cycle

(2) Hatch and slake cycle

(3) TCA cycle (4) Greater sunlight

Q.57 Source of CO_2 for photosynthesis during day in CAM plants is - **[UP CPMT- 2005]**

(1) 3-PGA (2) Malic acid

(3) Oxalo-acetic acid (4) Pyruvate

Q.58 Chlorophyll has.....in its centre - **[UP CPMT- 2005]**

(1) Iron (2) Magnesium

(3) Copper (4) Sulphur

Q.59 Calvin cycle of C_4 plants operates in : **[UP CPMT- 2005]**

(1) Grana of mesophyll chloroplasts

(2) Stroma of chloroplasts in mesophyll cells

(3) Bundle sheath cells chloroplasts

(4) The statements is wrong

Q.60 Photorespiration takes place in - **[UP CPMT- 2005]**

(1) Chloroplast, mitochondria

(2) Mitochondria, peroxisome

(3) Bundle sheath chloroplasts

(4) Chloroplast, peroxisome, mitochondria

Q.61 Which one is false about kranz anatomy ? **[UP CPMT- 2005]**

(1) Bundle sheath cells have large chloroplast and less developed grana

(2) Mesophyll cells have large chloroplast and more developed grana

(3) It is found in Atriplex, sugarcane, maize

(4) Plant having it have better photosynthesizing power than C_3 plants

Q.62 Who discovered that CO_2 is taken in and O_2 is released by green plants ? **[UP CPMT- 2006]**

(1) Meyer (2) Ijugen Housz

(3) Senebier (4) Priestly

Q.63 Primitive photosynthetic plants utilize solar energy by : **[UP CPMT- 2006]**

(1) Cyclic photophosphorylation

(2) Z-scheme

(3) Both (1) and (2)

(4) Calvin cycle

Q.64 Which one of the following is a wasteful process ? **[UP CPMT- 2006]**

(1) Photorespiration (2) Respiration

(3) Photosynthesis (4) ETS

Q.65 DCMU- **[UP CPMT- 2007]**

(1) Inhibits PS-1

(2) Inhibits PS-II

(3) Destroy chloroplast

(4) Inhibits oxidative phosphorylation

Q.66 NH_3 releases from **[MP PMT- 2007]**

(1) Photorespiration (2) Dark respiration

(3) CAM (4) All of these

Q.67 Photosystem I and Photosystem II are found in : **[MP PMT- 2001]**

(1) Stroma of chloroplast

(2) Grana of chloroplast

(3) Matrix of mitochondria

(4) Inner membrane of mitochondria

Q.68 A cell organelle essential for photorespiration is : **[MP PMT- 2001]**

(1) Ribosome (2) Dictyosome

(3) Peroxisome (4) Glysoxisome

Q.69 In which of the following the rate of transpiration is high ? **[MP PMT- 2001]**

(1) CAM Plant (2) C_3 plants

(3) C_3 and C_4 (4) C_4 plants

Q.70 Of which cell organelle is grana is part **[MP PMT- 2002]**

(1) Mitochondria (2) Chloroplast

(3) Aleurone grain (4) Starch grain

Q.71 The substrate of photorespiration is : **[MP PMT- 2002]**

(1) Glycolate (2) Glucose

(3) Pyruvic acid (4) Acetyl COA

Q.72 The maximum light absorbed by the chlorophyll 'a' is at the wavelength of : **[MP PMT- 2002]**

(1) 460 nm (2) 500 nm

(3) 600 nm (4) 660 nm

Q.73 During photosynthesis, Oxygen is evolved from: **[MP PMT- 2002]**

(1) H_2S (2) H_2O

(3) CO_2 (4) HCO_3

Q.74 Which of the following acts as electron carrier in both photosynthesis and respiration ? **[MP PMT- 2003]**

(1) Ferredoxin (2) Phytochrome

(3) Cytochrome (4) Cryptochrome

Q.75 Photosynthetic unit is : **[MP PMT- 2003]**

(1) Glyoxysome (2) Spherosome

(3) Microsome (4) Quantasome

Q.76 Warburg effect is related with : **[MP PMT- 2003]**

(1) conc. of O_2 (2) conc. of N_2

(3) conc. of H_2 (4) conc. of Cl

Q.77 Stroma is the ground substance of ..... **[MP PMT- 2004]**

(1) Endoplasmic reticulum

(2) Mitochondria

(3) Nucleous

(4) Chloroplast

Q.78 From which of the following peroxisomes in plants are associated : **[MP PMT- 2004]**

(1) Photorespiration (2) Photosynthesis

(3) Photoperiodism (4) Phototropism

Q.79 In C_3 plants the first stable product of photosynthesis is : **[MP PMT- 2004,05,06]**

(1) Malic acid

(2) Oxaloacetic acid

(3) Phosphoglyceric acid (PGA)

(4) Phosphoglyceraldehyde (PGAL)

Q.80 The process of taking CO_2 by plants and releasing O_2 is known as: **[MP PMT- 2004]**

(1) Photosynthesis (2) Endosmosis

(3) Transpiration (4) Respiration

Q.81 Which of the colour of light is mostly absorbed by chlorophyll 'a'? **[MP PMT- 2005]**

(1) Green (2) Red

(3) Blue (4) Infra red

Q.82 In photosynthesis, ATP is synthesized during: **[MP PMT- 2005]**

(1) Cyclic photophosphorylation

(2) Non-cyclic photophosphorylation

(3) Both (1) and (2)

(4) In the photolysis of water

Q.83 which of the following element is essential for photolysis of water ? **[MP PMT- 2005]**

(1) Fe (2) Mg

(3) Mn (4) Cu

Q.84 Peroxisomes are concerned with : **[MP PMT- 2005]**

(1) Respiration (2) Photorespiration

(3) Photosynthesis (4) Flowering

Q.85 Reduction process of CO_2 and ATP formation in plants has relationship. In this reaction ATP is : **[MP PMT- 2005]**

(1) Formed (2) Utilised

(3) Not utilised (4) None of these

Q.86 ATP synthesis during photosynthesis is termed as : **[MP PMT- 2006]**

(1) Phosphorylation

(2) Oxidative phosphorylation

(3) Photophosphorylation

(4) Photorespiration

Q.87 Which of the following is used during discovery of calvin : **[RMPT-2002]**

(1) Spirogyra (2) Volvox

(3) Chlamydomoans (4) Chlorella

Q.88 Primay receptor of CO_2 in photosynthesis is : - **[RMPT-2002]**

(1) Phosphoric acid

(2) Ribulose phosphate

(3) Glucose

(4) Ribulcose-1,5-biphosphate

Q.89 In sugarcane plant $^{14}CO_2$ is fixed in malic acid, in which the enzyme that fixes CO_2 is **[AIPMT-2002]**

(1) Ribulose biphosphate carboxylase

(2) Phosphoenol pyruvic acid carboxylase (PEP-case)

(3) Ribulose phosphate kinase

(4) Fructose phosphatase

Q.90 Photorespiration in C_3 plants starts from : - **[AIMS-2003]**

(1) Phosphoglycerate

(2) Glycerate

(3) Glycine

(4) Phosphoglycolate

Q.91 The subtrate of photorespiration is : - **[MP PMT-2002]**

(1) Glycolate (2) Glucose

(3) Pyruvic acid (4) Acetyl CO-A

Q.92 Tracer elements are :- **[MP PMT -2002]**

(1) Micro-elements (2) Macro-elements

(3) Radio-isotopes (4) Vitamins

Q.93 Choose the correct match - **[AIPMT -2002]**

Bladderwort, sundew, venus flytrap : -

(1) Nepenthese, Dionea, Drosera

(2) Nepenthese, Utricularia, Vanda

(3) Utricularia, Drosera, Doionea

(4) Dionea, Trapa, Vanda

Q.94 Which of the following is wrong in relation to photorespiration : - **[AIPMT-2003]**

(1) It occurs is chloroplasts

(2) It occurs in daytime only

(3) It is a characteristic of C_4 plants

(4) It is a characteristic of C_3 plants

Q.95 Photosynthetically active radiation (PAR) represents the following range of wavelength : **[AIPMT-2004]**

(1) 400-700 nm (2) 500 - 600 nm

(3) 450 - 950 nm (4) 340 - 450 nm

Q.96 In C_3 plants, the first stable product of photosynthesis during the dark reaction is :- **[AIPMT-2004]**

(1) Phosphoglycereldehyde

(2) Malic acid

(3) Oxaloacetic acid

(4) 3-Phosphoglyceric acid

Q.97 Plants adapted to low light intensity have : - **[AIPMT-2004]**

(1) Leaves modified to spines

(2) Large photosynthetic unit size than the sun plants

(3) Higher rate of CO_2 fixation than the sun plants

(4) More extended root system

Q.98 In chloroplast, chlorophyll is present in the : **[AIPMT-2004]**

(1) Stroma (2) Outer membrane

(3) Inner membrane (4) Thylakoids

Q.99 Which one of the following categories of organisms do not evolve oxygen during photosynthesis : - **[AIMS-2004]**

(1) Red algae

(2) Photosynthetic bacteria

(3) C_4–plants with Kranz anatomy

(4) Blue green alage

Q.100 Which pair is wrong : - **[AIPMT-2001]**

(1) C_3 plant-maize

(2) Calvin cycle-PGA

(3) Hatch-Slack cycle-OAA

(4) C_4-plant-Kranz Anatomy

Q.101 Photosynthesis in C_4 plants is relatively less limited by atmospheric CO_2 levels because : **[AIPMT-2005]**

(1) Four carbon acids are the primary inital CO_2 fixation produts

(2) The primary fixation CO_2 is mediated via PEP carboxylase

(3) Effective pumping of CO_2 into bundlesheath cells

(4) Rubisco in C_4 plants has higher affinity for CO_2

Q.102 Chlorophyll in chloroplasts is located in : **[AIPMT-2005]**

(1) grana (2) pyrenoid

(3) stroma

(4) both grana and stroma

Q.103 As compared to a C_3-plant how many additional molecules of ATP are needed for net production of one molecule of hexose sugar by C_4-plants : **[AIPMT-2005]**

(1) two (2) six

(3) zero (4) twelve

Q.104 Carbohydrates, the most abundant biomolecules on earth, are produced by : **[AIPMT-2005]**

(1) all bacteria, fungi, and algae

(2) fungi, algae and green plant cells

(3) some bacteria, algae and green plants cells

(4) viruses, fungi and bacteria

Q.105 The deficiencies of micronutrients, not only affects growth of plants but also vital functions such as photosynthetic and mitochondrial electron flow. Among the list given belows, which group of three elements shell affect most, both photosynthetic and mitochondrial electron transport : **[AIPMT-2005]**

(1) Cu, Mn, Fe (2) Co, Ni, Mo

(3) Mn, Co, Ca (4) Ca, K, Na

Q.106 Chemiosmotic theroy of ATP synthesis in the chloroplasts and mitochondria is based on : **[AIPMT-2005]**

(1) Proton gradient

(2) Accumulation of K ions

(3) Accumulation of Na ions

(4) Membrane potential

Q.107 Photosynthetic Active Radiation (PAR) has the following range of wavelengths : **[AIPMT-2005]**

(1) 400-700 nm (2) 450-920 nm

(3) 340-450 nm (4) 500-600 nm

Q.108 In light reaction of photosynthesis oxygen is come from - **[RPMT-2005]**

(1) Water (2) CO_2

(3) Soil (4) Atmosphere

Q.109 Product of light reaction of photosynthesis is **[RPMT-2005]**

(1) Carbohydrate
(2) ATP
(3) NADP and O_2
(4) $NADPH_2$, ATP & O_2

Q.110 In photosytem-I, the first electron acceptor is **[AIPMT-2005]**

(1) Plastocyanin
(2) An iron-sulphur protein
(3) Ferredoxin
(4) Cytochrome

Q.111 The translocation of organic solutes in sieve tube members is supported by **[AIPMT-2006]**

(1) Mass flow involving a carrier and ATP
(2) Cytoplasmic streaming
(3) Root pressure and transpiration pull
(4) P-protein

Q.112 During photorespiration, the oxygen consuming reactions(s) occur in **[AIPMT-2006]**

(1) Grana of chloroplasts and peroxisomes
(2) Stroma of chloroplasts
(3) Stroma of chloroplasts and mitochondria
(4) Stroma of chloroplasts and peroxisomes

Q.113 The first acceptor of electrons from an excited chlorophyll molecule of photosystem II is :- **[AIPMT-2007]**

(1) Quinone (2) Cytochrome
(3) Iron-sulphur protein
(4) Ferredoxin

Q.114 In the leaves of C_4 plants, malic acid formation during CO_2 fixation occurs in the cells of :- **[AIPMT-2008]**

(1) Epidermis (2) Mesophyll
(3) Budndle Sheath (4) Phloem

Q.115 In leaves of C_4 plants malic acid synthesis during CO_2 fixation occurs in : - **[AIPMT-2008]**

(1) Bundle sheath (2) Guard cells
(3) Empidermal cells (4) Mesophyll cells

Q.116 The C_4 plants are photosynthetcially more efficient then C_3 plants because : - **[AIPMT-2008]**

(1) The CO_2 efflux is not prevented
(2) They have more chloroplasts
(3) The CO_2 compensation point is more
(4) CO_2 generated during photorespiration is trapped and recylced through PEP carboxylase

Q.117 Electrons from excited chlorophyll molecule of photosystem II are accepted first by : - **[AIPMT-2008]**

(1) Quinone (2) Ferredoxin
(3) Cytochrome - b (4) Cytochrome - f

Q.118 Stroma in the chloroplasts of higher plant contains **[AIPMT-2009]**

(1) Chlorophyll
(2) Light-independent reaction enzymes
(3) Light-independent reaction enzymes
(4) Ribosomes

Q.119 Oxygenic photosynthesis occurs in : - **[AIPMT-2009]**

(1) Chlorobium (2) Chromatium
(3) Oscillatoria (4) Rhodospirillum

Q.120 Cyclic photophosphorylation results in the formation of : - **[AIPMT-2009]**

(1) ATP
(2) NADPH
(3) ATP and NADPH
(4) ATP, NADPH and O_2

Q.121 PGA as the first CO_2 fixation product was discovered in photosynthesis of- **[AIPMT-2010]**

(1) Angiosperm (2) Alga
(3) Bryophyte (4) Gymnosperm

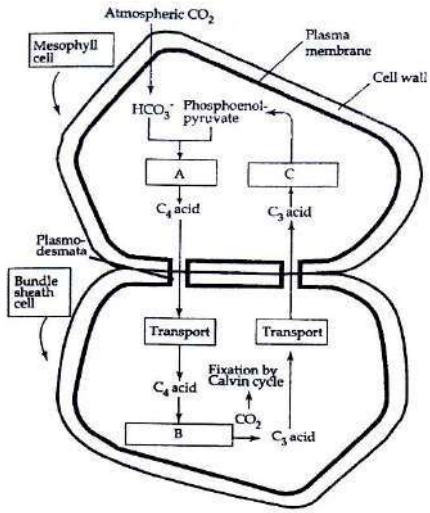
Q.122 C_4 plants are more efficient in photosynthesis than C_3 plants due to- **[AIPMT-2010]**

(1) Presence of thin cuticle
(2) Lower rate of photorespiration
(3) Higher leaf area
(4) Presence of larger number of chloroplasts in the leaf cells

Q.123 Kranz anatomy is one of the characteristics of the leaves of- **[AIPMT-2010]**

(1) What (2) Sugarcane
(3) Mustard (4) Potato

Q.124 Study the pathway given below :



In which of the following options correct words for all the three blanks A, B and C are indicated? **[AIPMT-2010]**

	A	B	C
(1)	Fixation	Transamination	Regeneration
(2)	Fixation	Decarboxylation	Regeneration
(3)	Carboxylation	Decarboxylation	Reduction
(4)	Decarboxylation	Reduction	Regeneration

Q.125 Read the following four statements, A, B, C and D and select the right option having both correct statements- **[AIPMT-2010]**

(A) Z scheme of light reaction takes place in presence of PS-I only

(B) Only PS-I is functional in cyclic photophosphorylation

(C) Cyclic photophosphorylation results into synthesis of ATP and $NADPH_2$

(D) Stroma lamellae lack PS-II as well as NADP

(1) A and B (2) B and C

(3) C and D (4) B and D

Q.126 A process that makes important difference between C_3 and C_4 plants is : **[AIPMT Pre 2012]**

(1) Glycolysis (2) Photosynthesis

(3) Photorespiration (4) Transpiration

Q.127 Which one of the following organisms is correctly matched with its three characteristics? **[AIPMT Mains 2012]**

(1) Pea : C_3 pathway, Endospermic seed, Vexillry aestivation

(2) Tomato : Twisted aestivation, Axile placentation, Berry

(3) Onion : Bulb, Imbricate aestivation, Axile placentation

(4) Maize : C_3 pathway, Closed vascular bundles, Scutellum

ANSWER KEY

EXERCISE - 3

Q.1	4	Q.2	2	Q.3	2	Q.4	1	Q.5	3	Q.6	3	Q.7	3
Q.8	3	Q.9	2	Q.10	1	Q.11	3	Q.12	2	Q.13	2	Q.14	2
Q.15	3	Q.16	3	Q.17	1	Q.18	4	Q.19	1	Q.20	1	Q.21	1
Q.22	1	Q.23	4	Q.24	2	Q.25	4	Q.26	1	Q.27	1	Q.28	2
Q.29	2	Q.30	2	Q.31	2	Q.32	4	Q.33	2	Q.34	4	Q.35	1
Q.36	2	Q.37	1	Q.38	4	Q.39	2	Q.40	2	Q.41	2	Q.42	4
Q.43	3	Q.44	3	Q.45	2	Q.46	1	Q.47	2	Q.48	2	Q.49	3
Q.50	4	Q.51	3	Q.52	1	Q.53	2	Q.54	3	Q.55	4	Q.56	2
Q.57	2	Q.58	2	Q.59	3	Q.60	4	Q.61	2	Q.62	4	Q.63	1
Q.64	1	Q.65	2	Q.66	1	Q.67	2	Q.68	3	Q.69	2	Q.70	2
Q.71	1	Q.72	1	Q.73	2	Q.74	3	Q.75	4	Q.76	1	Q.77	4
Q.78	1	Q.79	3	Q.80	1	Q.81	3	Q.82	3	Q.83	3	Q.84	2
Q.85	2	Q.86	3	Q.87	4	Q.88	4	Q.89	2	Q.90	4	Q.91	1
Q.92	3	Q.93	3	Q.94	3	Q.95	1	Q.96	4	Q.97	2	Q.98	4
Q.99	2	Q.100	1	Q.101	3	Q.102	1	Q.103	4	Q.104	3	Q.105	1
Q.106	1	Q.107	1	Q.108	1	Q.109	4	Q.110	2	Q.111	1	Q.112	4
Q.113	1	Q.114	2	Q.115	4	Q.116	2	Q.117	1	Q.118	3	Q.119	3
Q.120	1	Q.121	2	Q.122	2	Q.123	2	Q.124	2	Q.125	4	Q.126	3
Q.127	3												

These questions consist of two statements each, printed as "Assertion" and "Reason". While answering these Questions you are required to choose any one of the following responses.

(1) If both A and R are True and the R is a correct explanation of the A.

(2) If both A and R are True but R is not correct explanation of the A

(3) If A is True but the R is False.

(4) If both A and R are false.

Q.1 **A :** Dark reaction of photosynthesis occurs only in absence of light.

R : Dark reaction occur in grana.

Q.2 **A :** Photorespiration is a wasteful phenomenon in C_3-plants.

R : Decrease in photosynthetic productivity due to photorespiration.

Q.3 **A :** For evolution of O_2 in photosynthesis, PS-II is required.

R : O_2 is released in photosynthesis, of **Chromatium.**

Q.4 **A :** Insectivorous habit of plants is to cope with oxygen deficiency.

R : Insectivorous plants are non-green plants.

Q.5 **A :** O_2 is not released in photosynthesis of bacteria.

R : Photolysis of water is absent in bacterial photosynthesis.

Q.6 **A :** All plants are not photosynthetic.

R : Leaves are large in all types of plants.

Q.7 **A :** Lysosomes help in the process of photorespiration.

R : Lysosomes have enzymes for photorespiration.

Q.8 **A :** The first product of CO_2 fixation in C_4 plants is OAA.

R : Oxaloacetic acid is formed in agranal chloroplast.

Q.9 **A :** Dark-reaction occurs at night in the stroma of chloroplast.

R : All the enzymes responsible for CO_2 fixation remain inactive in presence of light.

Q.10 **A :** Oxygen liberates during photosynthesis in cyanobacteria.

R : Cyanobacteria use H_2S as source of electron or hydrogen.

Q.11 **A :** **Rafflesia** is a pitcher plant.

R : **Refflesia** grows in nitrogen deficient soil.

Q.12 **A :** Daily preodicity of stomatal movement is not character of CAM plants.

R : In CAM plants stomata are closedat night and day.

Q.13 **A :** ***Amaranthus*** and sugarcane are called as Hatch and Slack plants.

R : One glucose forms by fixation of $6CO_2$ in these plants.

Q.14 **A :** Site of light and Dark reactions are different in C_4-plants.

R : Two type of photosynthetic cells found in C_4-plants.

Q.15 **A :** Mangnese is important for Hill reaction.

R : Photolysis of water occurs in the presence of manganese.

Q.16 **A :** By insectivorous habit, the insectivorous plants fulfil their nitrogen deficiency.

R : Nitrogen requirement of insectivorous plants are fulfilled through the proteins of insects.

Q.17 **A :** Bacterial photosynthesis occurs in presence of oxygen.

R : Bacteria has only PS-II

Q.18 **A :** Photosynthetically C_4 plants are better than C_3 plants.

R : Photorespiration absent in C_4 plants.

Q.19 **A :** Red drop occur above 680 nm light.

R : PS-II becomes inactive above 680 nm of light.

Q.20 **A :** C_4-plants are more efficient than C_3-plants.

R : C_4-plants are photorespiratory plants.

Q.21 **A :** Photosynthetic production decreases above 680 nm light.

R : PS-II inactivates above 680 nm wavelength of light.

Q.22 **A :** Oxygen does not release in bacterial photosynthesis.

R : e^- donar is CO_2 in bacterial photosynthesis.

Q.23 **A :** Production of dark reaction is increased at high concentration of oxygen.

R : Rubisco converts in PEPCase at high conc. of oxygen.

Q.24 **A :** Photorespiration is absent in Hatch and Slack plants.

R : These plants lack enzyme of C_3-cycle.

Q.25 **A :** Photosynthetic bacteria do not release oxygen gas in photosynthesis.

R : Photosynthetic bacteria do not absorb light energy.

Q.26 **A :** CAM plants initialy, fixes CO_2 during night.

R : They overcome loss of water by this process as stomata closed during day time.

Q.27 **A :** Dark reaction of photosynthesis is biosynthetic phase.

R : Dark reaction is affected by temperature.

Q.28 **A :** Leaf of ***Nepenthes*** is modified in to pitcher to capture insects.

R : ***Nepenthes*** lacks chlorophyll & not green in colour.

Q.29 **A :** Liberation of O_2 in bacteria was discovered by Van Niel.

R : Bacteria use green light for photophosphorylation.

Q.30 **A :** Rate of photosynthesis is higher in combination of $680\uparrow$ & $680\downarrow$ nm than $680\uparrow$ nm alone.

R : Both cyclic & non cyclic Photophosphorylation takes place by mix light.

Q.31 **A :** C_3-plants photosynthetically more efficient than C_4-plants.

R : CO_2 inhibits photosynthesis in C_3 plants.

Q.32 **A :** Sulphur bacteria do not release O_2 in photosynthesis.

R : These bacteria do not use water in photosynthesis.

Q.33 **A :** Photosynthetically ***Zea mays*** is more efficient than Pea plant.

R : Pea is non photorespiratory plant.

Q.34 **A :** Initial fixation of CO_2 in CAM-plants takes place in night.

R : PS-II is absent in CAM-plants.

Q.35 **A :** Evolution of O_2 is not linked with bacterial photosynthesis.

R : Bacteria absorb the I-R spectrum.

Q.36 **A :** ***Utricularia*** captures insects for nitrogen source.

R : This plant grows in nitrogen deficient habitats.

Q.37 **A :** One mole of oxygen gas liberates in bacterial non cyclic ETS.

R : Bacteria is first photosynthetic Eukaryotes.

Q.38 **A :** Action spectrum of photosynthesis is Red & Blue colours of light.

R : Plants absorb maximum Red and Blue colour.

Q.39 **A :** D.C.M.U. is a photosynthetic inhibitor.

R : D.C.M.U. inhibits photolysis of water.

Q.40 **A :** Dark reaction does not occur in absence of light.

R : Synthesis of assimilatory powers occurs during light reaction.

Q.41 **A :** C_4-plants are most efficient photosynthetic plants of todays.

R : Photorespiration does not occurs in C_4-plants.

Q.42 **A :** CAM plants may show photorespiration.

R : Dark reaction occurs during day time in CAM plants.

Q.43 **A :** Photophosphorylation is the only process of generation of ATP in plants.

R : Light energy converted into stable chemical energy during photophosphorylation.

Q.44 **A :** Growth will stop in plants at compensation point.

R : Net primary productivity is zero at compensation point.

Q.45 **A :** Photorespiration is also known as glyoxilate cycle.

R : Substrate for photorespiration is glyoxylic acid.

Q.46 **A :** The only product of light reaction, required in dark reaction are $NADPH_2$ and ATP.

R : Dark reaction occurs in night only.

ANSWER KEY

EXERCISE - 4

Q.1	4	Q.2	1	Q.3	3	Q.4	4	Q.5	1	Q.6	3	Q.7	4
Q.8	3	Q.9	4	Q.10	3	Q.11	4	Q.12	4	Q.13	2	Q.14	1
Q.15	1	Q.16	1	Q.17	4	Q.18	1	Q.19	1	Q.20	3	Q.21	1
Q.22	3	Q.23	4	Q.24	3	Q.25	3	Q.26	1	Q.27	2	Q.28	3
Q.29	4	Q.30	1	Q.31	4	Q.32	1	Q.33	3	Q.34	3	Q.35	2
Q.36	1	Q.37	4	Q.38	3	Q.39	1	Q.40	1	Q.41	1	Q.42	2
Q.43	4	Q.44	1	Q.45	4	Q.46	3						

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

CELL RESPIRATION

HISTORY

- Respiration term was given by **Deutrochet**.
- **Malpighie** (1679) showed the importance of air at the time of **germination of seeds** of plants.
- **Pasteur** (1870) discovered **anaerobic** respiration with the help of **fermentation**.

INTRODUCTION

- Respiration is a **catabolic process** in which complex organic molecules are oxidized to simpler one with gradual and step wise release of energy.
- Such respiration is also called **cellular respiration** or **dark respiration** or **internal respiration**.
- It is a **catabolic**, **exothermic** and **oxidative** process.
- It is also **anabolic**
- Respiration is represented by following general equation :

$$C_6H_{12}O_6 + 6O_2 + 6H_2O \rightarrow 6CO_2 + 12H_2O + \text{Energy}$$

- Respiration is oxidation of organic food, which release the energy, which is utilized in systhesis of ATP.
- Various respiratory intermediates are used up in biosynthesis so **amphibolic** process.
- All living cells participate in the respiration process.

Significance of Respiration :

- **Energy** is necessary for all biological processes.
- The energy released during respiration is used for the various metabolic processes.
- Various chemical substances are formed in this process which are important for cellular components.
- CO_2 released in this process maintains a balance in the atmosphere.
- Complex insoluble food materials are converted into simple soluble molecules by this process.
- It converts the stored (static potential energy) into more useful (kinetic) form.

TYPE OF RESPIRATION

On the basis of kind of Respiratory Substrate:

- **Floating respiration :**

  It is normal respiration, where general respiratory substrate and stored food is oxidized, e.g., Starch, fat, protein

- **Protoplasmic respiration :**

  It is respiration of starved cells when protoplasmic constituents are oxidized.

On the basis of availability of Oxygen :

- Aerobic respiration
- Anaerobic respiration

Aerobic respiration - The **complete oxidation** of food with the use of oxygen and when entire carbon released as CO_2, is called as aerobic respiration.

$$C_6H_{12}O_6 + 6O_2 + 6H_2O \xrightarrow[\text{cyto.\&mito}]{\text{Enzyme}} 6CO_2 + 12H_2O + 686 \text{ Kcal E (38 / 36 ATP)}$$

Anaerobic respiration - This is incomplete oxidation.

- When food is oxidized into alcohol or organic acids without use of oxygen.

  During it most of energy is lost in form of heat. It occurs in cytoplasm and only 2ATP are produced.

$$C_6H_{12}O_6 \xrightarrow[\text{cytoplasm}]{\text{Enzyme}} 2C_2H_5OH + 2CO_2 + 21KCal\ (2ATP)$$

- Anaerobic respiration was first reported by Kostytchev.
- Anaerobic respiration may takes place in bacteria, some lower parasitic animals (Ascaris, Taenia) plants, R.BCs. & muscles of human body. When oxygen is not available, then food is incompletely oxidised in to some organic compounds like ethanol, acetic acid, lactic acid.
- In muscle cells & some bacteria, the energy is produced by breaking of glucose into lactic acid inside the cells.
- The amount of energy released in anaerobic respiration is much less than aerobic respiration.
- Fermentation is performed by some fungi & some bacteria (only by microbes) and is an extracellular process. 2 ATP are produced.

$$C_6H_{12}O_6 \xrightarrow[\text{Bact.}]{\text{Yeast}} 2C_2H_5OH + 2CO_2 + \text{Heat}\ (2\ ATP)$$

- Both anaerobic respiration and fermentation are incomplete oxidations.
- Inhibitory effect on respiration (anaerobic respiration) of oxygen is called **Pasteur effect**.

  (Anaerobic $\rightarrow$ Aerobic)

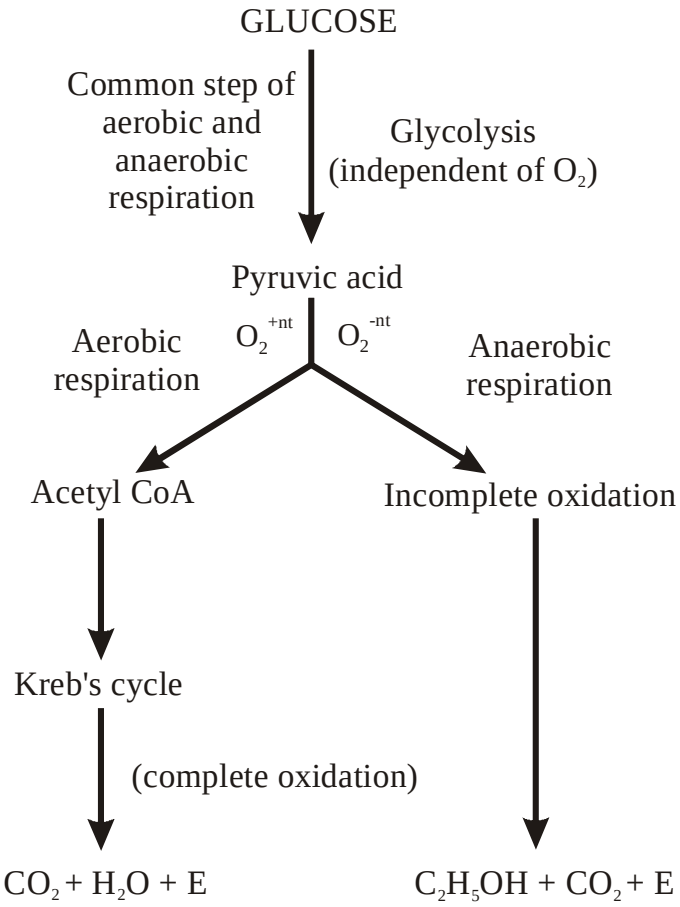
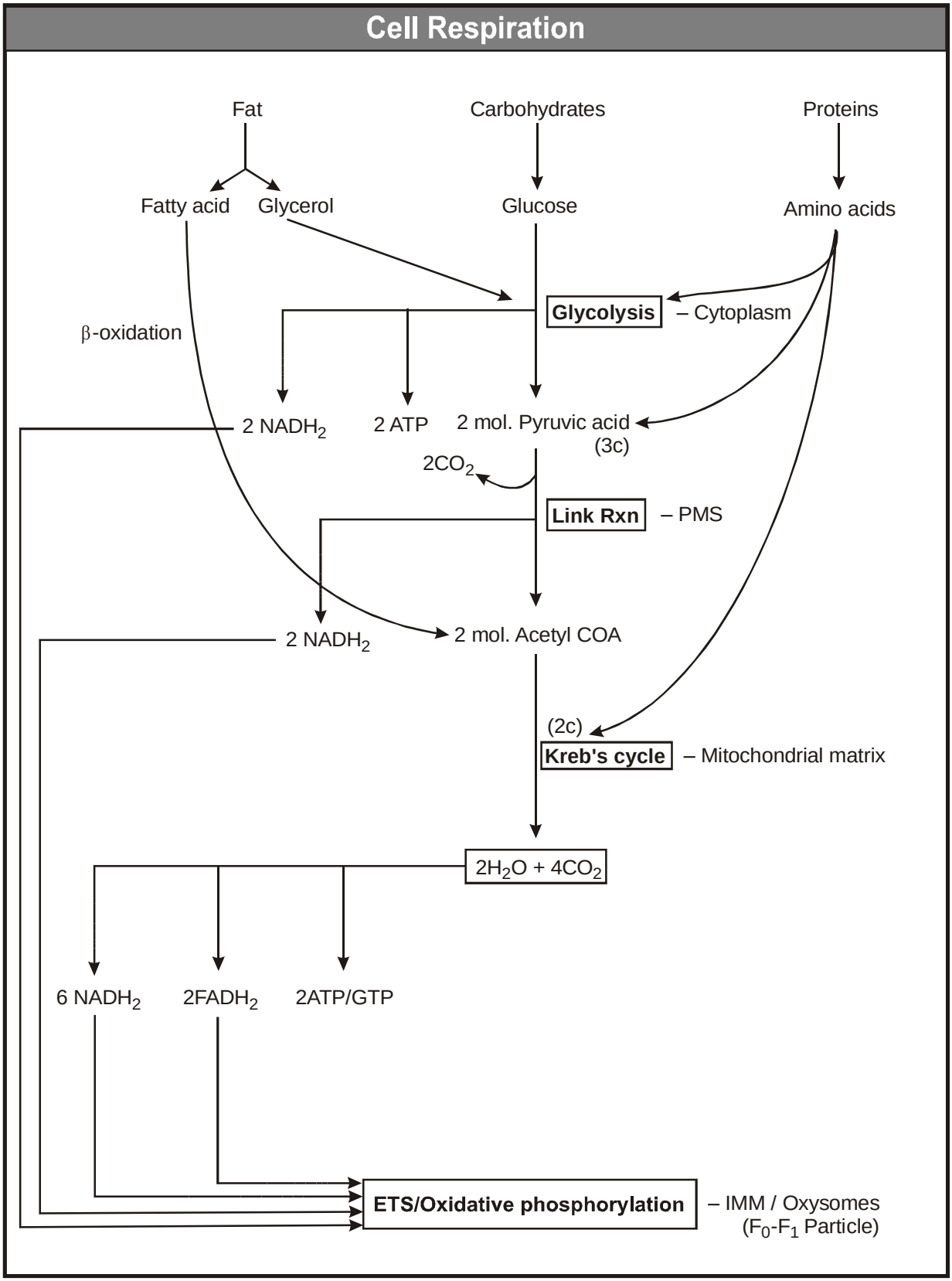


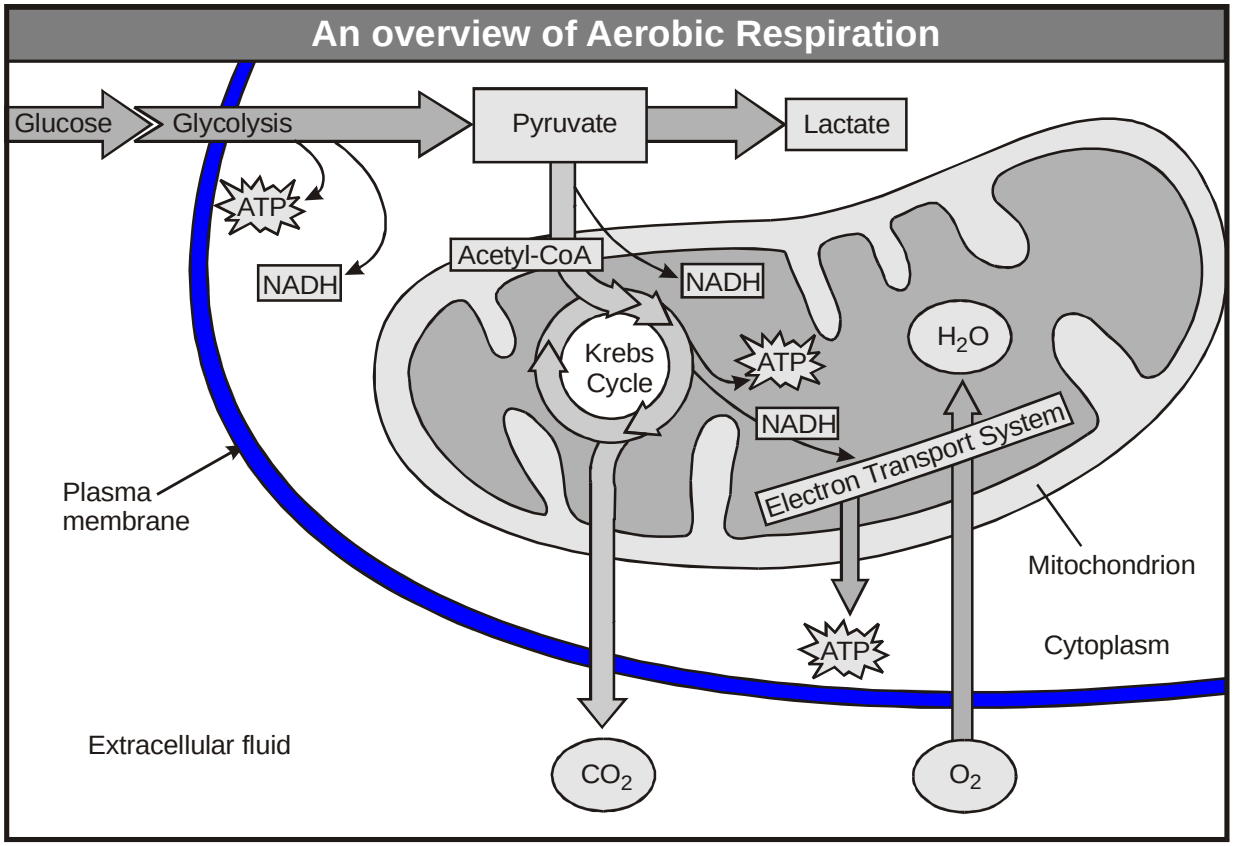
Fig : Aerobic and Anaerobic Respiration

MECHANISM OF RESPIRATION



- Initial steps of aerobic and anaerobic respiration are same i.e. Glucose is converted to pyruvic acid. Further fate of **pyruvic acid is dependent upon presence or absence of O_2**.
- There are **2 major** pathways of respiration.

  (i) Common Pathway (ii) Pentose Phosphate Pathway (PPP)



(i) Common Pathway :

It has 3 main parts.

(a) Glycolysis

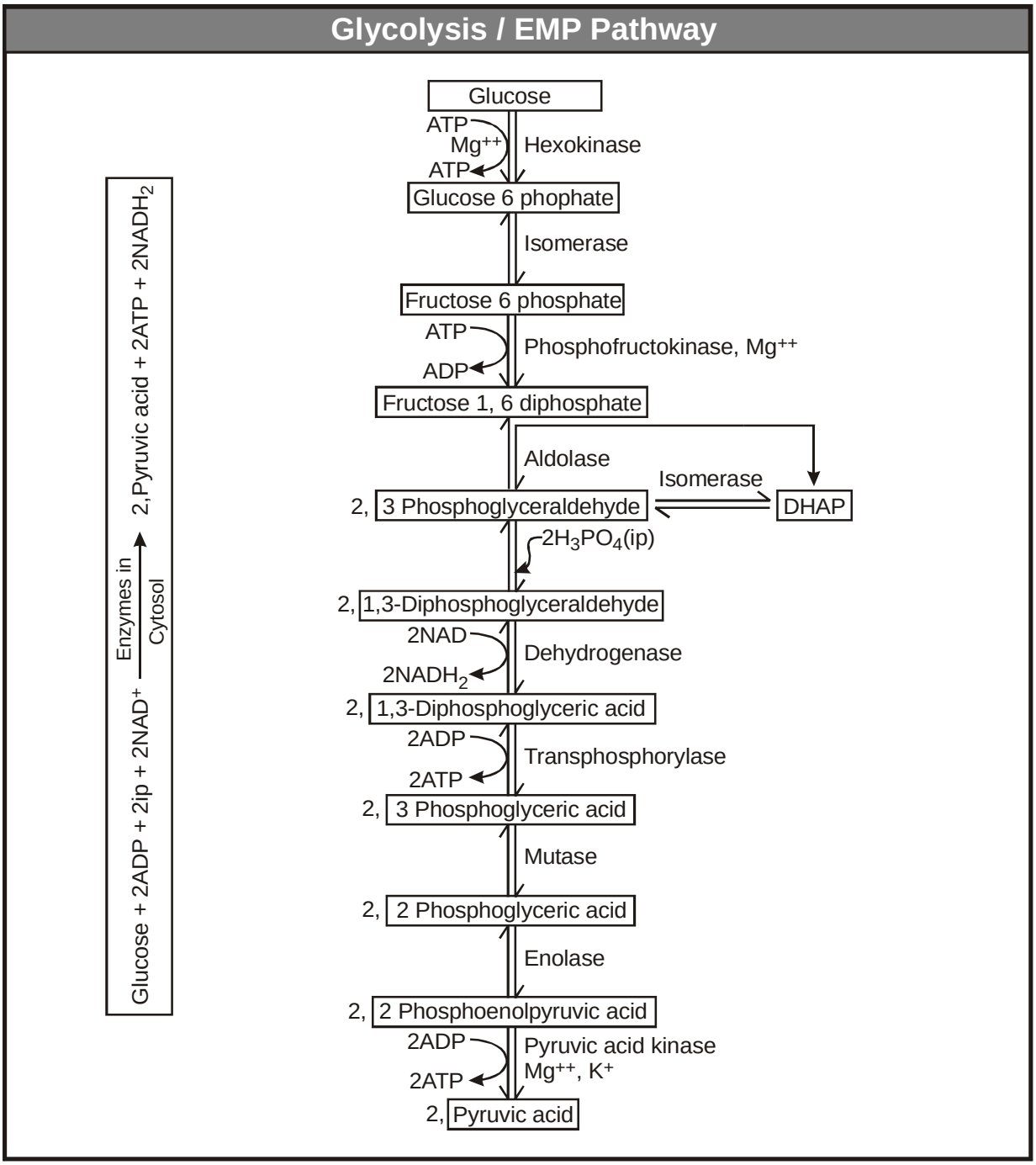
(b) Krebs Cycle

(c) Terminal Oxidation

(a) Glycolysis :

- Glycolysis was discovered by **Embden**, **Meyerhoff** and **Parnas** and hence it is called as **EMP pathway**.
- Glycolysis is **independent of O_2**, hence it is common in both **aerobic** and **anaerobic** conditions.
- Glycolysis is completed in **cytoplasm**.
- **Glucose** is substrate of glycolysis. Most of enzymes requires Mg as cofactor.
- The glycolysis is common phase for aerobic & anaerobic respirations both.
- Glycolysis involves a series of ten biochemical reactions in cytoplasm.
- In glycolysis, neither consumption of oxygen nor liberation of CO_2 take place.
- In glycolysis, 1 glucose, produces 2 mol. of pyruvic acids (3C)
- $2NADH_2$ & 2ATP are generated in glycolysis, which are equal to 8 ATP.
- **Substrate level phosphorylation** forms 2 ATP - [When the substrate releases energy for phosphorylation of ADP OR formation of ATP, without ETS then called as **substrate level phosphorylation**]
- Glycolysis is also known as **oxidative anabolism** or **catabolic resynthesis**, because it links with anabolism of fats and amino acids. Its intermediate PGAL is used for the synthesis of glycerol later forms fats or lipid. PGA is used for synthesis of Serine, Glycine, cystine. Alanine synthesized from pyruvate.

- Biochemical reactions of Glycolysis are



- **Phosphofructokinase** and **Hexokinase are allosteric enzymes**. The steps catalysed by these enzymes are considerd as control point reactions of glycolysis.
- Ist & 3rd and last reaction of glycolysis are considered as irreversible reactions of glycolysis.
- Further oxidation of puruvic acid and $NADH_2$ after glycolysis in mitochondria requires oxygen. So the fate of pyruvic acid is decided by presence or absence of Oxygen.

KREBS CYCLE / TRICARBOXYLIC ACID (TCA) CYCLE / CITRIC ACID CYCLE

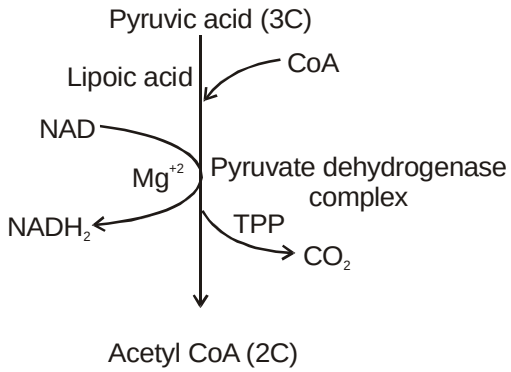
- Krebs cycle was discovered by **Sir Hans Krebs** in 1937 in **pigeon muscles**.
- It is also called **citric acid cycle**, citric acid being the **first** product of krebs cycle.

- Krebs cycle **occurs in matrix of mitochondria** as its enzymes are present in the matrix.
- Kreb's cycle is **amphibolic or anaplerotic in nature** because it is **central metabolic pathway** playing an important role in both **catabolism** and **anabolism**.
- **Acetyl CoA** is substrate entrant of krebs cycle.
- During oxidation of 1 molecule of glucose, there occurs **two rounds in a kreb's cycle**.
- **4 $NADH_2$, 1 $FADH_2$** and **1 ATP** molecules are obtained from **one pyruvic acid** molecule.
- Two pyruvic acid are formed from one glucose. Therefore, two molecules of pyruvic acid yields 8$NADH_2$, 2 $FADH_2$ and 2 ATP molecules.
- Before Krebs cycle operates, pyruvic acid is converted into Acetyl CoA.
- **Formation of Acetyl CoA / Link reaction / Gateway Reaction :**

  It occurs in perimitochondrial space.

  Pyruvic acid is **oxidatively decarboxylated** to form Acetyl CoA. This requires a **multienzyme complex**, **Pyruvate dehydrogenase complex**.

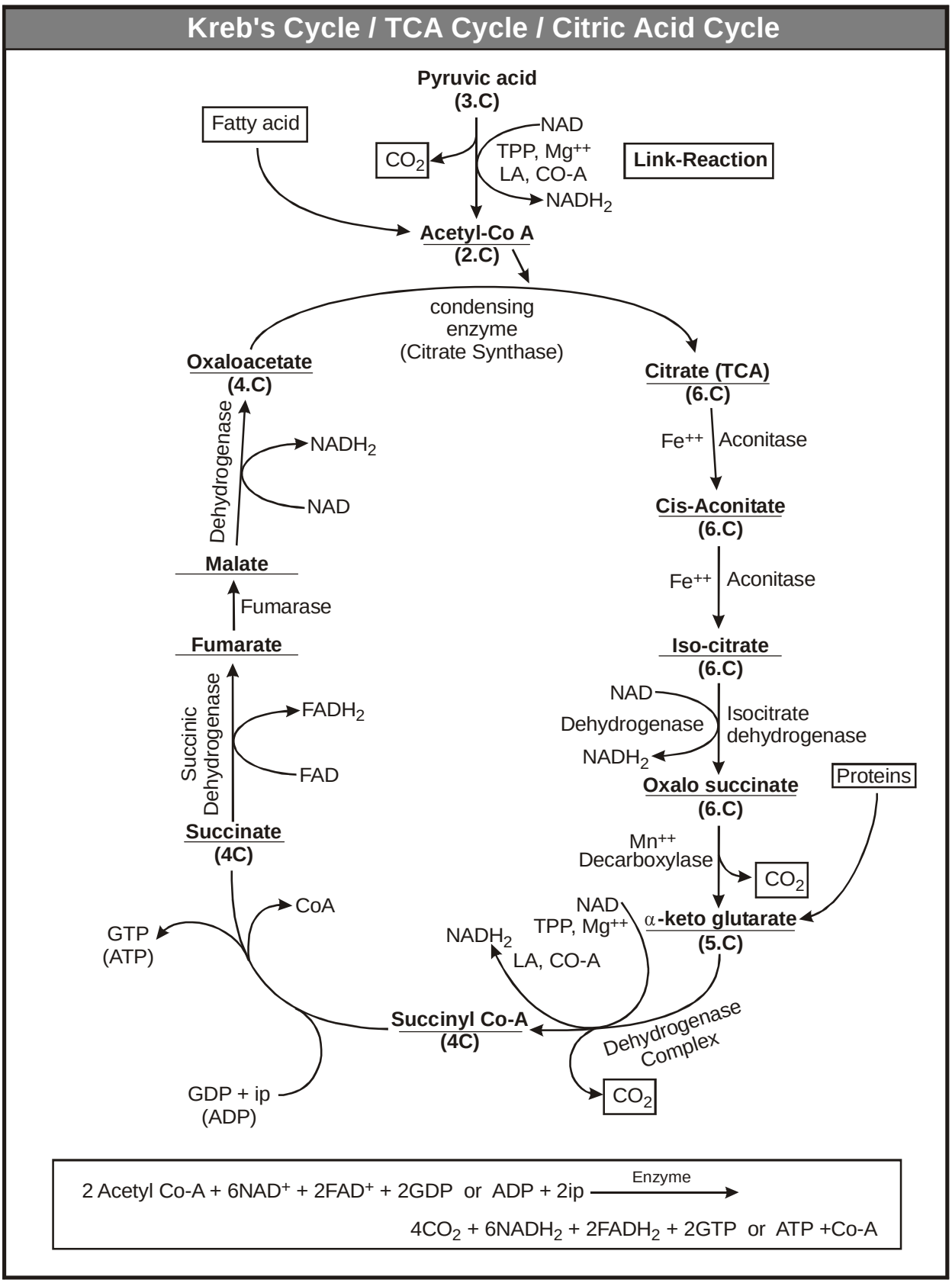
  Pyruvate dehydrogenase complex consists of **4 Coenzymes and one cofactors** i.e. **TPP** (Thiamine pyrophosphate), **lipoic acid, coenzyme A, NAD, Mg^{+2}**



  Acetyl CoA is **connecting link** between glycolysis and Kreb's cycle.

- Kreb cycle begins by formation of citric acid & O.A.A. is the aceptor molecule of Acetyl CoA in Kreb's cycle. All 6C intermediates have 3, carboxylic groups. So called as **tricarboxylic Acid cycle**.
- A number of Krebs cycle intermediates are used in synthetic (anabolic) pathways, thus TCA cycle is also called **amphibolic pathway** or **anaplerotic pathway**.
- **Succinyl CO-A** is important for synthesis of porphyrin ring compounds like **Chlorophylls, Phytochromes, Cytochromes, Haemoglobin** etc.
- **α-ketoglutaric acid** (5c) involves in Amino Acid **Glutamate** formation (Nitrogen-metabolism)
- Oxidation occurs at 4 steps in Kreb cycle.
- 3 $NADH_2$, 1$FADH_2$ & 1 GTP (ATP) produced by each turn of TCA cycle. (= 12 ATP)
- All the enzymes of TCA cycle, except mitochondrial marker enzyme **Succinic dehydrogenase** (on **inner mitochondrial membrane**) present in **matrix**.

- Biochemical reactions in Krebs Cycle :



TERMINAL OXIDATION

- It is combination of oxygen with electrons and protons released from reduced co-enzymes which produces water (metabolic water).

- Terminal oxidation consists of two processes :

  (i) Electron Transport System (ETS) **(ii) Oxidative Phosphorylation**

(i) Electron Transport System (ETS) :

- $NADH_2$ & $FADH_2$ obtained from **glycolysis** and **Kreb's cycle** enter in electron transport chain and form water molecule by oxidation with the help of **molecular oxygen**.
- In this process, energy is released which is used for the synthesis of ATP.
- Transfer of electrons from $NADH_2$ or $FADH_2$ occurs through a chain of electron acceptors and donors arranged in a specific sequence.
- Electron transport chain is located in **inner mitochondrial membrane** in **Eukaryotes** and in inner side of **plasma membrane or in mesosome membrane in prokaryotes.**
- ETS (Respiratory chain) consists of four components
  - FP (flavoprotein) or FMN
  - Fe-S Protein
  - Co-Q
  - Cytochromes.
- Cytochromes are cyt.-b, cyt.-C_1 & cyt. C, cyt.-a & cyt a_3 (cyt a & a_3 – **Cu** containing)
- Now compounds of ETS are categories as follows :

Name of complexes	Components of ETS	Inhibitors
Complex-I	FMN-$NADH_2$ dehydrogenase	Rotenone & amytal
Complex-II	CoQ/UQ-$FADH_2$ dehydrogenase / Succinate dehydrogenase	
Complex-III	Cytochrome b-Cyt c_1	antimycin
Complex-IV	Cyt, a – Cyt. a_3	cyanide, CO
Complex-V	ATP synthase / ATPase	

- Two electron acceptors **coenzyme Q** or **ubiquinone** and **cytochrome** C can be easily separated from respiratory chain, therefore they are called **mobile carriers**. CoQ functions for e^- transport between complex I and III and cyt.C transports e^- between complex III and IV.
- Hydrogen is transferred from $NADH_2$ to FMN and NAD is obtained back from $NADH_2$. FMN forms $FMNH_2$.
- Two **protons** and **electrons** are released from $FMNH_2$. Two protons are transported out through membrane and two electrons are taken up by Fe-S protein.
- Terminal oxidation of reduced coenzyme $FADH_2$ also occurs at mitochondrial ETS. FADH2 gives its e^- & H^+ to CoQ and become FAD.
- During the ETS, **$NADH_2$** gives it's $2e^- / 2H^+$ to FMN in respiratory chain, thus **3 ATP** are generated, while **$FADH_2$** give it's $2e^- / 2H^+$ to CoQ hence only **2 ATP** are formed during the process of oxidative phosphorylation.
- Cyanide inhibits the activity of cytochrome oxidase as it inhibits the oxidation of cyto-a_3. The respiration of most of living organisms is **cyanide sensitive respiration**.

- In mitochondria, of some plants **alternative oxidase** system is present, in which ETS continues even in presence of cyanides. This type of respiration is known as **cyanide resistance respiration** or Alternate electron pathway. Ex. **Spinacea, Pisum**. Alternate oxidase is inhibited by mCLAM and SHAM.

ELECTRON SHUTTLES

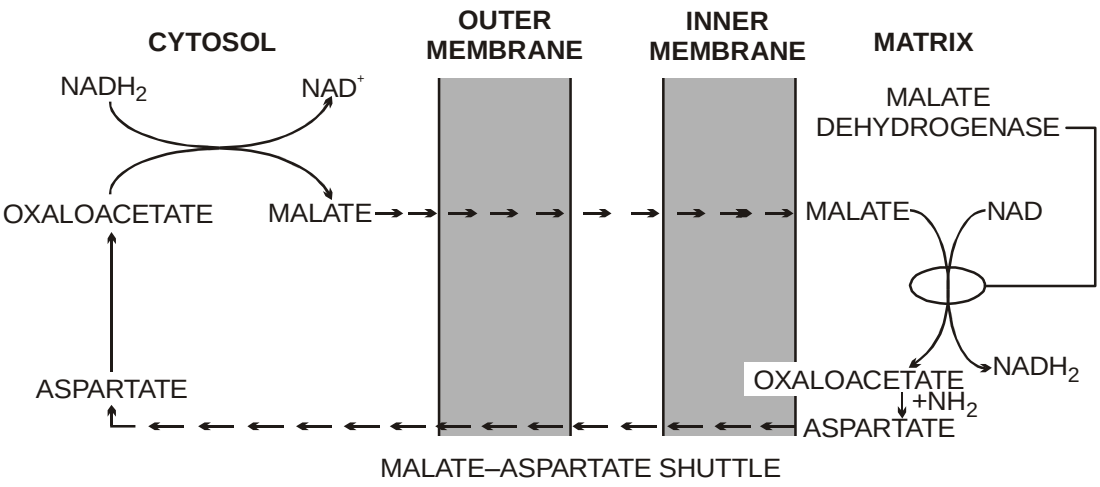
- 2 molecule of $NADH_2$ produced during glycolysis in cytoplasm have to go inside the mitochondria for production of ATP through ETS.
- The mitochondrial membrane is impermeable to $NADH_2$.
- Hence a **special carrier system** known as electron shuttle is present in inner mitochondrial membrane which transports electrons from $NADH_2$ to the electron carriers inside the mitochondria.
- Shuttle system is only present in eukaryotes, as prokaryotes does not have membrane bounded cell organelle.
- Electron shuttles are of two types in eukaryotes :

  (i) Malate–Aspartate Shuttle

  (ii) Glycerol–Phosphate Shuttle

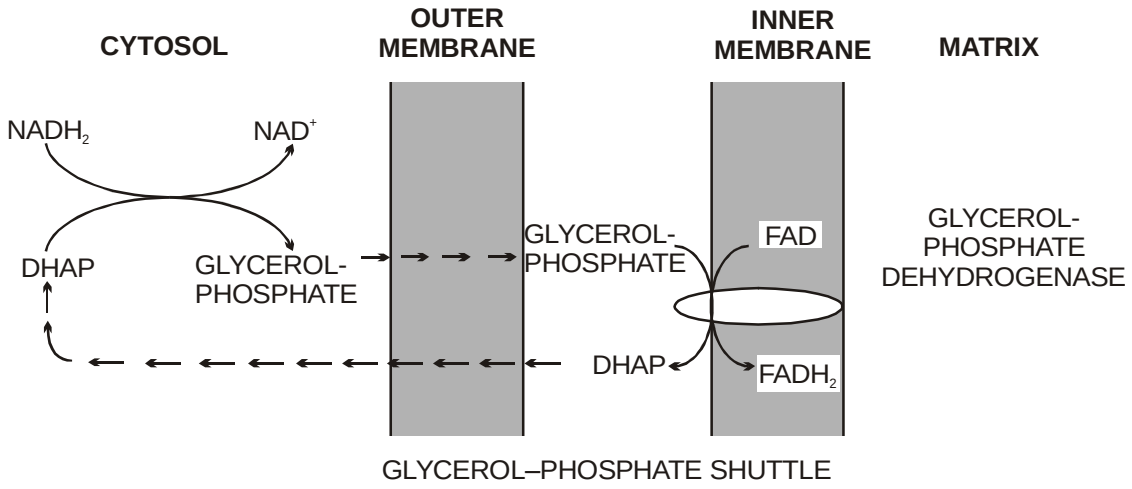
(i) Malate-Aspartate Shuttle :

- The electrons and hydrogen of $NADH_2$ are transferred to malate which enter into the **matrix of mitochondria**.
- Malate and NAD react to form $NADH_2$ and **Oxaloacetic acid**.
- Oxaloacetic acid cannot cross mitochondrial membrane. Hence it is ammonified to form **aspartic acid** which passes from matrix to the cytoplasm.
- If this shuttle is effective, then **38 ATPs are formed from one glucose molecule. (2 Glycolytic $NADH_2$ = 6ATP)**.
- It is **more efficient** and present in **heart**, **liver** and **kidney** cells.



Malate-aspartate shuttle scheme

(ii) Glycerol Phosphate Shuttle :



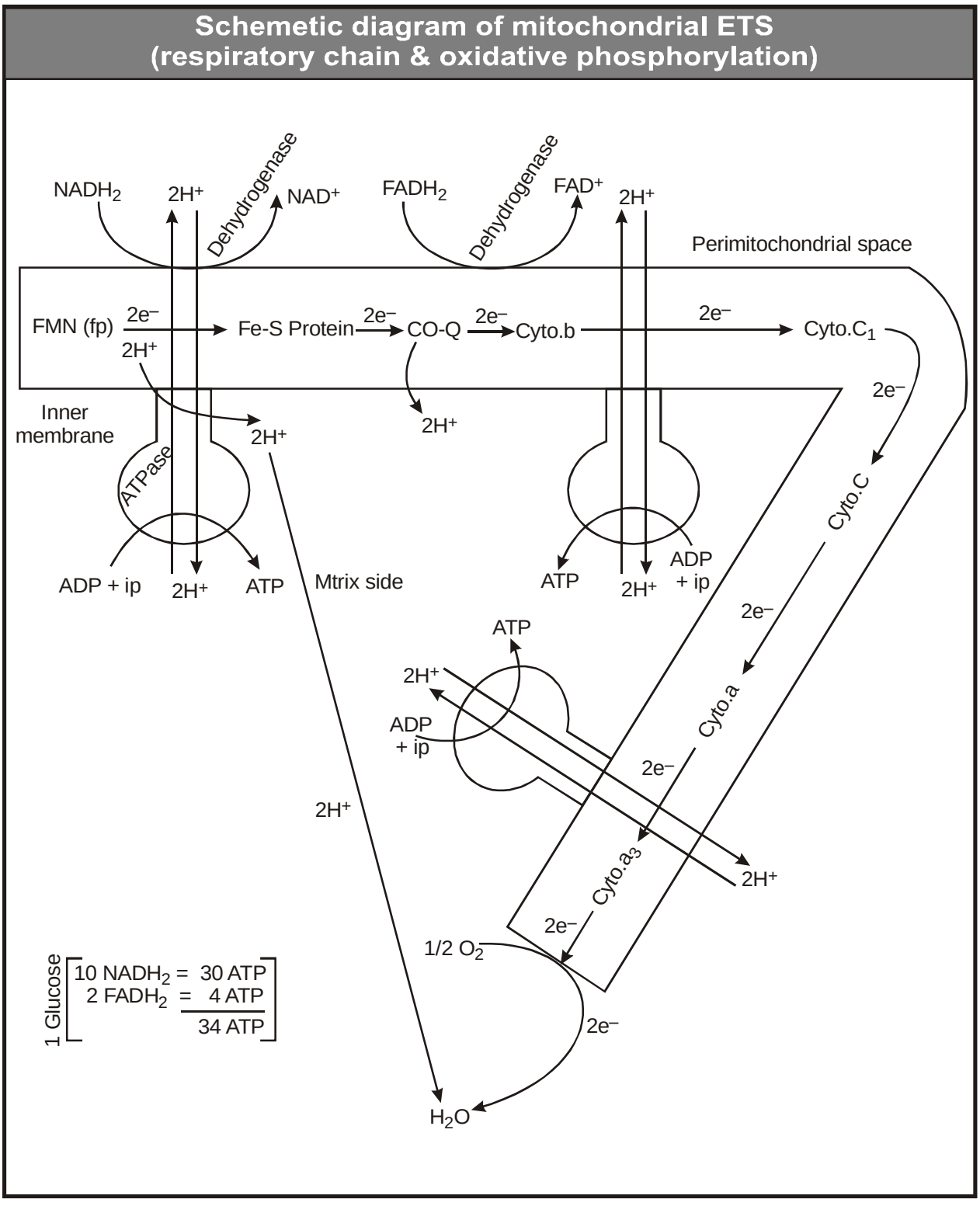
Glycerol–Phosphate Shuttle Scheme

- It is **less efficient** and present in **skeletal** muscles and **brain cells** or most **eukaryotic** cells.
- In this $NADH_2$ transfers electrons to FAD of mitochondria.
- **Dihydroxyacetone phosphate** (DHAP) and $NADH_2$ react to form Glycerol-Phosphate in cytoplasm.
- Glycerol-Phosphate goes to outer surface of inner membrane of mitochondria, where it reacts with FAD to form $FADH_2$ and DHAP.
- $FADH_2$ enters the electron system to form 2 ATP. DHAP gets transferred to **cytosol**.
- In the presence of this **shuttle**, **36 ATP are produced from one glucose molecule**. **(2 Glycolytic $NADH_2$ = 4 ATP)**
  Note : When which shuttle will be functional, depends on the tissue and the species.

OXIDATIVE PHOSPHORYLATION AND CHEMIOSMOTIC THEORY

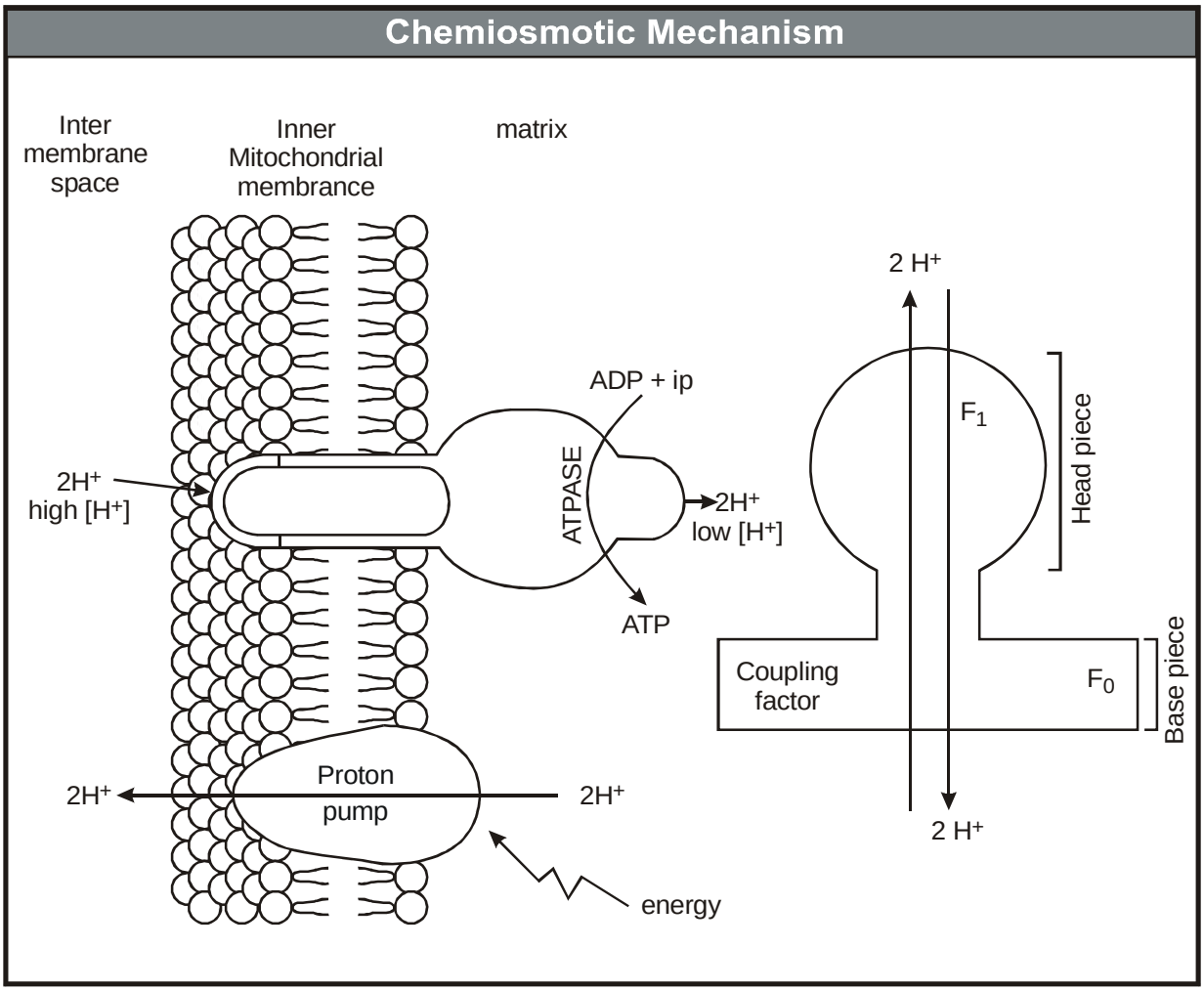
- **By P.Mitchell**
- The synthesis of energy rich ATP molecules with the help of energy librated by **oxidation** of reduced coenzyme produced during respiration is called **Oxidative Phosphorylation**.
- The protons which are expelled out from inner mitochondrial membrane during electron transport, produce proton gradient (ΔpH) and membrane potential in the external environment.
- This creates **proton motive force**. This is utilized in the formation of ATP.
- ATP synthesis is explained by **chemiosmotic theory.**
- **Oxidative phosphorylation** occurs on **F_1–F_0 particles** (oxysomes or elementary particles) which are located on inner mitochondrial membrane.
- **ATPase activity** is found in **F_1 (head)** which is protruded towards matrix of the mitochondria. **F_0 (base)** which is embedded in inner membrane has **proton channels**.
- ATPase becomes active only when **proton gradient** develops.
- Passage of $2e^-$ from $NADH_2$ pushes out three pairs of protons to outer chamber of mitochondria causing **proton gradient** and **membrane potential**. These collectively create **proton motive force (pmf)**.
- pmf cause protons to move back only passing through F_0, as inner membrane is impermeable for H^+.
- Energy is released during transfer of protons to the matrix passing through F_1 which is used for ATP formation. Formation of ATP from ADP is induced by the enzyme **ATP synthase (ATPase) present in F_1**.
- Transfer of **one pair of proton** back into inner chamber through F_1 head form **one ATP**. Thus, 3ATPs are formed by 3 pairs of H^+ released during electron transport of **1 molecule of $NADH_2$**.

- Two pairs of H^+ are liberated in respiratory chain by $FADH_2$, thus **2ATPs** are formed.



Chemiosmosis during oxidative phosphorylation :

- ATP synthesis during oxidative phosphorylation & Photophosphorylation is explained by Chemi-osmotic theory of P.Mitchell 1978. According to this theory energy liberated during ETS, is used in creation of proton gradient (pH gradient) & membrane potential which constitutes proton motive force (pmf) due to this formation of ATP takes place in F_1 particle of oxysome.



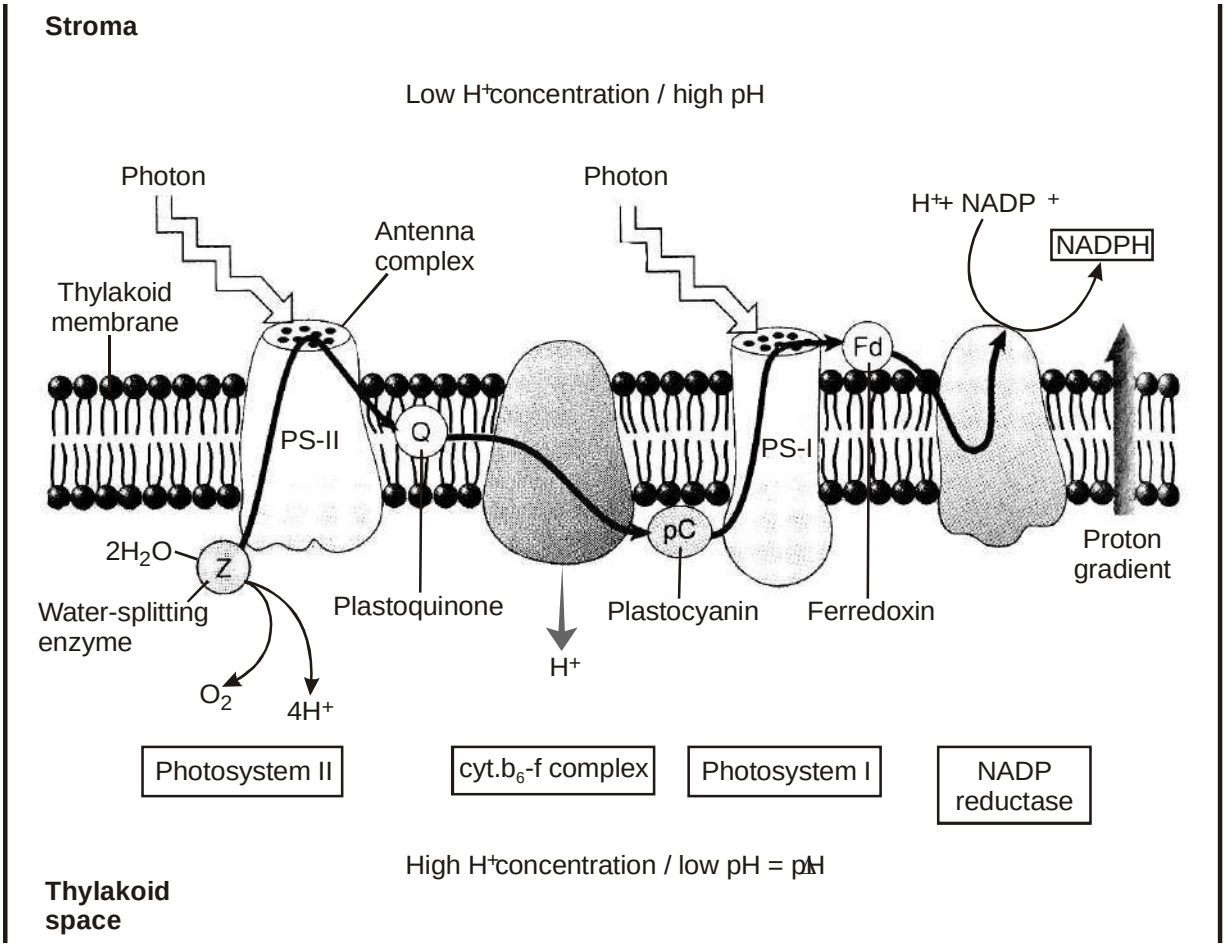
- Coupling factor : ATP formation requires H+ transport. These H+ only passes through the proton tunnel or **coupling** factor or **F_0 particle** in mitochondrial membrane, and bacterial membrane
- The process of electron transport and oxidative phosphorylation in mitochondria is tightly coupled. Some chemicals like 2,4 Dinitrophenol (2, 4 DNP) and oligomycin acts as **uncouplers** for this process.

Chemiosmosis during photophosphorylation :

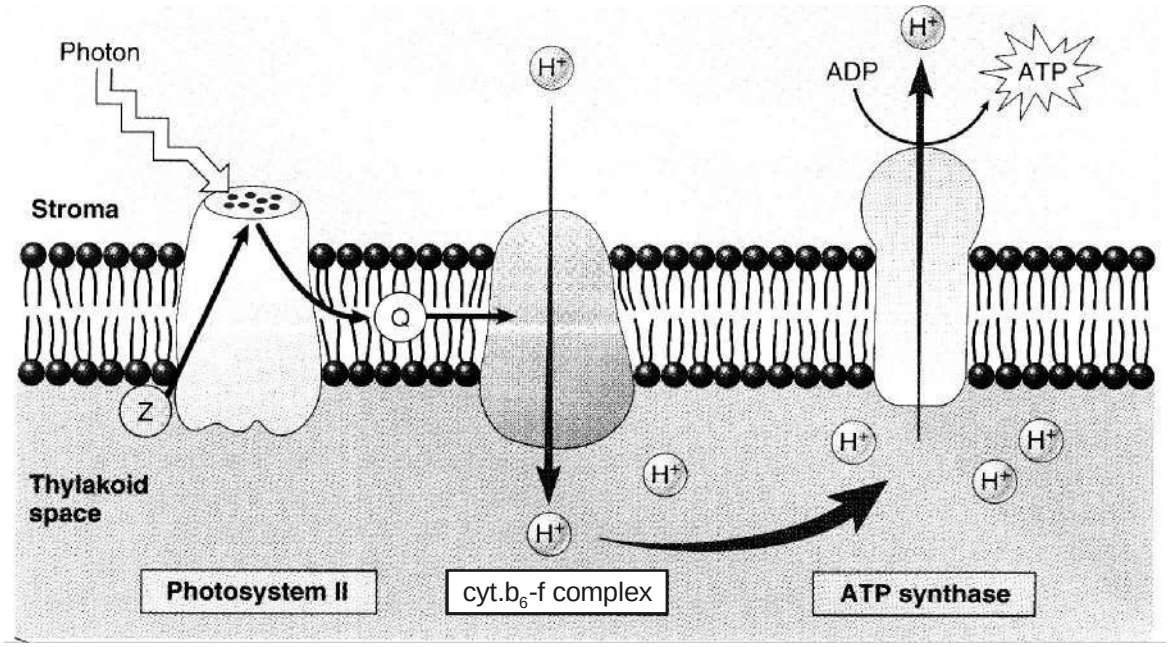
- The synthesis of ATP is coupled with electron transport system and creation of proton gradient across the membrane during photophosphorylation and oxidative phosphorylation. Both are same but the difference is that during oxidative phosphorylation high H^+ ion concentration at intermembrane space/perimitochondrial space and low H^+ concentration in mitochondrial matrix. While during photophosphorylation High H+ conc. inside the thylakoid lumen (due to photolysis of water at thylakoid lumen) and low H+ ion conc. in stroma.
- Thylakoid membrane is impermeable for protons so plastoquinone (which acts as both e^- and H^+ carrier) and Cf_0 particle (similar to F_0 particle of oxysome in mitochondria) helps in proton transport across the thylakoid membrane.
- Due to free energy of electrons, protons or H^+ ions transported from stroma side towards lumen of thylakoid by PQ or CF_0($PQ + 2H^+ \rightarrow PQH_2$ then $PQH_2 \rightarrow PQ + 2H+$)
  So within the chloroplast protons in the stroma decreases in number, while in the lumen there is accumulation of protons. This event creates a proton gradient (ΔpH) across the thylakoid membrane, which results in development of membrane protential. Both **proton gradient** and **membrane potential** constitute **proton motive force (Pmf)** or **electro-chemical gradient.**

- Due to high proton motive force (Pmf) inside the lumen results in collapse's of proton gradient and this potential is used in phosphorylation of ADP, results in synthesis of ATP (ADD + ip → ATP) catalysed by enzyme ATP synthase.

  The returned protons are accepted by NADP leads to formation of $NADPH_2$ in stroma side.



The photosynthesis electron transport system



Chemoiosmosis in a chloroplast

BIOENERGETICS OF RESPIRATION - (1 MOL. OF GLUCOSE)

- EMP-Pathway -

  ATP formed at substrate level phosphorylation ⇒ 4 ATP

  ATP produced via ETS ($2NADH_2$) ⇒ 6 ATP

  ATP consumed in glycolysis ⇒ 2 ATP

  10 ATP – 2 ATP = $\boxed{8\ ATP}$

  Gross – Expenditure = Net or Total gain

  Direct Gain = 2 ATP

- Link reaction or Gateway reaction -

  $2NADH_2$ = $\boxed{6\ ATP}$ (via ETS)

- Kreb's Cycle -

  ATP produced at substrate level phosphorylation ⇒ 2GTP / 2ATP

  ATP produced via ETS $\begin{cases} 6NADH_2 \rightarrow 18ATP \\ 2FADH_2 \rightarrow 4ATP \end{cases}$

  $22\ ATP + 2ATP$

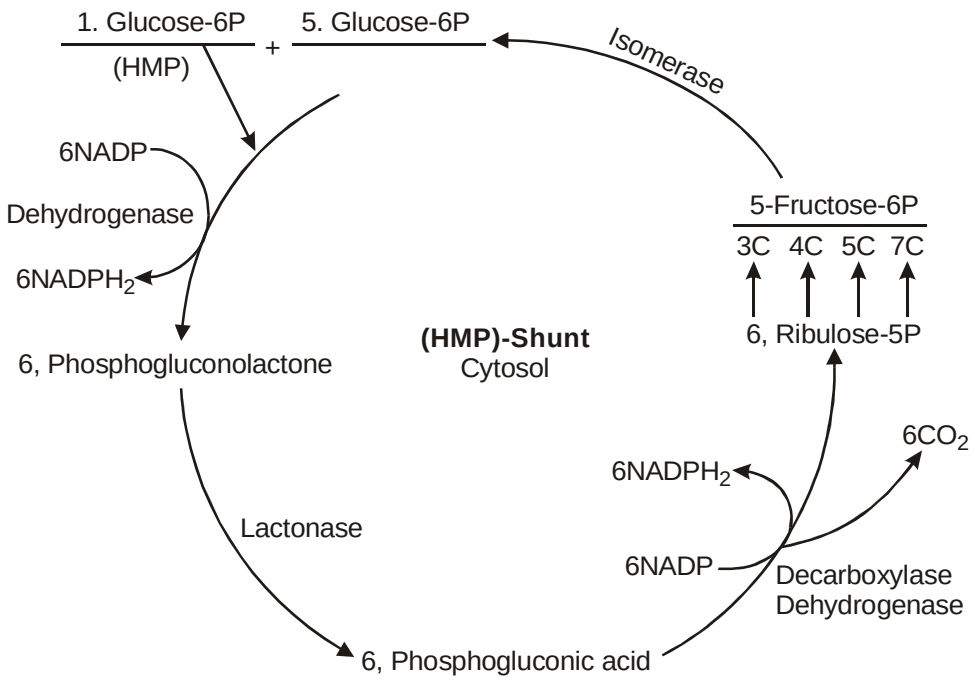
  $24\ ATP$

  Total ⟶ $38\ ATP$

  (8ATP in EMP + 6ATP link reaction + 24 ATP Krebs cycle)

- 1 Sucrose = 76 ATP
- 1 Fructose 1,6-Biphosphate = 40 ATP
- 1 Pyruvic acid = 15 ATP
- 1 Acetyl Co-A or 1 TCA cycle = 12 ATP

PENTOSE PHOSPHATE PATHWAY



HMP–Shunt

- It is an **alternative pathway** for glucose break down which was discovered by **Warburg et al** in 1935 and **Dickens et al** in 1938 in animal cells.
- It was described in detail by **Raecker** in 1954.
- It is completed in **cytoplasm.**
- This pathway is also known as **hexose monophosphate shunt (HMP shunt)**, **Pentose phosphate shunt, Phosphogluconate shunt, Warburg Dickens pathway, Oxidative pentose pathway Direct oxidation pathway and cytosolic oxidative decarboxylation**.
- This pathway starts with **6 molecules of Glucose-6-PO_4.12 $NADPH_2$ are obtained** and **6 CO_2** are released and **5** molecules of **Glucose-6-PO_4** are recovered.

Pentose Phosphate pathway can be summarized as :

- 6 Glucose-6-P + 12 NADP $\longrightarrow$ 6 CO_2 + 12 $NADPH_2$ + 5 Glucose-6-P

or

- Glucose-6-P + 12 NADP $\longrightarrow$ 6CO_2 + 12 $NADPH_2$

Significance of PPP / HMP shunt :

- This pathway **produces reducing power $NADPH_2$** for the various biosynthetic pathways, other than photosynthesis like **fats synthesis, starch synthesis, hormone synthesis and chlorophyll synthesis.**
- An intermediate **erythrose-P (4C)** of this pathway is precursor of **shikimic acid**, which goes **synthesis of aromatic compounds and amino acids.**
- This cycle provides pentose sugars **Ribose-p** for synthesis of nucleotides, nucleosides, ATP and GTP.
- A five carbon intermediate **Ribulose-5-phosphate** may used as CO_2 acceptor in green cells.
- Intermediates like **PGAL** and **fructose-6-phosphate** of this pathway may link with glycolytic reactions.

OTHER METHODS OF RESPIRATION

Respiration of Fats :

- It occurs **during germination of fatty seeds** and in plants when carbohydrates reserve declines.
- Fats are hydrolysed in presence of **enzymes lipase** to yield **fatty acid and glycerol**.

Oxidation of Glycerol :

- Glycerol reacts with ATP in presence of **glycerol kinase** to form **glycerol-3-PO_4**, which is then oxidised in presence of glycerol phosphate dehydrogenase and NAD to form **dihydroxy acetone phosphate** (DHAP). DHAP enters into glycolysis.

  Glycerol + ATP $\xrightarrow{\text{Kinase}}$ Glycerol-3-PO_4

  Glycerol-3-PO_4 + NAD $\xrightarrow{\text{Dehydrogenase}}$ DHAP/PGAL + $NADH_2$

Oxidation of Fatty Acids (β–oxidation) :

- It takes place **in mitochondria and glyoxysomes**.
- It involves sequential **removal of 2C in the form of acetyl COA** molecules from the carboxyl end of the fatty acid.
- Each turn of β–oxidation generates one $FADH_2$, one $NADH_2$ and one acetyl COA molecule. So each turn of β–oxidation generates 5 ATP molecules.

- Complete oxidation of one mole of acetyl COA in TCA results in production of 12 ATP molecules, CO_2 and H_2O.

  Palmitic acid (16 C)
  (1 mole)

  7 turns of β–oxidation ↓ 5 ATP per turn

  = 35 ATP – 2 ATP (consumed in first turn) = 33 ATP

  8 mole of Acetyl COA

  TCA cycle ↓ 12 ATP per cycle = 96 ATP

  16 mole CO_2 + 16 mole H_2O Total = 129 ATP
- **Acetyl COA** which is the end product of β–oxidation of fatty acids may enter into **Kreb's cycle** or into **glyoxylate cycle** in **germinating fatty seeds** to form **sucrose**.

  Note : Glyoxylate cycle is an example of **gluconeogenesis**.

Respiration of Proteins :

- Proteins are hydrolysed to form amino acids.
- Amino acids are deaminated to form organic acids, which are oxidized in glycolysis and Kreb's cycle.

FERMENTATION

- It is **anaerobic breakdown** of carbohydrates and organic compounds into **CO_2**, **alcohols** and **organic acids** with the help of microorganisms and their enzymes.

Mechanism of Fermentation :

- It occurs in two steps :

  Glycolysis

  Breakdown of Pyruvic acid

Glycolysis :

- Pyruvic acid is formed in glycolysis.

$$C_6H_{12}O_6 \xrightarrow[\text{Complex}]{\text{Enzyme}} \text{Pyruvic acid} + 2ATP + 2NADH_2$$

Breakdown of Pyruvic acid :

- Pyruvic acid in anearobic respiration is broken down in **different** products.

Types of Fermentation :

- Based on different products formed by pyruvic acid, fermentation can be of following types

Alcoholic Fermentation :

- Most common type. It occurs in **some fungi** (yeast) and **higher plants** during anaerobic conditions.
- It is completed in 2 step :

$$2CH_3CO.COOH \xrightarrow{\text{Decarboxylase}} 2CH_3CHO + 2CO_2$$

Pyruvic acid — Acetaldehyde

$$2\ CH_3CHO + 2\ NADH_2 \xrightarrow{\text{Alcohol dehydrogenase}} 2C_2H_5OH + 2NAD$$

Acetaldehyde — Ethyl Alcohol

Lactic Acid Fermentation :

- Lactic acid is formed by the activity of bacteria **Lactobacillus lactis** in presence of enzyme **lactic dehydrogenase** which requires **FMN** and **Zn^{+2}**.

$$2CH_3CO.COOH + 2\ NADH_2 \xrightarrow[Zn^{+2}]{\text{Lactic dehydrogenase}} 2CH_3.CHOH.COOH$$

Pyruvic acid — Lactic acid

Acetic Acid Fermentation :

- It is a **fermentation process** which requires atmospheric oxygen.
- Ethyl alcohol is oxidized into **acetic acid** by the activity of **acetic acid bacteria** (Acetobacter aceti).

$$C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2C_2H_5OH + 2CO_2$$

$$2\ C_2H_5OH + O_2 \xrightarrow{\text{Acetobacter aceti}} CH_3COOH + H_2O$$

Acetic acid

Butyric Acid Fermentation :

- **Pyruvic** acid is converted to **butyric** acid by the activity of **anaerobic bacteria**. e.g. Bacillus butyricus, Clostridium butyricum.
- CO_2 is liberated during such fermentation.

Pyruvic acid $\xrightarrow{\downarrow CO_2}$ Acetoacetic acid $\longrightarrow$ Butyric acid.

RESPIRATORY QUOTIENT

- The ratio of volume of CO_2 released to the volume of O_2 absorbed in respiration is called **respiratory quotient** (RQ) or **respiratory ratio**.

$$\boxed{RQ = \frac{\text{Vol. of } CO_2 \text{ released}}{\text{Vol. of } O_2 \text{ absorbed}}}$$

- Value of RQ measured by **Ganong's respirometer**.
- Value of RQ varies from one **substrate** to another.
- RQ gives the idea of nature of substrate being respired in a particular tissue.

R.Q. value equal to unity (RQ = 1) :

- When carbohydrates are the respiratory substrate, as in green leaves, flowers, fruits, germinating seeds of cereals etc.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

RQ = 6 / 6 = 1

RQ value less than unity (RQ < 1) :

Fats as respiratory substrate :

- When fats are respiratory substrate RQ is **less than one** because **fats are poorer in oxygen** and hence require more oxygen for their oxidation. e.g. : **germinating seeds of peanuts**, **mustard**, **sunflower**, **castor** etc.

$$2\ C_{51}H_{98}O_6 + 145O_2 \longrightarrow 102\ CO_2 + 98H_2O$$

Tripalmitin

RQ = 102/145 = 0.7

Proteins as respiratory substrate –

- RQ value for proteins is also **less than one**. Value of RQ is between 0.8 and 0.9. Eg : germinating seeds of gram, pea, bean etc.

RQ equal to zero (RQ = 0) or less than 1 :

- **In some succulent or CAM plants** (Eg. – Opuntia, Bryophyllum) carbohydrates are incompletely oxidised to organic acids in dark.

  $2\ C_6H_{12}O_6 + 3\ O_2 \longrightarrow 3\ C_4H_6O_5 + 3\ H_2O + 2\ CO_2$

  Malic acid

  $2/3 = RQ = < 1$

  CO_2 is not evolved.

  $RQ = 0/3 = 0$

RQ value more than unity (RQ > 1) :

When respiratory substrates are **organic acids**

- Succulent plants form organic acids during the night which are completly oxidized during the day.
- **Organic acids are rich in oxygen** and therefore require less O_2 during respiration but release more CO_2.

  $C_4H_6O_5 + 3\ O_2 \longrightarrow 4\ CO_2 + 3\ H_2O$

  Malic acid

  $RQ = 4/3 = 1.33$

- **Hightest R.Q., oxalic acid = 4**

RQ value equal to infinity (RQ = ∞) :

- During **anaerobic respiration**, CO_2 is evolved, without intake of oxygen and so value of RQ is **infinite**.

  $C_6H_{12}O_6 \longrightarrow 2\ C_2H_5OH + 2\ CO_2$

  $RQ = 2 / 0 = \infty$

FACTORS AFFECTING RESPIRATION

Temperature :

- A rise in temperature from 0°C to 40°C **increases** the **rate of respiration**.
- Optimum temperature for respiration lies between 20° - 40°C.
- In most of the plants rate of respiration is affected according to **Von't Hoff's Law**. **Q_{10} value** or **temperature coefficient value** (increase in rate of a particular process with every 10°C increase in temp.) for respiration is 2–3.
- At low temp. (below 0°C), activity of enzyme is less and hence low respiration. It is for this reason that **vegetables and fruits are stored at low temp**. (cold storage or refrigerators).
- At high temp. (45°C or above), denaturation of enzymes occurs and hence **respiratory rate** is decreased.

Oxygen :

- The presence or absence of O_2 determines the kind of respiration and respiratory products.
- **Oxygen is essential** for aerobic respiration, as it is one of the reactants in the process. It is the **final acceptor of electrons and protons** in electron transport system of the mitochondria.
- The inhibition of anaerobic respiration by O_2 concentration is called as **Pasteur's effect**.
- The minimum amount of oxygen, at which aerobic respiration takes place & anaerobic respiration become extinct is called as **extinction point**.

- Oxygen conc^{n} at which both aerobic & anaerobic respiration take place simultaneously is called as **transition point**.

Carbondioxide :

- Increase in CO_2 concentration reduces respiration. Consequently inhibits the **germination of many seeds** and rate of growth falls down.

Water :

- Proper hydration of respiring cells is must because decrease in water content, **decreases respiratory rate** as water is **necessary for the activity of enzymes**.
- **Dry seeds** having 8–12% of water, have negligible respiratory rate but as the seeds **imbibe** water the respiration increases.
- **The rate of respiration of seeds increases with increase of water** because water causes hydrolysis and so enzyme activity increases. Oxygen also enters the seed through water.

Light :

- Light has no direct effect.
- Under suitable light, **rate of photosynthesis** is optimun which supplies respiratory substrate at a moderate rate and hence **indirectly affects respiration**.

Injury :

- Injury or **wounds causes increase in respiration** because healing of wound needs more meristmatic activity of cells which needs more energy provided by increased rate of respiration.
- After some time the rate of respiration returns to normal.

Mineral Salts :

- If the plants are transferred from water to adequate salt solution, then **rate of respiration** increases. This process is known as **salt respiration**.

Hormones :

- IAA, GA & cytokinin increase the respiration rate.
- The rapid increase in rate of respiration during ripening of fruits and senscence of leaves and plant organs is called as "**Climacteric respiration**". The rate is decrease after sometime.
  It is due to production of **ethylene** hormone.

Inhibitors :

- CN, azides, DNP (Dinitrophenol) CO, rotenone, antimycin, amytal, etc inhibit the respiration.
- **Heavy metals** like lead and zinc **inhibit respiration** by inactivating respiratory enzymes.

SPECIAL POINTS

- In the prokaryotic cells, oxidation of a glucose molecule always provides 38 ATP molecules because $NADH_2$ enter to the mitochondria which are absent.
- A lot of energy is released during seed germination and flowering which cause increase in their temperature.
- **Bioluminescence** is the production of light by some living organisms like bacteria and fungi. This mechanism requires water, inorganic ions, O_2, ATP, **luciferin** and **enzyme luciferase**.
- Inhibition of fermentation due to presence of O_2 is called **Pasteur effect**.
- Glycolysis provides energy to **RBCs** and **most muscles**.
- **Glyoxylate cycle** occurs in **seed rich in fats** and convert stored fats into carbohydrates. Enzymes for this cycle are present in **glyoxysomes**.

- **Comparison between Respiration & Combustion :**

  Burning of fuel is also oxidation in which energy is released from organic substances but it is different from respiration.

S.No.	Respiration	Combustion
1	It is a biological process occuring in all living cells.	It is not performed in living cells.
2	It is a sequential chain of numerous small reactions controlled by specific enzymes.	It is a simple chemical reaction. Enzymes are not needed.
3	Energy is liberated in numerous step.	Energy is released in one step continuously.
4	Fraction of released energy is stored as ATP and rest is released as heat.	Whole energy is released as heat and light.
5	Respiration occurs at body temperature. Body temperature does not increase by this process.	As most energy is released in form of heat and light thus, there is an enormous increase in temperature of the environment.

- **Significance of ATP**

  ATP transfers the energy conveniently. Therefore, ATP is called the '**universal currency of energy transaction**' in the cell.

  Besides ATP, **GTP** (Guanosine triphosphate), **CTP** (Cytosine triphosphate), **TTP** (Thymidine triphosphate) and **UTP** (Uridine triphosphate) are also high energy compounds which are used in certain biosynthetic processes.

- **Entner Duodoroff Pathway :**

  This pathway was discovered by **Entner & Duodoroff**.

  This pathway was first discovered in **bacteria Pseudomonas**.

  It is also known as **glycolysis of bacteria**.

- ATP discovered by Lohman, while importance of ATP in metabolism by Lipman.
- 1 gram of fat equals to 9.8 K.Cal.
  Proteins = 4.8 K.Cal.
  Carbohydrate = 4.4 K.Cal (Old 3.8 K.Cal)
  (Fat is energy rich respiratory substrate)
- Almost all enzymatic reactions are reversible type.
- Cytochromes are Iron-porphyrin protein discoverd by MacMunn (Termed by Keilin)
- When respiratory substrate is **fats** or **proteins**, then **level of Hg rises in Ganong's respirometer**, because more O_2 absorbed than CO_2 released, If respiratory substrate is **organic acids** than **Hg level will fall**.
- In bacteria site of ETS is **mesosome.**
- Respiration efficiency :

  1 glucose = 686 K cal.

  $$38 \text{ ATP} \times 7.6 \text{ K cal} = \frac{288\,\text{kcal}}{686} \times 100 = 42\%$$

  Thus efficiency of aerobic respiration is 42%.

- For the complete oxidation of one glucose if, option 38 or 36 ATP are not given, then the answer goes to 32 or 30 ATP.
- Biochemical difference between Aerobic, Anaerobic respiration and fermentation.

Aerobic Respiration → The electron ejected by oxidation of organic ompound is terminally accepted by external component to organic compound or inorganic compound which is **oxygen**.

Anaerobic Respiration → The electron ejected by oxidation of organic compound is terminally accepted by external component to organic ompound or inorganic compound other than oxygen **NO_2^-, NO_3^-, SO_4^{-2}, N_2** etc.

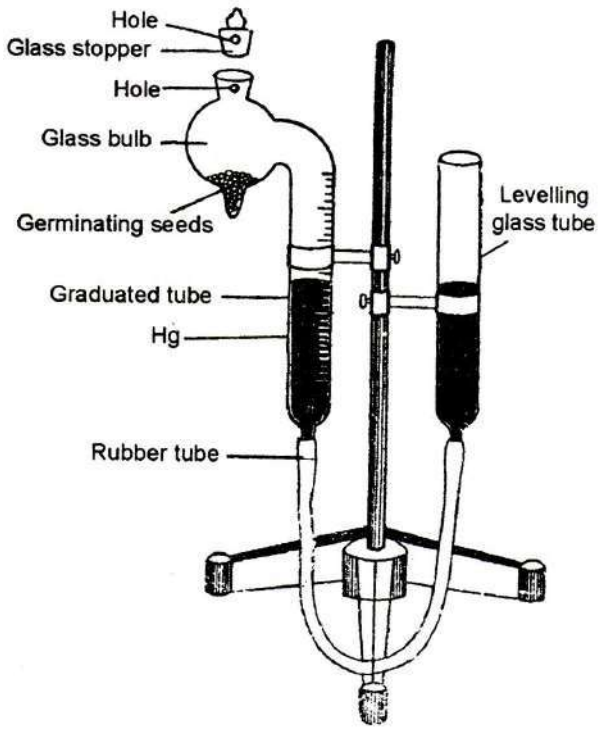
Fermentation → The electron ejected by oxidation of organic compound is terminally accepted by internal component to organic compound or organic compound **C_2H_5OH**, **Lactic Acid**, etc

- During fermentation and anaerobic respiration only 2 ATP and $2NADH_2$ are produced during glycolysis. The $2NADH_2$ produced terminally **reduce the organic compound in fermentation** and **inorganic compound, in anaerobic respiration** and energy lost in form of heat **as mitochondrial ETS not occurs.**

EXPERIMENT

Measurement of R.Q. by means of Ganongs respirometer.

Ganong's respirometer has a large stoppered bulb, a graduated side tube and a large stoppered bulb, a graduated side tube and a levelling tube. Both the stopper and neck of the bulb have a hole which can be used to equalise the atmospheric pressure inside the apparatus.



Place the respiring material in the bulb of Ganong's respirometer. Pour saturated common salt solution (CO_2 is sparingly soluble in it) in the levelling tube. Adjust the level of solution in the levelling tube and note the reading. After an hour note the reading. Calculate the rise (e.g., when organic acids are substrate) of salt solution level in the graduated tube through the levelling tube. KOH shall absorb CO_2. Take a new reading. Let it be $V_2CC.V_2CC$ is the volume of CO_2 librated during respiration. The O_2 used is V_2 plus V_1. R.Q. will therefore be

$$\text{R.Q.} = \frac{V_2}{V_2 + (-\text{ve or } +\text{ve } V_1)}$$

If v_1 is zero, positive or negative, R.Q. will be accordingly unity, less than unity or more than one respectively.

EXERCISE - 1

Q.1 How many molecules of ATP are produced per molecule of $FADH_2$ oxidised -
(1) One (2) Two
(3) Three (4) four

Q.2 Which of the following cytochrome donated electron to oxygen -
(1) cyto.-a_1 (2) cyto.-a_3
(3) cyto.-b (4) cyto.-c

Q.3 The amount of energy given by one ATP molecule is -
(1) 67 K cal (2) 6.7 K cal
(3) 7.6 K cal (4) 75 K cal

Q.4 How many ATP molecules produced from the complete oxidation of a molecule of active acetate or acetyl Co-A -
(1) 38 ATP (2) 15 ATP
(3) 12 ATP (4) 4 ATP

Q.5 How many ATP equivalents are produced by the oxidation of succinate into fumarate -
(1) 1 ATP (2) 2 ATP
(3) 3 ATP (4) 4 ATP

Q.6 The product of aerobic respiration of glucose is -
(1) $CO_2 + H_2O + ATP$
(2) CO_2 + Pyruvic acid
(3) CO_2 + ethyl alcohol
(4) CO_2 + Pyruvic acid + citric acid

Q.7 Product formed by the activity of malic dehydrogenase is -
(1) Fumaric acid (2) Malic acid
(3) Oxaloacetic acid (4) Succinc acid

Q.8 Which of the following is 5-carbon compound of Kreb's cycle -
(1) Citric acid
(2) Furmaric acid
(3) Oxalosuccinic acid
(4) α-Ketoglutaric acid

Q.9 Energy for ATP synthesis is obtained from -
(1) Oxygen ion gradient
(2) Heavy water grdient
(3) Uranium ion gradient
(4) Hydrogen ion gradient

Q.10 Mitochondria is the site of -
(1) CO production (2) Cell division
(3) The release of energy during respiration
(4) None of the above

Q.11 Substrate level ATP molecules during complete oxidation of molecule of glucose-
(1) 8 ATP (2) 6 ATP
(3) 4 ATP (4) 2 ATP

Q.12 How many ATP generates in aerobic respiration via glycerol phosphate shuttle in eukaryotes ?
(1) 38 ATP (2) 36 ATP
(3) 40 ATP (4) 80 ATP

Q.13 How many ATP generates in aerobic respiration of eukaryotic cell ?
(1) 28 ATP (2) 36 ATP
(3) 20 ATP (4) 40 ATP

Q.14 Respiration differs from burning in which of the following ?
(1) Energy released in respiration
(2) Oxidation of substance occurs
(3) Enzymes are involved
(4) All the above

Q.15 Energy produced per gram is highest in -
(1) Starch (2) Sucrose
(3) Protein (4) Lipid

Q.16 Site of Kreb's-cycle in respiration & ATP synthesis is -
(1) Mitochondrial stroma
(2) Matrix & oxysome
(3) Cytoplasm (4) None of the above

Q.17 Minimum respiration rate found in -
(1) Leaves (2) Stem
(3) Parenchyma (4) Seeds

Q.18 Cyanide resistant respiration is found in -
(1) Homo sapiens (2) Brassica
(3) Spinacea (4) Bacteria

Q.19 Ganong's respirometer used for -
(1) Respiration measuring
(2) R.Q. measuring
(3) Transpiration measuring
(4) All of the above

Q.20 Direct gain of ATP from one mole of glucose during glycolysis or EMP pathaway -
(1) 2 ATP (2) 6 ATP
(3) 36 ATP (4) 38 ATP

Q.21 In glycolysis of aerobic respiration the ATP synthesized are -
(1) 2 ATP (2) 6 ATP
(3) 8 ATP (4) 30 ATP

Q.22 $FADH_2$ Produced in Kreb's-cycle from -
(1) Isocitrate (2) α-ketoglutarate
(3) succinate (4) malate

Q.23 Which 5-carbon organic acid of TCA-cycle is key compound in N_2 -metabolism ?
(1) Cirtric acid (2) Fumaric acid
(3) Oxalosuccinic acid
(4) α-ketoglutaric acid

Q.24 mole of glucose when oxidised through EMP & TCA-cycle would yield -
(1) 30 ATP gross
(2) 40 ATP net
(3) 36 or 38 ATP net
(4) 38 ATP only

Q.25 When 00% carbon is oxidised to CO_2 the efficiency of such a respiration is ?
(1) 40% (2) 60%
(3) 80% (4) 00%

Q.26 What is true for Kreb's cycle ?
(1) GTP/ATP is formed
(2) 2 Decarboxylation
(3) Acetyl Co-A acceptor is O.A.A .
(4) All the above

Q.27 β-oxidation takes place in -
(1) Cell Membrane
(2) Mitochondrial Membrane
(3) Oxysomes Head
(4) Perimitochondrial space

Q.28 Warburg-Dickens pathaway is -
(1) PPP (2) TCA-cycle
(3) EMP pathway (4) None

Q.29 Which enzyme break downs the fructose, 6-Disphosphate ?
(1) Hexokinase (2) Phosphatase
(3) Aldolase (4) None

Q.30 How much energy equal to ATP will be produced by HMP shunt ?
(1) 40 ATP (2) 38 ATP
(3) 35 ATP (4) 8 ATP

Q.31 Link between glycolysis & TCA cycle is -
(1) Pyruvic acid (2) Acetyl Co-A
(3) Citric acid (4) None

Q.32 Aceptor of acetyl Co-A in Kreb's-cycle is -
(1) Malic acid (2) Fumaric acid
(3) α-ketoglutric acid
(4) Oxalo acetic acid

Q.33 Enzyme alternate oxidase is inhibited by :
(1) NADP
(2) SHAM (Salicy hydroxamic acid)
(3) m-CLAM (m-chloro-benzhydroxamic acid)
(4) 2 & 3

Q.34 When 2-pyruvic acids froms two lactic acid by anaerobic respiration then ?
(1) One ATP is lost (2) 3 ATP is lost
(3) 6 ATP is lost (4) None

Q.35 During oxidative phosphorylation follwoing provides energy for the ATP formation -
(1) Co-A
(2) NADPH
(3) Efflux of proton to PMS
(4) Pyruvic acid

Q.36 Energy required for start of biochemical reaction is -
(1) Potential energy (2) Entropy
(3) Activation enegy (4) Kinetic energy

Q.37 R.Q. of maturing fatty seeds will be -
(1) 1 (2) More than one
(3) 0 (4) 0.7

Q.38 Anaerobic degradation of proteins by microbes is known as -
(1) Putreification (2) Degradation
(3) Decomposition (4) None

Q.39 How is the energy present in food released during biological oxidation ?
(1) In one step, quickly
(2) In two steps, slowly
(3) In different steps, slowly
(4) In different steps, quickly

Q.40 During biological oxidation in which form energy is temporarily stored –
(1) In the form of Glucose
(2) In the form of Pyruvic acid
(3) In the form of ATP
(4) All the above

Q.41 Which of these is a high energy molecule ?
(1) GTP (2) CTP
(3) TTP (4) All the above

Q.42 ATP is formed in –
(1) Respiration
(2) Photosynthesis
(3) Photophosphorylation
(4) All the above

Q.43 ATP is called the –
(1) Cellular furnace
(2) Energy centre of the cell
(3) Biological energy currency
(4) Energy depositing molecule

Q.44 What is wrong about respiration ?
(1) It does not occur in cell
(2) Oxidation occurs without the use of enzymes
(3) Energy is released in one step quickly
(4) All the above

Q.45 Which statement about respiration is correct ?
(1) All energy is released in the form of heat
(2) Some energy is stored and rest is released as heat
(3) Body temperature increases greatly
(4) All the above

Q.46 What is the product of aerobic respiration ?
(1) CO_2 (2) H_2O
(3) Energy (4) All the above

Q.47 It is equally found in aerobic as well as anaerobic respiration ?
(1) Glycolysis (2) Kreb's Cycle
(3) Both of above (4) ETS

Q.48 What happens in fermentation ?
(1) Incomplete breakdown of Glucose
(2) Complete breakdown of Glucose
(3) Any of the above
(4) None of the above

Q.49 What are the reasons for less frequent fermentation ?
(1) Due to less energy production, the energy supply is less
(2) Due to more use of respiratory substrate, it is not available for growth and other process
(3) The excess of final and intermediate products of fermentation produce toxicity
(4) All the above

Q.50 What is the other name of glycolysis
(1) HMP pathway (2) EMP pathway
(3) PPP (4) All the above

Q.51 What is formed at the end of first step of phosphorylation of glycolysis ?
(1) Glucose 6-PO_4 (2) Fructose 6-PO_4
(3) Fructose-6 diPO_4 (4) Any of the above

Q.52 Phosphorylation of glucose occurs by –
(1) H_3PO_4 (2) ATP
(3) Any of the above (4) None of the above

Q.53 What is formed by the breakdown of Fructose -6 diphosphate in glycolysis ?
(1) PGAL (2) DHAP
(3) Both of above (4) PGA

Q.54 When is $NADH_2$ formed in glycolysis ?
(1) During the formation of DiHAP from PGAL
(2) During the formation of -3 DiPGAL from PGAL
(3) During the formation of -3 DiPGA from -3 DiPGAL
(4) During the formation of PeP from PGA

Q.55 When is ATP formed in glycolysis ?
(1) During the formation of 3-PGA from -3 DiPGA
(2) During the formation of Pyruvic acid from PEP
(3) Both of above
(4) None of the above

Q.56 How many molecules of pyruvic acid are formed in glycolysis ?
(1) One (2) Two
(3) Three (4) Four

Q.57 The products of glycolysis are –
(1) Pyruvic acid (2) 2 $NADPH_2$
(3) 2 ATP (4) All the above

Q.58 What is the total gain in terms of ATP in glycolysis ?
(1) Six (2) Four
(3) Eight (4) Ten

Q.59 How many ATPs are stored in anaerobic respiration ?
(1) Two (2) Four
(3) Six (4) Eight

Q.60 What is formed during exercising in skeletal muscles ?
(1) Pyruvic acid (2) Lactic acid
(3) Ethyl alcohol (4) Acetone

Q.61 Why the animals feel fatigue during exercise?
(1) Due to accumulation of malic acid
(2) Due to accumulation of lactic acid
(3) Due to accumulation of pyruvic acid
(4) Due to all the above

Q.62 What is there in Pyruvic dehydrogenase complex ?
(1) Pyruvic decarboxylase with TPP Mg^{++}
(2) COA
(3) Lipoic acid (4) All the above

Q.63 What is the other name for Kreb's Cycle ?
(1) TCA Cycle (2) DCA Cycle
(3) Both of above (4) None of the above

Q.64 Which is the 6 carbon compound in Kreb's cycle ?
(1) Citric/Isocitric acid
(2) Aconitic acid
(3) Oxalosuccinic acid
(4) All the above

Q.65 What is formed besides succinic acid during its formation in Kreb's Cycle ?
(1) ADP (2) GTP
(3) $NADH_2$ (4) $FADH_2$

Q.66 Which is the 4-carbon compound found in Kreb's cycle ?
(1) Succinic acid (2) Fumaric acid
(3) Malic acid (4) All the above

Q.67 What else is formed during formation of Fumaric acid from succinic acid ?
(1) $FADH_2$ (2) $NADH_2$
(3) $NADPH_2$ (4) None of these

Q.68 How many $FADH_2$ are formed from one pyruvic acid molecule ?
(1) One (2) Two
(3) Three (4) Four

Q.69 How many $NADH_2$ are formed from one glucose molecule ?
(1) Four (2) Five
(3) Eight (4) Ten

Q.70 How many $FADH_2$ are formed in one Kreb's cycle ?
(1) One (2) Two
(3) Three (4) Four

Q.71 How many $FADH_2$ are formed from one glucose molecule ?
(1) One (2) Two
(3) Three (4) Four

Q.72 Where the reaction of Kreb's cycle occur ?
(1) Cytoplasm
(2) Mitochondrial matrix
(3) Mitochondrial cristae
(4) F_1 particles of mitochondia

Q.73 How many ATP are obtained from $NADH_2$?
(1) One (2) Two
(3) Three (4) Four

Q.74 How many ATP are obtained from $FADH_2$?
(1) One (2) Two
(3) Three (4) Four

Q.75 $NADH_2$ to ATP synthesis occurs through –
(1) ETS (2) PPP
(3) EMP (4) HMP

Q.76 Which complex is formed by FMN $NADH_2$, Dehydrogenase,?
(1) Complex–I (2) Complex–II
(3) Complex–III (4) All the above

Q.77 Which substances are found in complex II of ETS ?
(1) FMN $NADH_2$, dehydrogenase
(2) Co-Q $FADH_2$, Dehydrogenase
(3) Both of above (4) None of above

Q.78 Which complex is formed by Cyt.a_3 and Cyt.a of ETS ?
(1) Complex–I (2) Complex–II
(3) Complex–III (4) Complex–IV

Q.79 Where is ATPase complex found ?
(1) On cristae of mitochondria
(2) In matrix of mitochondria
(3) In oxysomes present on cristae of mitochondria
(4) On F_0 particles of mitochondria

Q.80 Which electron acceptors can easily be separated from respiratory chain ?
(1) Co-Q (2) Cyt-c
(3) Both of above (4) Fe-S Protein

Q.81 Which are called mobile carriers of respiratory chain ?
(1) Co-Q (2) Cyt-c
(3) Both of above (4) None of the above

Q.82 Which acts as mobile carrier between complex-III and complex-IV ?
(1) Fe-S (2) Co-Q
(3) Cyt-C (4) None of these

Q.83 Hydrogen is transferred from $FADH_2$ to –
(1) NAD (2) FMN
(3) Co-Q (4) NADP

Q.84 Hydrogen is transferred from $NADH_2$ to –
(1) FAD (2) FMN
(3) Co-Q (4) Fe-S

Q.85 Who discovered chemiosmosis ?
(1) Mitchell (2) Warburg & Dickens
(3) Raecker (4) Krebs

Q.86 From which place H^+ protons enter matrix from outside of inner membrane of mitochondria ?
(1) Any part of the membrane
(2) Through elementary particles/oxysomes of membrane
(3) From terminal end of cristae
(4) None of the above

Q.87 Which part of elementary particle is completely embedded in the membrane ?
(1) F_0 (2) F_1
(3) Both of above (4) None of these

Q.88 By transfer of how many protons, one ATP is formed ?
(1) $1H^+$ (2) $2H^+$
(3) $3H^+$ (4) $4H^+$

Q.89 How many pairs of protons are released in respiratory chain by one $NADH_2$?
(1) One pair (2) Two pairs
(3) Three pairs (4) Four pairs

Q.90 What is the method of formation of ATP in mitochondria?
(1) Osmosis
(2) Chemiosmosis
(3) Chemiphosphorylation
(4) Osmophosphorylation

Q.91 Phosphorylation at substrate level is found in-
(1) Glycolysis (2) Kreb's cycle
(3) Both (1) and (2) (4) None of the above

Q.92 Which is called phosphorylative coupling ?
(1) Formation of ATP
(2) Formation of ATP by energy present in $NADH_2$, $FADH_2$ through respiratory chain
(3) Formation of ATP at substrate level
(4) All the above

Q.93 Who resists terminal oxidation of respiratory chain ?
(1) CO (2) KCN
(3) Both (1) and (2) (4) None of these

Q.94 Where is PPP (Pentose Phosphate pathway) performed in cell ?
(1) In mitochondrial matrix
(2) In cytoplasm
(3) In mitochondrial membrane
(4) None of the above

Q.95 PPP is related to –
(1) Glycolysis (2) Kreb's cycle
(3) Respiration (4) Photosynthesis

Q.96 PPP is an alternative of –
(1) Anaerobic respiration
(2) Fermentation
(3) Aerobic respiration
(4) All the above

Q.97 What is the significance of PPP ?
(1) It provides reductive power
(2) It provides ribose sugars for nucleic acid synthesis
(3) Provides Erythrose 4-P for synthesis of lignin, anthocyanin, auxin etc
(4) All the above

Q.98 Why $NADH_2$ produced in glycolysis cannot enter mitochondria generally ?
(1) Mitochondrial membrane is impermeable to $NADH_2$
(2) $NADH_2$ is used in cytoplasm only
(3) Both of above
(4) None of the above

Q.99 If malate aspartate shuttle is effective then how many ATPs are formed from Glucose ?
(1) 36 ATP (2) 38 ATP
(3) 30 ATP (4) 34 ATP

Q.100 Where H_2 of $NADH_2$ obtained by glycolysis through Glycerol Phosphate shuttle is transferred ?

(1) In matrix of mitochondria

(2) On inner surface of inner membrane of mitochondria

(3) On inner surface of outer membrane of mitochondria

(4) On outer surface of inner membrane of mitochondria

Q.101 In presence of Glycerol Phosphate shuttle, a glucose molecule yields –

(1) 38 ATP (2) 36 ATP

(3) 34 ATP (4) 30 ATP

Q.102 In prokaryotes, a glucose molecule always yields –

(1) 38 ATP (2) 36 ATP

(3) 2 ATP (4) 8 ATP

Q.103 In eukaryotes, a glucose molecule forms –

(1) Always 36 ATP (2) Always 38 ATP

(3) Always 38 ATP or 36 ATP

(4) None of the above

Q.104 Which is the substrate generally used first of all in respiration ?

(1) Protein (2) Fat

(3) Carbohydrate (4) Organic acid

Q.105 The ratio of CO_2 released and O_2 utilised in a definite time by a definite weight of respiratory substrate is called –

(1) Respiration (2) Respiratory quotient

(3) Respiratory ratio (4) Respiratory effect

Q.106 Why RQ value of carbohydrates is one ?

(1) Carbohydrates breakdown completely in respiration

(2) Carbohydrates have almost equal C and O

(3) Both of above

(4) None of the above

Q.107 Why the RQ value for fats and proteins is less than one ?

(1) Due to less O as compared to C in fats and proteins

(2) Due to incomplete breakdown of fats and proteins

(3) Due to complete breakdown of fats and proteins

(4) Due to more O in fats and proteins

Q.108 The fruits in which rate of respiration increases during ripening is called –

(1) Respiratory fruit (2) Climacteric fruit

(3) Climax fruit (4) Ethylinated fruit

ANSWER KEY

EXERCISE - 1

Q.1	2	Q.2	2	Q.3	3	Q.4	3	Q.5	2	Q.6	1	Q.7	3
Q.8	4	Q.9	4	Q.10	3	Q.11	3	Q.12	2	Q.13	2	Q.14	3
Q.15	4	Q.16	2	Q.17	4	Q.18	3	Q.19	2	Q.20	1	Q.21	3
Q.22	3	Q.23	4	Q.24	3	Q.25	1	Q.26	4	Q.27	4	Q.28	1
Q.29	3	Q.30	3	Q.31	2	Q.32	4	Q.33	4	Q.34	3	Q.35	3
Q.36	3	Q.37	2	Q.38	1	Q.39	3	Q.40	3	Q.41	4	Q.42	4
Q.43	3	Q.44	4	Q.45	2	Q.46	4	Q.47	1	Q.48	1	Q.49	4
Q.50	2	Q.51	1	Q.52	2	Q.53	3	Q.54	3	Q.55	3	Q.56	2
Q.57	4	Q.58	3	Q.59	1	Q.60	2	Q.61	2	Q.62	1	Q.63	1
Q.64	4	Q.65	2	Q.66	4	Q.67	1	Q.68	1	Q.69	4	Q.70	1
Q.71	2	Q.72	2	Q.73	3	Q.74	2	Q.75	1	Q.76	1	Q.77	2
Q.78	4	Q.79	3	Q.80	3	Q.81	3	Q.82	3	Q.83	3	Q.84	2
Q.85	1	Q.86	2	Q.87	1	Q.88	2	Q.89	1	Q.90	2	Q.91	3
Q.92	2	Q.93	3	Q.94	2	Q.95	3	Q.96	3	Q.97	4	Q.98	1
Q.99	2	Q.100	4	Q.101	2	Q.102	1	Q.103	3	Q.104	3	Q.105	2
Q.106	2	Q.107	1	Q.108	2								

EXERCISE - 2

Q.1 What is the importance of respiration in organisms ?
(1) It provides oxygen to plant
(2) It liberates energy
(3) It liberates CO_2
(4) All of the above

Q.2 Energy obtained by a cell from catabolic reaction is stored immediatlety in the form of-
(1) Pyruvic acid (2) Glucose
(3) ATP (4) DNA

Q.3 Which component of ETS is mobile, e^- carrier?
(1) UQ (CO-Q) (2) Cyto a
(3) Cyto - b (4) Cyto - f

Q.4 Which of the following is the source of respiration ?
(1) Stored food (2) RNA
(3) DNA (4) ATP

Q.5 R.Q. is less than one at the time of respiration of-
(1) Starch (2) Sugarcane
(3) Glucose (4) Ground nut

Q.6 Number of ATP produced from one pyruvic acid during conversion to actyl Co-A-
(1) 6 (2) 3
(3) 12 (4) 15

Q.7 In succulent plants R.Q. is less than one because of
(1) Complete oxidation
(2) Complete reduction
(3) Incomplete reduction
(4) Incomplete oxidation

Q.8 The link between Glycolysis and Krebs cycle is
(1) Citric acid (2) Malic acid
(3) Fumaric acid (4) Acetyl co-enzyme-A

Q.9 Aerobic respiration of glucose produces energy-
(1) 637 K.cal (2) 640 K.cal
(3) 686 K.cal (4) 693 K.cal

Q.10 Succinyl Co-A is related to -
(1) Krebs cycle (2) Calvin cycle
ycle (4) HMP-cycle

Q.11 According to chemiosmotic theory of P.Mitchell (1978), ATPs are synthesised on membrance due to the -
(1) Proton gradient (2) Electron gradient
(3) Osmosis (4) From H_2SO_4

Q.12 A reducton of NADP to $NADPH_2$ is associted with-
(1) EMP-pathway (2) HMP-shunt
(3) Calvin cycle (4) Glycolysis

Q.13 Cut surface of fruit and vgetable often become dark because -
(1) Dirty knife makes it dark
(2) Oxidation of tannic acid in the presence of trace of iron from the knife makes it dark
(3) Dust of the air makes it dark
(4) None of the above

Q.14 An example of competitive inhibition of an enzyme is the inhibition of :
(1) Succinic dehydrogenase by malonic acid
(2) Cytochrome oxidase by cyanide
(3) Hexokinas by glucose-6 phosphate
(4) Carbonic anhydrase by carbon-dioxide

Q.15 In hexose monophosphate shunt the number of CO_2 molecules evolved is-
(1) Same as in glyclysis
(2) Less than glycolysis
(3) More than glycolsis
(4) Much less than glycolysis

Q.16 Conversion of pyuvic acid into ethyl alcohol is mediated by -
(1) Phosphatase (2) Dehydrogenase
(3) Decarboxylase & dehydrogenase
(4) Catalase

Q.17 The commonest living, which can respire in the absence of O_2 is -
(1) Fish (2) Yeast
(3) Potato (4) Chorella

Q.18 The formation of Acetyl Co-A from pyuvic acid is the result of its -
(1) Reduction (2) Dehydration
(3) Phosphorylation
(4) Oxidative decarboxylation

Q.19 Which of the following is link between carbohydrate and fat metabolism ?

(1) CO_2 (2) Acetyl Co-A

(3) Pyruvic acid (4) Citric acid

Q.20 Pyruvate dehydrogenase complex is used in converting-

(1) Pyuvate to glucose

(2) Glucose to pyruvate

(3) Pyruvic acid to lactic acid

(4) Pyruvate to acetyl Co-A

Q.21 The first compound of TCA cycle is -

(1) Oxalo succinic acid

(2) Oxalo acetic acid

(3) Citric acid

(4) Cis aconitic acid

Q.22 End product of glycolysis is-

(1) Citirc acid

(2) Glyceraldeyde

(3) Phosphoglyceraldehyde

(4) Pyruvic acid

Q.23 First reaction in pentose phosphate pathway is-

(1) Oxidation of glucose-6-phosphate

(2) 6-Phosphogluconic acid

(3) Ribose-5-phosphate

(4) Fructose-5-phosphate

Q.24 Oxidation of one molecule of glucose in aerobic respiration result in the formation of-

(1) 36 ATP molecules (2) 38 ATP moleules

(3) 3 ATP molecules (4) 15 ATP molecules

Q.25 In the electron transport chain during terminal oxidation, the cytochrome, which donated electrons to O_2 is ?

(1) Cytochrome-b (2) Cyto-C

(3) Cyto-a_3 (4) Cyto-f

Q.26 Number of oxygen atoms required for aerobic oxidation of one pyruvate-

(1) 5 (2) 8

(3) 10 (4) 12

Q.27 Alternate name of Krebs cycle is -

(1) Glyoxylate cycle (2) Glycolate cycle

(3) Citric acid cycle (4) EMP Pathway

Q.28 Respiration in plants

(1) Occurs only during day

(2) Results in the formation of vitamins

(3) Is characteristic of all living cells

(4) Often requires CO_2

Q.29 In plants energy is produced during the process of -

(1) Photosynthesis (2) Transpiration

(3) Respiration (4) Water abosrption

Q.30 A very important feature of respiration is that

(1) It liberates energy

(2) It provides O_2

(3) Utilize CO_2

(4) Synthesize complex compounds

Q.31 Complete oxidation of 1 gm mol of glucose gives rise to -

(1) 6860000 cals (2) 686000 cals

(3) 68600 cals (4) 6860 cals

Q.32 The cell orgnelle in, which aerobic respiration occurs -

(1) Ribosome (2) Mitochondria

(3) Lysosmes (4) Chloroplast

Q.33 For the purpose of respiration in plants

(1) Light is necessary

(2) CO_2 is necessary

(3) O_2 is necessary

(4) Chlorophyll is necessary

Q.34 The end products of respiration in plants are

(1) CO_2, H_2O and energy

(2) Starch and O_2

(3) Sugar and oxygen

(4) H_2O and energy

Q.35 The incomplete breakdown of sugars in anaerobic respiration result in the formation of-

(1) Fructose and water

(2) Glucose and carbon dioxide

(3) Alcohol and CO_2

(4) Water and CO_2

Q.36 Carbon dioxide is liberated during -

(1) Phtosynthesis (2) Transpiration

(3) Acent of sap (4) Respiration

Q.37 Common immediate source of energy in cellular acticity is -

(1) glucose (2) aldohexose

(3) ATP (4) NAD

Q.38 Energy obtined by a cell from catabolic reaction is stored immediataly in the form of

(1) Glucose (2) Pyruvic acid

(3) ADP (4) ATP

Q.39 A.T.P. is

(1) A hormone (2) A protiein

(3) An enzyume which brings about oxidation

(4) A molecule which contain high energy bond

Q.40 In anaerobic respiration seeds respirs -

(1) In presence of O_2

(2) In presence of CO_2

(3) In absence of O_2

(4) In absence of CO_2

Q.41 The following is required both by the process of respiration and phtosynthesis -

(1) Carbohydrates (2) Sunlight

(3) Chlorophyll (4) Cytochromes

Q.42 The net gain of ATP molecules in glycolysis is-

(1) Zero (2) Two

(3) Four (4) Eight

Q.43 Cytochromes are concerned with -

(1) Protein synthesis (2) Cellular digestion

(3) Cell division (4) Cell-respiration

Q.44 How is respiration affected on the basis of protoplasm activity ?

(1) Rate of respiration in seed is found low

(2) In dormant organs, rate of respiration is low

(3) Rate of respiration is high in meristematic cells

(4) All the above

Q.45 Number of every cytochrome molecule require for transfer of $2e^-$ in ETS :

(1) 2 (2) 4

(3) 1 (4) 10

Q.46 Kreb's cycle takes place in -

(1) Vesicles of E.R

(2) Mitochiondrial matrix

(3) Dictyosomes (4) Lysosomes

Q.47 The respiration in germinating seeds produces energy, which can be defflected in the form of-

(1) water (2) O_2

(3) Heat (4) CO_2

Q.48 In respiration pyruvic acid is -

(1) Formed only when oxygen is available

(2) One of product of krebs cycle

(3) Broken down into Acetyl Co-A and CO_2

(4) a result of protein break down

Q.49 Most of the energy of the carbohydrates is released by oxidation when -

(1) Pyruvic acid is converted into CO_2 and H_2O

(2) Pyuvic acid is converted into acetyl Co-A

(3) Sugar is converted into pyruvic acid

(4) Glucose is converted into alcohol and CO_2

Q.50 Glycolysis takes place in -

(1) Cytoplasm (2) Chloroplast

(3) Ribosome (4) Mitochondria

Q.51 The universal hydrogen acceptor is -

(1) NAD (2) ATP

(3) Co-A (4) FMN

Q.52 The end product of fermentation when sugar are used as raw materials are -

(1) Alcohol and CO_2 (2) Alcohol, Pyruvate

(3) CO_2 (4) Alcohol

Q.53 Iron-porphyrin protein complex occurs in -

(1) phytochrome (2) cytochrome

(3) chlorophyll (4) both (1) and (3)

Q.54 Fermentation is conducted by

(1) All bacteria (2) All fungi

(3) Some fungi and some bacteria

(4) All microorganism

Q.55 In the process of respiration in plants 180 gm of Glucose plus192 gm of oxygen produce -

(1) 132 gm of CO_2 , 54 gm of H_2O & 483 Cal.E

(2) 264 gm of CO_2 , 108 gm of H_2O & 686 Cal.E

(3) 200 gm of C_2H_5OH, 72 gm of H_2O & 21 K. Cal E.

(4) None

Q.56 Respiratory enzymes are localised in -
(1) Ribosomes (2) Chloroplast
(3) Mitochondria (4) None of the above

Q.57 Respiration is an -
(1) Exothermic process
(2) Endothermic process
(3) Anabolic process
(4) None of these

Q.58 In Opuntia during night the R.Q. will be -
(1) 1 (2) less than 1
(3) More than 1 (4) 0

Q.59 Number of ATP molecules formed during aerobic respiration in break down of one glucose molecule via malate aspartate shuttle-
(1) 38 (2) 18
(3) 28 (4) 4

Q.60 During respiration pyruvic acid is formed by-
(1) Glycolysis (2) Kreb's cycle
(3) TCA cycle (4) None of the above

Q.61 Enzyme involved in alcoholic fermentation -
(1) Pyruvate decarboxylse
(2) Lactate dehydrogenase
(3) Hexoisomerase
(4) Both decarboxylase and dehydrogenase

Q.62 Kreb's cycle is -
(1) Aerobic respiration
(2) Photosynthesis
(3) Transpiration
(4) Anaerobic respiration

Q.63 The organism in which kreb's cycle does not occur in mitochondria is -
(1) Yeast (2) E.coil
(3) Ulothrix (4) Molds

Q.64 Citric acid is produced in
(1) Bacterial episome
(2) Kreb's cycle
(3) Calvin cycle
(4) Calvin + HSK cycle

Q.65 How many times CO_2 released in aerobic respiration -
(1) One or two (2) Three
(3) Six (4) Twelve

Q.66 Raw material for respiration is -
(1) Glucose & O_2
(2) Glucose & CO_2
(3) Glucose & Carbon
(4) Glucose & sucrose

Q.67 Slow respiring plant or plants tissues are -
(1) Promeristem
(2) Cambium
(3) Leaf primordia & young plant
(4) Adult plants & matured tissues

Q.68 The tissue of highest respiratory activity is -
(1) Meristem (2) Ground tissue
(3) Phloem (4) Mechanical tissue

Q.69 Respiratory quotient is expressed as -
(1) O_2/CO_2 (2) CO_2/O_2
(3) O_2/H_2O (4) CO_2-O_2

Q.70 What causes R.Q. to vary
(1) Respiratory Substrate
(2) Light & O_2
(3) Respiratory Product
(4) Temperature

Q.71 The first preferred respiratory substrate is -
(1) Glucose (2) Fats
(3) Protein (4) Polypeptide

Q.72 Respiration results into -
(1) Gain in weight (2) Loss in weight
(3) No change in weight
(4) Loss of ATP

Q.73 Respiration occurs in -
(1) All living cells both in lights & dark
(2) Non green cells only in light
(3) Non green cells in light and dark
(4) All living cells in light only

Q.74 The value of R.Q. at compensation point is -
(1) One (2) More than one
(3) Less than one (4) Inifinite

Q.75 The value of R.Q. at compensation point is -
(1) Unity (2) Two
(3) >1 (4) Zero

Q.76 The value of R.Q. of starved cell is -
(1) Zero (2) Less than one
(3) 1 (4) infinite

Q.77 R.Q. of an activley phtosynthesizing tissue is-
(1) Unity (2) < 1
(3) > 1 (4) Zero

Q.78 R.Q. of germinating ground nut & castor seed is-
(1) 1 (2) < 1
(3) >1 (4) 0

Q.79 The value of RQ of a ripening fatty seed is-
(1) < 1 (2) > 1
(3) zero (4) Unity

Q.80 When the evolution of CO_2 is more than the intake of O_2 the respired substrate should be-
(1) Fatty acid (2) orgainc acid
(3) Glucose (4) Polysaccharides

Q.81 The value of R.Q. of a succulent plant at night is-
(1) unity (2) >1
(3) Zero (4) Infinite

Q.82 Protoplasmic proteins are used as a respiratory substrate only when -
(1) Carbohydrates are absent
(2) Fats are absent
(3) Both 1 & 2 are absent
(4) Fats & carbohydrates are abundant

Q.83 The term ''Protoplasmic respiratory'' is used when the respiratory substrate is -
(1) Carbohydrates (2) Portein
(3) Organic acid (4) Lipid

Q.84 The term ''Floating respiration'' is used when the respiratory substrate is -
(1) Carbohydrates (2) Fats
(3) Both 1 and 2 (4) Protein

Q.85 Respiration may take place -
(1) In the presence of O_2
(2) In the absence of O_2
(3) In the presence or absence of O_2
(4) In the presence of CO_2

Q.86 Apparatus used to measure respiratory quotient-
(1) Potometer (2) Auxanometer
(3) Respirometer (4) Warburg's apparatus

Q.87 Glycolysis involves the conversion of -
(1) Protein into glucose
(2) Glucose into fructose
(3) Starch into glucose
(4) Glucose into pyruvic acid

Q.88 The end product of glycolysis is -
(1) Glycolate & ethanol
(2) Glyoxylic acid & CO_2
(3) Glucose or hexose units
(4) Pyruvate

Q.89 The common phase between aerobic & anaerobic respiration is -
(1) TCA cycle (2) Kreb's cycle
(3) Glycolysis (4) Photo respiration

Q.90 Which of the follwing scientist discovered the conventional path of glycolysis -
(1) Embeden, Myerhof and Parnas
(2) Emerson, Hoffman and Peterson
(3) Embeden, Morrison and Pitcher
(4) Warburg, Dickens and Horecker

Q.91 What is active glucose -
(1) FAD glucose (2) NAD glucose
(3) Glucose-6-P (4) Glycerophosphate

Q.92 The enzyme which converts glucose to glucose 6-phosphate-
(1) Phosphorylase
(2) Gluco-phosphorylase
(3) Hexokinase
(4) Phospho glucomutase

Q.93 Glycolysis give rise to -
(1) 8ATP, $2NADH_2$, 2 Pyruvate
(2) 2ATP, 2CoA, $2NADH_2$
(3) 2ATP, $2NADH_2$, 2 Pyruate
(4) 2ATP, 2 acetate, $2NADPH_2$

Q.94 The inhibitory effect of the presence of O_2 on anaerobic respiration is termed -
(1) Warburg effect (2) Pasteur effect
(3) Emerson's effect (4) Oxygen effect

Q.95 During glycolysis the mineral needed as an enzyme activator is -
(1) Mn^{++} (2) Fe^{++}
(3) Ca^{++} (4) Mg^{++}

Q.96 Green plants kept in light produce ATP from the glucose. This process is -
(1) Photophosphroylation
(2) Hill reaction
(3) Oxidative phosphorylation
(4) β-oxidation

Q.97 Anaerobic respiration was reported for the first time by -

(1) Pasteur (2) Kostytchev

(3) Klein (4) Pfeffer

Q.98 Which of the follwing ETS complex is inhibited by cyanide -

(1) Complex II (2) Complex V

(3) Complex IV (4) Comlex III

Q.99 Final e^- acceptor of mitochondria is -

(1) Pyruvate (2) NADP

(3) O_2 (4) OAA

Q.100 The number of ATP molecules produced from one Kreb's cycle are -

(1) 15 (2) 30

(3) 38 (4) 40

ANSWER KEY

EXERCISE - 2

Q.1	2	Q.2	3	Q.3	1	Q.4	1	Q.5	4	Q.6	2	Q.7	4
Q.8	4	Q.9	3	Q.10	1	Q.11	1	Q.12	2	Q.13	2	Q.14	1
Q.15	3	Q.16	3	Q.17	2	Q.18	4	Q.19	2	Q.20	4	Q.21	3
Q.22	4	Q.23	1	Q.24	2	Q.25	3	Q.26	1	Q.27	3	Q.28	3
Q.29	3	Q.30	1	Q.31	2	Q.32	2	Q.33	3	Q.34	1	Q.35	3
Q.36	4	Q.37	3	Q.38	4	Q.39	4	Q.40	3	Q.41	4	Q.42	4
Q.43	4	Q.44	4	Q.45	1	Q.46	2	Q.47	3	Q.48	3	Q.49	1
Q.50	1	Q.51	1	Q.52	1	Q.53	2	Q.54	3	Q.55	2	Q.56	3
Q.57	1	Q.58	4	Q.59	1	Q.60	1	Q.61	4	Q.62	1	Q.63	2
Q.64	2	Q.65	3	Q.66	1	Q.67	4	Q.68	1	Q.69	2	Q.70	1
Q.71	1	Q.72	2	Q.73	1	Q.74	3	Q.75	4	Q.76	2	Q.77	1
Q.78	2	Q.79	2	Q.80	2	Q.81	3	Q.82	3	Q.83	2	Q.84	3
Q.85	3	Q.86	3	Q.87	4	Q.88	4	Q.89	3	Q.90	1	Q.91	3
Q.92	3	Q.93	3	Q.94	2	Q.95	4	Q.96	3	Q.97	2	Q.98	3
Q.99	3	Q.100	1										

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Respiratory Quotient (R.Q) is defined as - **[Uttaranchal 2004]**

(1) vol. of O_2 / vol. of CO_2

(2) vol. of CO_2 / vol. of O_2

(3) vol. of O_2 / vol. of N_2

(4) vol. of N_2 / vol. of CO_2

Q.2 Pyuvic acid is formed during - **[Uttaranchal 2005]**

(1) Krebs cycle (2) Glycolysis

(3) Ornithine cycle (4) Calvin cycle

Q.3 The correct sequence of electron acceptor in ATP synthesis - **[Uttaranchal 2005]**

(1) cyt a,a_3 b, c (2) cyt b, c, a, a_3

(3) cyt b, c_3, a, a_3 (4) cyt c, b, a, a_3

Q.4 Which one of the following contains copper besides iron -

(1) Cytochrome-f

(2) Cytochrome oxidase

(3) Platoquinone

(4) Cytochrome-c_1

Q.5 Where does formaton of acetyl Co-A from pyruvic acid take place -**[Uttaranchal 2006]**

(1) Mitochondria (2) Cholroplast

(3) Cytoplasm (4) Golgi body

Q.6 The number of ATP molecules prduced by electron transport system from kreb's cycle intermediates in a single turn is - **[Uttaranchal 2004]**

(1) 11 (2) 14

(3) 12 (4) 16

Q.7 In anaerobic respiration the number of ATP molecules produced are - **[West Bengal 2006]**

(1) 1 (2) 2

(3) 3 (4) 8

Q.8 In which of the following steps of Krebs cycle CO_2 is evolved - **[West Bengal 2007]**

(1) Isocitric acid $\rightarrow$ oxalosuccinic acid

(2) Oxalosuccinic acid $\rightarrow$ α-ketoglutaric acid

(3) succinic acid $\rightarrow$ fumaric acid

(4) malic acid $\rightarrow$ oxaloacetic acid

Q.9 Which of the following enzyme is not used in Krebs' cycle - **[West Bengal 2007]**

(1) Aconitase (2) Decarboxylase

(3) Aldolase (4) Furmarase

Q.10 End produced of fermentation is - **[West Bengal 2007]**

(1) O_2 (2) N_2O

(3) H_2O (4) C_2H_5OH

Q.11 Gluconeogenesis is - **[West Bengal 2007]**

(1) Formation of glucose from other than carbohydrate

(2) Formation of glycogen

(3) Breakdown of glucose

(4) Formation of ammonia from glucose

Q.12 β-oxidation takes place in - **[West Bengal 2007]**

(1) Matrix of mitochondria

(2) Cell cytoplasm

(3) Inter mitochondrial chamber

(4) Ribosomes

Q.13 In TCA cycle the conversion of succinyl co-A to succinic acid requires - **[West Bengal 2007]**

(1) Acetyl Co-A + GTP + ip

(2) Acetyl Co-A + GDP + iP

(3) Co-A + GTP + iP

(4) GDP + iP

Q.14 Yeast is used in the formation of - **[C.G. PMT 2007]**

(1) Ammonia (2) Alcohol

(3) Curd (4) Petrol

Q.15 Fermentation is represented by equation - **[C.G. PMT 2007]**

(1) $C_6C_{12}O_6+6O_2 \rightarrow 6CO_2+6H_2O$ +673 Kcal

(2) $C_6C_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

(3) $6CO_2+12H_2O \rightarrow C_6H_{12}O_6 + 6H_2O + 6O_2$

(4) $6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$

Q.16 Which of the following is formed during respiration ? **[C.G. PMT 2004]**

(1) O_2 (Oxygen)

(2) CO_2 (Carbon dioxide)

(3) NO_2 (NItrogen dioxide)

(4) SO_2 (Shulphur dioxide)

Q.17 The pyruvic acid formed in glycolysis is oxidised to CO_2 and H_2O in a cycle called : **[C.G. PMT 2007]**

(1) Calvin cycle (2) Hill reaction

(3) Krebs cycle (4) Nitrogen cycle

Q.18 The end product of glycolysis is : **[C.G. PMT 2005]**

(1) Glucose (2) Fructose

(3) Pyruvic acid (4) Ethyl alcohol

Q.19 R.Q. is more than one in case of : **[C.G. PMT 2005]**

(1) Fat (2) Fructose

(3) Glucose (4) Organic acid

Q.20 Total yield in one Kerb cycle : **[C.G. PMT 2006]**

(1) 3 $FADH_2$, 2 $NADH_2$, 1 ATP

(2) 2 $FADH_2$, 2 $NADH_2$, 2 ATP

(3) 2 $NADH_2$, 1 $FADH_2$, 2ATP

(4) 3 $NADH_2$, 1 $FADH_2$, 1 ATP

Q.21 How many ATP will be produced during the production of 1 molecule of Accetyl Co-A from 1 molecule of pyryvic acid ? **[C.G. PMT 2006]**

(1) 3 ATP (2) 5 ATP

(3) 8 ATP (4) 38 ATP

Q.22 Sequence of cytochromes is : **[Jharkhand- 2006]**

(1) cyt. a, b,c, a_3 (2) cyt. b, c, a, a_3

(3) cyt. b, a,,a_3, c (4) cyt. b, c, a_3, a

Q.23 Cytochrome is a : **[Jharkhand- 2006]**

(1) Mg pyrole ring (2) Fe prophyrin ring

(3) Nucleotide (4) Alloy of nichrome

Q.24 Krebs cycle takes place in : **[Jharkhand- 2006]**

(1) mitochondrial matrix

(2) Cytoplasm

(3) Lysosome (4) Nucleus

Q.25 Cellular respiration occurs in - **[Jharkhand- 2005]**

(1) Chloroplast (2) Golgibodies

(3) Mitochondria (4) Nucleus

Q.26 Maximum amount of energy/ATP is liberated on oxidation of : **[Jharkhand- 2004]**

(1) Fats (2) Proteins

(3) Starch (4) Vitamins

Q.27 More CO_2 is evolved than the volume of oxygen consumed when the respiratory substrate is : **[Jharkhand- 2004]**

(1) Fat (2) Sucrose

(3) Glucose (4) Organic acid

Q.28 Krebs cycle begins with the reaction : **[Jharkhand- 2004]**

(1) Citric acid + Acetyl CO-A

(2) Oxalacetic acid + Pyruvic acid

(3) Oxalacetic acid + Citric acid

(4) Oxaloacetate + Acetyl CO-A

Q.29 Hydrolysis of fat yields : **[Jharkhand- 2004]**

(1) Facts

(2) Fatty acids and glycerol

(3) Mannose and glycerol

(4) Maltose and fatty acid

Q.30 Respiratory quotient of which diet is less than unity ? **[Jharkhand- 2004]**

(1) Carbohydrate (2) Fats

(3) Organic acid (4) Sugar

Q.31 Richest energy compound is : **[Bihar- 2005]**

(1) Creatinine phosphate

(2) Protein

(3) carbohydrate (4) Fat

Q.32 The stage upto which glycolysis and fermentation is common : **[Bihar- 2005]**

(1) dihydroxy acetone

(2) 3-phosphoglyceraldehyde

(3) pyruvate

(4) glucose-6-phosphate

Q.33 Respiratory quotient of carbohydrate is - **[Bihar- 2005]**

(1) unity (2) greater than unity

(3) less than units (4) equal to five

Q.34 During conversion of pyruvic acid into acetyl Co-A, pyruvic acid is **[Bihar- 2003]**

(1) oxidised (2) reduced

(3) isomerised (4) condensed

Q.35 In Kreb's cycle : **[Bihar- 2003]**

(1) ADP is converted into CO_2

(2) Pyruvic acid is converted into CO_2 and H_2O

(3) Glucose is converted into CO_2

(4) Pyruvic acid is converted into ATP

Q.36 Incomplete breakdown of sugar in anaerobic respiration forms- **[Bihar- 2003]**

(1) glucose and CO_2 (2) alcohol and CO_2

(3) water and CO_2 (4) fructose and water

Q.37 Significance of Kreb's cycle : **[Bihar- 2002]**

(1) Synthesis of ATP

(2) Synthesis of amino acid

(3) Synthesis of chlorphyll

(4) All

Q.38 In plants, respiration takes place : **[Bihar-2002]**

(1) During day only (2) During night only

(3) All the 24 hours (4) At dusk

Q.39 Glycolysis takes place in : **[Bihar- 2001]**

(1) Cytoplasm (2) Nucleus

(3) Plastid (4) Miltochondria

Q.40 In respiration, largest amount of energy is produced in - **[Bihar- 2006]**

(1) anaerobic respiration

(2) Krebs cycle

(3) glycolysis

(4) none of the above

Q.41 Which of the following is not an intermediate in Krebs cycle ? **[Bihar- 2006]**

(1) Acetic acid

(2) Succinyl coenzyme-A

(3) Malic acid

(4) Citric acid

Q.42 The pyruvic acid is formed during : **[UP CPMT- 2001]**

(1) Krebs cycle (2) glycolysis

(3) ornithine cycle (4) photophosphorylation

Q.43 The number of ATP molecules gained during aerobic respiration of 1 mole of glucose is : **[UP CPMT- 2001]**

(1) 12 (2) 18

(3) 30 (4) 38

Q.44 Alcoholic fermentation takes place in the presence of : **[UP CPMT- 2001]**

(1) maltase (2) zymase

(3) amylase (4) invertase

Q.45 The site of EMP pathway in cell is : **[UP CPMT- 2001]**

(1) peroxisome

(2) cytoplasm

(3) matrix of mitochondria

(4) inner membrane of mitochondria

Q.46 Step of respiration are controlled by : **[UP CPMT- 2002]**

(1) Substrates (2) Enzymes

(3) Hormone (4) Bile juice

Q.47 Enzymes of electron transport system is present in : **[UP CPMT- 2003]**

(1) Inner mitochondrial membrane

(2) Matrix

(3) Intermembranous space

(4) Endoplasmic reticulum

Q.48 Which of the following connects glycolysis to Kreb's cycle ? **[MP PMT 2001,UP CPMT- 2003]**

(1) Acetyl CO-A

(2) Ribozyme

(3) Cytochrome oxidase

(4) N-acetyl glucosamine

Q.49 Pyruvic acid is the end product of **[UP CPMT- 2003]**

(1) Kreb's cycle

(2) Electron transport system

(3) Phtosynthesis

(4) Glycolysis

Q.50 Which of the following accepts terminal electron during aerobic respiration ? **[UP CPMT- 2003]**

(1) Molecular O_2 (2) Molecular H_2

(3) Molecular CO_2 (4) $NADOH_2$

Q.51 Glycolysis occurs in : **[UP CPMT- 2004]**
(1) Cytoplasm (2) Nucleus
(3) Mitochondria (4) Both 'a' and 'c'

Q.52 Which one of the following is the first step of glycolysis ? **[UP CPMT- 2004]**
(1) Breakdown of glucose
(2) Phosphorylation of glucose
(3) Conversion of gloucose into fructose
(4) Dehydrogenation of glucose

Q.53 How many ATP molecules released when 1 molecules of glucose is oxidised in our liver cells ? **[UP CPMT- 2005]**
(1) 36 (2) 38
(3) 2 (4) 8

Q.54 Sequence of food materials consumed during starvation is : **[UP CPMT- 2005]**
(1) Carbohydrate $\rightarrow$ fats $\rightarrow$ protein
(2) Carbohydrate $\rightarrow$ proteins $\rightarrow$ fats
(3) Proteins $\rightarrow$ facts $\rightarrow$ carbohydrate
(4) Fats $\rightarrow$ proteins $\rightarrow$ carbohydrate

Q.55 How many ATPs are produced during glycolysis of one molecule of glucose ? **[UP CPMT- 2006]**
(1) 4 (2) 2
(3) 36 (4) 38

Q.56 Final electron acceptor in ETS is : **[UP CPMT- 2006]**
(1) NAD (2) FAD
(3) Oxygen (4) Hydrogen

Q.57 Respiratory cycle where $NADH_2$ are produced is - **[UP CPMT- 2006]**
(1) Calvin cycle (2) Kreb's cycle
(3) EMP pathway (4) HMP shunt

Q.58 Most of the enzymes which participate in Kreb's cycle are found in :**[MP PMT- 2001]**
(1) Matrix of mitochondria
(2) Inner membrane of mitochondria
(3) Outer membrane of mitochondria
(4) Stroma of chloroplast

Q.59 The connecting link between glycolysis and Krebs cycle is : **[MP PMT- 2001]**
(1) Acetyl CO A (2) CO Q
(3) Conenzyme (4) COA

Q.60 The process of oxidative phosphorylation takes place in : **[MP PMT- 2002]**
(1) Mitochondria (2) Chloroplasts
(3) Ribosomes (4) Cytoplasm

Q.61 Glycolysis is the conversion of : **[MP PMT- 2002]**
(1) Glucose to glycogen
(2) Glycogen to glucose
(3) Glucose to pyruvic acid
(4) Glucose to citric acid

Q.62 Anaerobic respiration takes place in : **[MP PMT- 2002]**
(1) Ribosome (2) Nucleus
(3) Cytoplasm (4) Vacuole

Q.63 Which of the following is the product of glucose fermentation by yeast? **[MP PMT- 2003]**
(1) $C_6H_{12}O_6$ (2) C_2H_5OH
(3) $(C_6H_{10}O_5)_n$ (4) CH_2OH

Q.64 Fermentation is an : **[MP PMT- 2003]**
(1) Anaerobic respiration
(2) Incomplete oxidation
(3) Excertory process
(4) None of the above

Q.65 Organelles which are regarded as ''Power house of the cell and in which the oxidative reactions of the respiratory process takes place are known as : **[MP PMT- 2004]**
(1) Chloroplast (2) Ribosomes
(3) Mitochondria
(4) Endoplasmic reticulum

Q.66 In which of the following, respiration in absence of oxygen also takes place : **[MP PMT- 2004]**
(1) Man (2) Potato
(3) Yeast (4) Spirogya

Q.67 CO_2 is liberated during : **[MP PMT- 2004]**
(1) Ascent of sap (2) Respiration
(3) Photosynthesis (4) Transpiration

Q.68 ATP stands for which of the following - **[MP PMT- 2004]**
(1) Adenine tetraphosphate
(2) Adenine triphosphate
(3) Adenosine diphosphate
(4) Adenosine triphosphate

Q.69 Glycolysis occurs in : **[MP PMT- 2005]**
(1) Vecuoles (2) Nucleolus
(3) Mitochondria (4) Cytoplasm

Q.70 The number of ATP produced during the production of 1 molecule of acetyl CoA from 1 molecule of Pyruvic acid is : **[MP PMT- 2006]**
(1) 3 ATP (2) 8 ATP
(3) 36 ATP (4) 38 ATP

Q.71 The energy produced by one ATP molecule is : **[MP PMT- 2006]**
(1) 7.6 kcal (2) 12 kcal
(3) 20 kcal (4) 100 kcal

Q.72 Which of the following show anaerobic respiration : **[MP PMT- 2006]**
(1) Earthwarm (2) Rabbit
(3) Echinoderms (4) Tapeworms

Q.73 It is belived that the organisms first inhabited earth's sufarce were : **[MP PMT- 2006]**
(1) Autotrophs (2) Mixotrophs
(3) Chemoautotrophs (4) Heterotrophs

Q.74 Pyruvic acid before combining with oxaloacetic acid of Krebs cycle, becomes :
(1) Citric acid (2) Acetoacetic acid
(3) Cis-aconitic acid (4) Acetyl CoA

Q.75 Anaerbic respiration takes place in - **[MP PMT 2002]**
(1) Ribosome (2) Nucleus
(3) Cytoplasm (4) Vacuole

Q.76 What is the energy coin of a cell ? **[MP PMT 2002]**
(1) DNA (2) RNA
(3) ATP (4) Minerals

Q.77 The process of oxidative phosphorylation takes place in - **[MP PMT 2002]**
(1) Mitochondria (2) Chloroplasts
(3) Ribosomes (4) Cytoplasm

Q.78 R.Q. of which diet is less than unit ? **[RPMT 2002]**
(1) Carbohydrate (2) Fats
(3) Organic acid (4) Sugar

Q.79 Pyruvic acid is the end product of which process ? **[RPMT 2002]**
(1) Kreb's cycle (2) Calvin cycle
(3) Pentose phosphate pathway
(4) Glycolysis

Q.80 molecule glucose + 6 molecule of O_2 and 38 ADP combined to form 6 H_2O, 6 CO_2 and- **[RPMT 2002]**
(1) 38 molecules of ATP
(2) 28 ATP
(3) 38 ADP (4) 28 ADP

Q.81 Number of ATP obtained at the end of Kreb's cycle - **[RPMT 2002]**
(1) 2 ATP (2) 4 ATP
(3) 8 ATP (4) 38 ATP

Q.82 During the formation of bread, it becomes porous due to release of CO_2 by the action of- **[CPMT 2002]**
(1) Yeast (2) Bacterial
(3) Virus (4) Protozoans

Q.83 How many ATP molecules produced by aerobic oxidation of one molecule of glucose ? **[CPMT 2002]**
(1) 2 (2) 4
(3) 38 (4) 34

Q.84 In which one of the following do the two names refer to one and the same thing - **CPMT 2003]**
(1) Kreb's cycle and calvin cycle
(2) Tricarboxylic acid cycle and citric acid cycle
(3) Citric and cycle and Calvin cycle
(4) Tricarboxylic acid cycle and urea cycle

Q.85 In alcohol fermentation - **[CPMT 2003]**
(1) Triose phosphate is the electron donor, while acetaldehyde is the electron accceptor
(2) Triose phosphate is the electron donor, while pyruvic acid is the electron acceptor
(3) There is no electron donor
(4) Oxygen is the electron acceptor

Q.86 In glycolysis, during oxidation electrons are removed by - **[CPMT 2004]**
(1) Molecular oxygen (2) ATP
(3) Glyceraldehyde (4) NAD^+

Q.87 Aerobic respiration is how many times useful than anaerobic respiration - **[RPMT 2004]**
(1) 2 (2) 8
(3) 9 (4) 38

Q.88 For retting of jute, the fermenting microbe used is - **[AIPMT 2005]**

(1) Helicobactor pylori

(2) Methophilic bacteria

(3) Streptococcus lactin

(4) Butyric acid bacteria

Q.89 During which stage in the complete oxidation of glucose are the greatest number of ATp molecules formed form ADP? **[AIPMT 2005]**

(1) Conversion of pyruric acid to acetyl Co A

(2) Electron transport chain

(3) Glycolysis (4) Krebs cycle

Q.90 The deficiencies of micronutrients, not only affects growth of plants, but also vital functions such as photosynthetic and mitochondrial electron flow. Among the list given below, which group of three elements shall affact most, both photosynthetic and mitochodrial electron transport - **[AIPMT 2005]**

(1) Cu, Mn Fe (2) Co, Ni, Mo

(3) Mn Co, Ca (4) Ca, K, Na

Q.91 Chemiosmotic theory of ATP synthesis in the chloroplast and mitochondria is based on - **[AIPMT 2005]**

(1) Proton gradient

(2) Accumulation of K ions

(3) Accumulation of Na ions

(4) Membrane potential

Q.92 Respiration is which type of process- **[RPMT 2005]**

(1) Catabolic (2) Metabolic

(3) Anabolic (4) None

Q.93 R.Q. is represented by- **[RPMT 2005]**

(1) O_2/CO_2 (2) CO_2/O_2

(3) $V_2/V_2–V$ (4) O_2 taken in

Q.94 Which is the site of Kreb's cycle -

(1) Chloroplast **[RPMT 2005]**

(2) Golgibody

(3) Mitochondria

(4) Endophasmic reticulum

Q.95 Curing of tea leaves is broght about by the actiivty of - **[AIPMT 2006]**

(1) viruses (2) fungi

(3) bacteria (4) mycorrhiza

Q.96 Which of the following statements regarding mitochondrial membrane is NOT correct ? **[AIPMT 2006]**

(1) The inner membrance is highly convoluted forming a series of infolding

(2) The outer membrane resembles a sieve

(3) The outer membrance is permeable to all kinds of molecules

(4) The enzymes of the electron transfer chain are embedded in the outer membrane.

Q.97 How many ATP molecules could maximally be generated from one molecule of glucose, if the complete oxidation of one mole of glucose to CO_2 and H_2O yields 686 kcal and the useful chemical energy available in the high energy phosphate bond of one mole of ATP is 2 Kcal? **[AIPMT 2006]**

(1) 57 (2)

(3) 2 (4) 30

Q.98 The overall goal of glycolysis, Krebs cycle and the electron transport system is the formation of - **[AIPMT 2007]**

(1) Nucleic acids

(2) ATP in small stepwise units

(3) ATP in one large oxidation reaction

(4) Sugars

Q.99 All enzymes of TCA cycle are located in th mitochondrial martix except one which is located in inner mitochondrial membrane in eukaryotes and in cytosol in prokaryotes. This enzyme is - **[AIPMT 2007]**

(1) Succinate dehydrogenase

(2) Lactate dehydrogenase

(3) Isocitrate dehydrogenase

(4) Malate dehydrogenase

Q.100 Which one of the following mamalian cells are not capable of metabolising glucose to carbondioxide aerobically ? **[AIPMT 2007]**

(1) Red blood cells

(2) White blood cells

(3) Unstriated muscle cells

(4) Liver cells

Q.101 A competitive inhibitor of succinc dehydrogenase is - **[AIPMT 2008]**

(1) $\propto$-ketoglutarate (2) Malate

(3) Malonate (4) Oxaloacetate

Q.102 The chemiosmotic coupling hypothesis of oxidative phosphorylation proposes that adenosine triphosphate (ATP) is formed because - **[AIPMT 2008]**

(1) A proton gradient forms across the inner membrane

(2) There is a change in the permeabity of the inner mitochondrial membrane towrds adenosine diphosphate (ADP)

(3) High energy bonds are formed in mitochondrial proteins

(4) ADP is pumped out of the matrix into the intermembrane space

Q.103 The energy-relesing process in which the substrate is oxidised without an external electron acceptor is called - **[AIPMT 2008]**

(1) Aerobic respiration

(2) Glycolysis

(3) Fermentation

(4) Photorespiration

Q.104 In germinating seeds fatty acids are degraded exclusively in the - **[AIPMT 2008]**

(1) Peroxisomes (2) Mitochondria

(3) Proplastids (4) Glyoxysomes

Q.105 The energy-releasing metabolic process in which substrate is oxidised without an external electron acceptor is called- **[AIPMT-2010 (Pre)]**

(1) Aerobic respiration

(2) Photorespiration

(3) Glycolysis (4) Fermentation

ANSWER KEY

EXERCISE - 3

Q.1	2	Q.2	2	Q.3	2	Q.4	2	Q.5	1	Q.6	1	Q.7	2
Q.8	2	Q.9	3	Q.10	4	Q.11	1	Q.12	3	Q.13	4	Q.14	2
Q.15	2	Q.16	2	Q.17	3	Q.18	3	Q.19	4	Q.20	4	Q.21	1
Q.22	2	Q.23	2	Q.24	1	Q.25	3	Q.26	1	Q.27	4	Q.28	4
Q.29	2	Q.30	2	Q.31	4	Q.32	3	Q.33	1	Q.34	1	Q.35	2
Q.36	2	Q.37	4	Q.38	3	Q.39	1	Q.40	2	Q.41	1	Q.42	2
Q.43	4	Q.44	2	Q.45	2	Q.46	2	Q.47	1	Q.48	1	Q.49	4
Q.50	1	Q.51	1	Q.52	2	Q.53	2	Q.54	1	Q.55	2	Q.56	3
Q.57	2	Q.58	1	Q.59	1	Q.60	1	Q.61	3	Q.62	3	Q.63	2
Q.64	2	Q.65	3	Q.66	3	Q.67	2	Q.68	4	Q.69	4	Q.70	1
Q.71	1	Q.72	4	Q.73	4	Q.74	4	Q.75	3	Q.76	3	Q.77	1
Q.78	2	Q.79	4	Q.80	1	Q.81	4	Q.82	1	Q.83	3	Q.84	2
Q.85	1	Q.86	4	Q.87	3	Q.88	4	Q.89	2	Q.90	1	Q.91	1
Q.92	1	Q.93	2	Q.94	3	Q.95	3	Q.96	4	Q.97	1	Q.98	2
Q.99	1	Q.100	1	Q.101	3	Q.102	1	Q.103	3	Q.104	4	Q.105	4

These questions consist of two statements each, printed as Assertion and Reason. While answering these Questions are required to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **Assertion :-** In the process of alcoholic fermentation, the hexose molecule is converted in starch.

Reason:- Alcoholic fermentation is aerobic.

Q.2 **Assertion :-** Respiration occurs both in prokaryotic & eukaryotic cells.

Reason:- In eukaryotic cells respiration is only aerobic.

Q.3 **Assertion :-** Pentose phosphate pathway is also known as cytosolic decarboxylation.

Reason:- All the carbon dioxide is released in cytosol during this pathway.

Q.4 **Assertion :-** Aerobic (oxygenated) atmosphere on earth is maintained due to the action of photosynthetic organisms

Reason:- Cyanobacteria are non oxygenic form of plants

Q.5 **Assertion :-** Value of R.Q. is more than one during the germination of fatty seeds.

Reason:- More CO_2 liberated than absorbed O_2 in fat-oxidation.

Q.6 **Assertion :-** Enzymes of Krebs cycle are endo enzymes.

Reason:- All the enzymes of Kreb's cycle function inside the cell

Q.7 **Assertion :-** Kerbs cycle is called as amphibolic pathway of respiration

Reason:- Krebs cycle takes place in cytosol

Q.8 **Assertion :-** Pyruvic acid can not enter in mitochondria

Reason:- Pyruvic acid is 4-Carbon compund.

Q.9 **Assertion :-** Fermentation is an incomplete oxidation of substrate outside the cell.

Reason:- In Alocholic fermentation the hexose converts in to glucose & fructose

Q.10 **Assertion :-** Glyoxilate cycle is an example of gluconeogenesis.

Reason:- Glyoxilate cycle operates in stroma of chloroplast.

Q.11 **Assertion :-** Only 2 molecules of ATP generates in anaerobic respiration

Reason:- Anaerobic respiration is incomplete oxidation of respiratory substrate

Q.12 **Assertion :-** 4-carbon intermediate of Kreb's-cycle is **Erythrose**-P

Reason:- Kreb's-cycle occurs in night

Q.13 **Assertion :-** Lactic acid is produced anaerobically in human muscles

Reason:- The reaction is catalysed by lactobacillus

Q.14 **Assertion :-** Anaerobic respiration gives only 2 ATP.

Reason:- Only one FADH2 reacts at ETS in anaerbic respiration

Q.15 **Assertion :-** Glycolysis is also known as oxidative anabolism.

Reason:- Glucose splits during this and some intermediates involve in anabolism

Q.16 **Assertion :-** Anaerobic respiration occurs only in fungi.

Reason:- Fungi are green plants.

Q.17 **Assertion :-** HMP-shunt is alternate of Glucose oxidation.

Reason:- This take place in cytoplasm.

Q.18 **Assertion :-** Kreb-cycle is called as TCA-cycle.

Reason:- First formed compound of Krebs cycle is tri carboxylic acid.

Q.19 **Assertion :-** Respiration is a vital process.

Reason:- Respiration is characteristic of only living cells.

Q.20 **Assertion :-** Glycolysis is common step in aerobic & anaerobic respiration.

Reason:- Glycolysis splits the pyruvate in to H_2O & CO_2

Q.21 **Assertion :-** HMP shunt is also known as Reductive pentose phosphate pathway.

Reason:- Reduction of pentose sugar ribulose occurs during HMP shunt.

Q.22 **Assertion :-** Succinyl CoA is the precursor of most pf porphyrin ring containing compounds

Reason:- Chlorophyll is synthesised from succinyl Co-A.

Q.23 **Assertion :-** Reduction of NAD in glycolysis is energy conserving step.

Reason:- Energy neither be created nor be destroyed.

Q.24 **Assertion :-** Glycolysis is common between aerobic & anaerobic respiration.

Reason:- Glycolysis can takes place in presence and absence of O_2.

Q.25 **Assertion :-** Lactobacillus Perfoms fermentation

Reason:- Lactobacillus is an anaerobic bacteria

Q.26 **Assertion :-** Oxidative decarboxylation occurs in mitochondria.

Reason:- Link reaction and Kreb's cycle occurs in mitochondria.

Q.27 **Assertion :-** Formation of Acetyl CoA in mitochondria is known as link reaction.

Reason:- Acetyl CoA is a compound which links the glycolysis & TCA-cycle

Q.28 **Assertion :-** HMP shunt is known as oxidative decarbroxylation.

Reason:- HMP shunt involves removal of H+/ e and CO_2.

ANSWER KEY

EXERCISE - 4

Q.1	4	Q.2	3	Q.3	1	Q.4	3	Q.5	4	Q.6	1	Q.7	3
Q.8	4	Q.9	3	Q.10	3	Q.11	1	Q.12	4	Q.13	3	Q.14	3
Q.15	1	Q.16	4	Q.17	2	Q.18	1	Q.19	1	Q.20	3	Q.21	4
Q.22	2	Q.23	2	Q.24	1	Q.25	2	Q.26	1	Q.27	1	Q.28	1

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A Question I am unable to solve in first attempt	COLUMN : B Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

PLANT GROWTH & GROWTH HORMONES

INTRODUCTION

- Growth is defined as **permanent and irreversible change** in the size or volume of cell organ or whole organism, usually accompanied by an **increase** in **fresh** or **dry weight**.
- Growth is a **biological reaction**, occuring in protoplasm of all living cells.
- Growth is a basic feature of all living organisms.

FEATURES OF PLANT GROWTH

- Seed germination is the first step of plant growth. Almost all the plants face a period of suspended growth.
- If the suspension of growth is due to **exogenously cotrolled factors** (environmental factors) then it is called **quiescence.**
- When the suspension of growth is due to the **endogenously controlled factors** (hormonal, genetics) then it is termed as **dormancy.**
- Growth is **diffused in animals,** but in **plants growth is localised & irregular** (nail in plant stem, occupies same height till several years of growth).
- Growth in plant is both **limited/determinate** and **unlimited/Indeterminate.**

  Limited/Determinate growth - In annuals & biennials. Growth activities are restricted for a determined period of time.

  Unlimited/Indeterminate growth - In perennials. Growth activities occurs through out the life.
- **Differentiation :** Cell derived from active meristem tissue, become mature to perform specific function.
- **Development :** Sum of morphogenesis and differentiation activities in livings is called as development.
- **Dedifferentiation :** In plants the living differentiated cell which lost the capacity of cell division, regain the capacity of cell division under certain conditions called Dedifferentiation.

  e.g.: Formation of meristems intrafascicular cambium and cork from differentiated parenchyma cells.
- **Redifferentiation :** The regain of differentiation by losing the capacity of cell division for performing specific function by a dedifferentiated cells.

MEASUREMENT OF PLANT GROWTH

✸ **Main base for growth measurement :**

- Increase in number of cells.
- Increase in weight.
- Increase in volume and area of fruits and leaves.
- Increase in length of roots and shoot - This is the general basis for growth measurement.

✸ **Instruments used for measurement of growth :**

- **Auxanometers –** Arc auxanometer and Pfeffer's auxanometer.
- **Horizontal microscope**
- **Bose's Crescograph** - It is **most sensitive** apparatus. It magnify growth as 10,000 times.
- **Space maker disc** - It is maximally used instrument to determine the area of leaves.
- **Efficiency index (E.I.) :-**

  Growth can be measured by an increase **in size** or **area of an organ** of the plant (leaf, flowers, fruits etc.) in a unit time is called as **efficiency index (E.I.)** may be same or different in species to species and organ to organ.

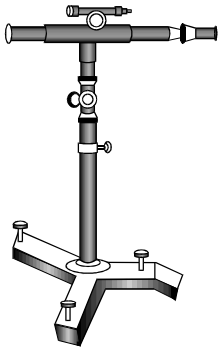


Fig.: Horizontal Microscope

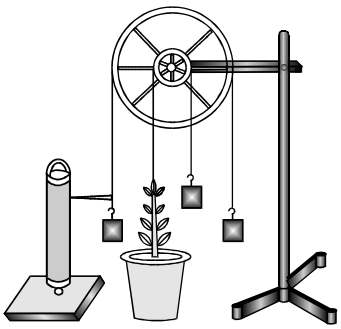


Fig.: Pfeffer's Auxanometer

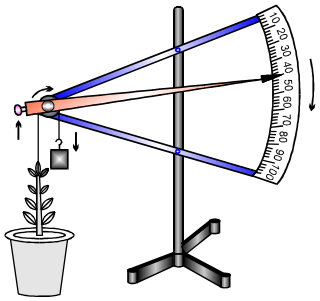
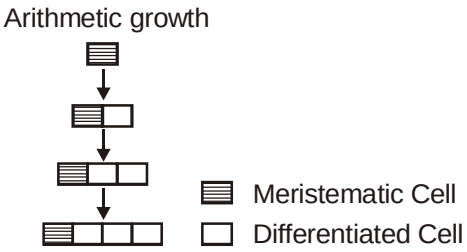


Fig.: Arc Auxanometer

✸ **Growth rate :**

Increased growth per unit time. Plant growth is of two types :

A. Arithmetic growth : From dividing cell two new cells are formed (by mitotic division) out of them one daughter cell continues to divide while other differentiate and mature (stop dividing).



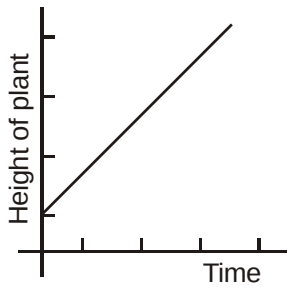
e.g. **Root** & **Shoot elongation** at constant rate.

- It is methematically expressed as
- It's curve is **linear**

$L_t = L_0 + rt$ where L_t - length at time 't'

L_0 - length at time 'zero'

r - growth rate / elongation per unit time.



B. Geometric / Exponential growth : From dividing cell (by mitotic division) both doughter cells retains the ability to divide and continue to do so.

e.g. All cells, **tissue**, **organs**, **developing seed**, **germinating seed**, **seasonal activities** etc.

It is mathematically represented as

It's curve is **sigmoid**

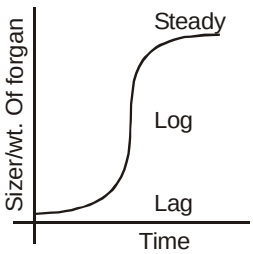
$W_1 = W_0 e^{rt}$

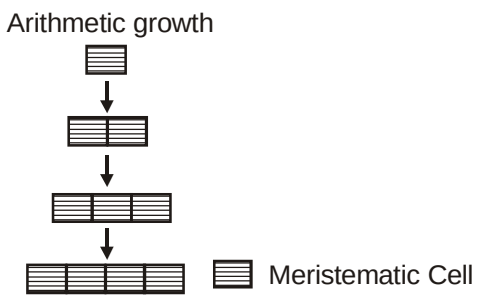
Where W_1 - final size (Weight, height, number etc.)

W_0 - initial size at the beginning of period.

r - growth rate

e - base of natural logrithms.





C. Absolute and relative growth rates : Absolute growth rate : Measurement and the comparision of total growth per unit time in plant or plant parts.

or

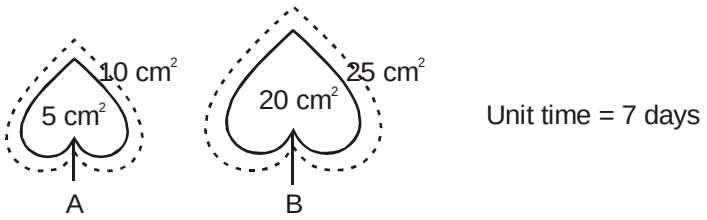
Total growth occurs in unit time in plant or plant parts.

Relative growth rate : The growth of the given system per unit time expressed in a common basis i.e., per unit initial parameter in plant parts.

or

Total growth occurs in unit time in comparision to initial growth in plant or plant parts. Relative growth rate is generally high in young developing plant parts.

Ex.



- Both passes same absolute growth rate i.e., 5 cm^2 in 7 days.
- But high relative growth rate in leaf 'A' about 100%, while in leaf 'B' it is about 25%.

COURSE OF GROWTH

✸ **Growth Activities and Phases of Growth :**

- **Cell division or cell formation :** Number of cells is increased by cell division.
- **Cell enlargement or cell elongation :** Size of cells increases due to **vacuolization** & T.P. (turgor pressure).
- **Cell maturation or differentiation phase :** (Also called as **morphogenetic, organogenic** or differentiation phase) Development or qualitative change is important feature of this phase.
- Growth in size or weight of a specific part in a definite time is known as rate of growth.
- Rate of growth is not uniform. In all parts of a plant, rate of growth in initial stages is more, then it increases more, becomes slow and finally stops.
- If rate of growth of a plant is plotted against time, a **'S'** shaped curve is obtained. This is known as **sigmoid curve**.
- So, growth curve is the graphic representation of the total growth against time.
- Sigmoid curve or total time period can be divided into **three phases** :–

(I) Lag Phase (II) Log Phase (III) Stationary or Steady Phase

(I) Lag Phase :

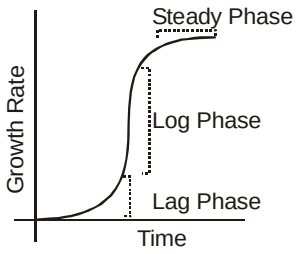
- It is initial phase of slow growth.
- It is a phase of formation of cells.

(II) Log Phase :

- It is middle phase of rapid growth
- Growth increases rapidly to a maximum during elongation phase.
- It represents **grand period of growth.**

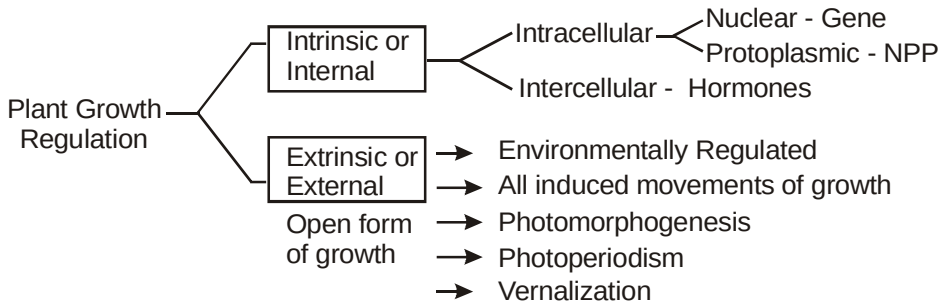
(III) Stationary or Steady Phase :

- Finally rate of growth becomes almost zero.



FACTORS AFFECTING GROWTH / REGULATION OF PLANT GROWTH

Growth is affected by **external** and **internal** factors -



✸ Photoperiodism

- The relative length of day and night is called **photoperiod.**
- The response of plants to the photoperiod, expressed in the form of flowering is called as **Photoperiodism.** "Effect or requirement of relative length of day **(photoperiod)** & night **(dark phase)** on flowering of plants is called as **Photoperiodism.**"
- The phenomenon of photoperiodism was first dicsovered by **Garner & Allard.** They experiment on **Maryland mammoth** (a mutant variety of **tobacco**), They study the **Biloxy soyabean**.

- **Garner** & **Allard** classified the plants in following groups :

(1) SDP (Short Day Plants) : "These plants give flowers on exposure to photoperiod **equal** or **shorter than their critical day length."**

- They need a continuous (uniterrupted) dark period for flowering. Thus SDP also called as **LNP (Long Night Plants).**
- Example of SDP :- **Tobacco, Soyabean, Viola, Xanthium (Cocklebur), Chrysanthemum, Cannabis, Coleus, Chenopodium, Mustard, Dahlia, Sugarcane, Strawberry, Cosmos, Rice etc.**
- In SDP the **dark period is critical** and **must be continuous.** If this dark period is breaks by a brief exposure to red light, then SDP will not flowers.
- Maximum inhibition of flowering with red light occur at about the middle of critical dark period.
- Prolongation of the continuous dark period, initiates early & good flowering in SDP.

(2) LDP (Long Day Plants) : "These plants flowers only when they exposed to critical photoperiod or photoperiod longer than their critical day length".

The **light period is critical for LDP.**

Ex.: **Henbane** (Hyoscyamus) **Spinach, Sugarbeet, Radish, Carrot, Wheat, Larkspur, Barley, Avena, Potato.**

- A brief exposure of red light in the dark period stimulates flowering in LDP.

(3) DNP (Day Neutral Plants) or Intermediate Plants : These plants do not need specific critical day length for the flowering. Ex. **Zea, Cotton, Tomato, Sunflower, Cucumber.**

- **L-SDP :** These are SDP but must be exposed to long day during early stage of their growth. Ex. Bryophyllum.
- **S-LDP :** These are LDP but must be exposed to short photoperiod during early stage of growth.

Ex. **Wheat & Rye.**

- **Cajlachjan :** Reported that stimulation of critical photoperiod is percepted by **leaves**.
- **Chailakhyan :** Discovered **"Florigen"**. It has been not isolated, thus called as **Hypothetical hormone.**

✸ **Phytochrome**

- **Borthwick & Hendricks :-** Discovered a light sensitive pigment responsible for flowering .
- **Butler :-** Given term **"phytochrome"** for this pigment and isolated it.
- Pigment phytochrome is a chromophore billiprotein, which have open tetrapyrrolic structure similar to phycobilin.
- Phytochrome mainly located on cell membrane of all type of plants.
- Phytochrome :- exists in two different forms

  Pr (Phytochrome red) - Red light absorbing from (**630-670 nm**, Peak-**667 nm**), **Blue colour, stable** form, **Physiologically inactive,** induce **flowering in SDP,** inhibits flowering in LDP.
- **Pfr (Phytochrome far red) -** This is **far-red light absorbing** form **(720 - 740 nm, Peak-735 nm), Yellow colour, unstable** form, **Physiologically active** form, induce **flowering in LDP,** inhibits flowering in SDP.
- Both forms of phytochrome are photobiochemically show **photochromicity** and **interconvertibility.**
- The **Pfr** (Yellowish) form, gradually changed into **Pr** (Bluish) form in dark.
- During the day both Pr and Pfr form are accumulated in the plants.
- Control of morphogenesis by light and phytochrome is called **Photomorphogenesis.**
- Now phytochrome is considered as universal distribution in plant kingdom..

Photomorphogenesis in plants appear to be under control of three phtoreceptors.

(i) Phytochrome - Which absorbs red and far red region of light.

(ii) Cryptochrome - Which absorbs blue and UV-A (380 nm) light.

(iii) UV-B-Receptors - Which absorb UV-B (290 nm) light.

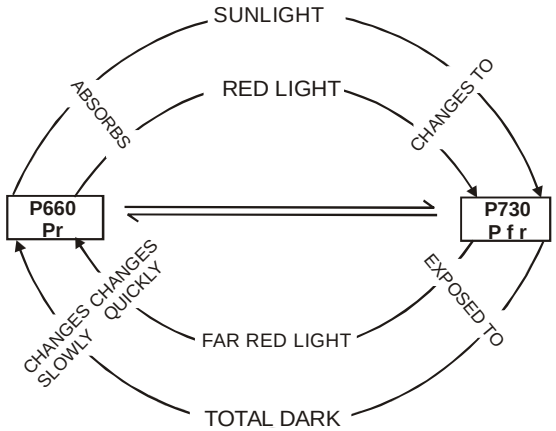


Fig : The Phytochrome concept

- In SDP, during critical dark period P_{fr} form gradually changes into P_r form which results in flowering.
- If critical dark period is interuptted by red light for short duration then P_r form is again converted to P_{fr} form, thus inhibiting flowering.

- The **inhibitory** effect can be **reversed** by subsequent far red light exposure.
- In SDP, whether flowering will be promoted or inhibited will **depend** on the exposure given in the last when the two types of radiations (Red and far red) are given **successively** –

  SDP + R $\rightarrow$ Inhibits flowering

  SDP + R + FR $\rightarrow$ Promotes flowering

  SDP + R + FR + R $\rightarrow$ Inhibits flowering
- In LDP, **prolongation** of light period or interruption of dark period by red light result in **accumulation** of P_{fr} form which stimulates flowering.
- P_{fr} form is biologically active form which is responsible to initiate a number of physiological process such as -

  (a) Seed germination (b) Photoperiodism

  (c) Stomatal opening & closing (d) Photomorphogenesis

✸ **Vernalization**

- Effect of low temperature on the initiation and development of flower, was first realised by **Klippart 1857** (Experiment on winter & $\rightleftharpoons$ Spring wheat)
- Detail study and term - **"Vernalisation"** by **Lysenko** (Credit of discovery).
- **Chourad** defined as **'acceleration of ability to produce flower by chilling treatment is called vernalisation'.**
- Mainly **embryo tip, shoot apex and leaves percept** induction of low temperature on plants.
- Concept of hormone **'vernalin'** in vernalisation was given by **Melcher et. al.** This is a **hypothetical plant hormone,** because not has been isolated till today.
- Vernalisation of **seeds or plant progagule** in laboratory can be induced at 1ºC to 10ºC in presence of O_2 and H_2O. Proper photoperiodic induction also required after vernalization.
- If vernalized plant prapagules are kept in high temperature, just after the low temperature treatment then effect of vernalization is reverse, this effect is called as **devernalization.**

✸ **Significance :-**

(i) Better and early flowering

(ii) Vernalization increases the resistance to fungal diseases.

(iii) Protects natural precocious reproductive development.

GROWTH REGULATORS

Growth is mainly regulated by small amount of chemical substances present at growth points in plants. These are known as **Growth regulators** or **Growth hormones**.

✸ **Growth regulators or Plant Growth hormones :**

- Term 'hormone' was first of all used by **Starling** (1902).
- **Sachs** (1948) first suggested the presence of **growth regulating substances** in the plants.
- **Thimann** (1948) gave the term **Phytohormone**.
- **Thimann** defined Phytohormones as organic substances produced naturally in minute quantities in one part of plant body and transported to another parts where they are active and produce effect on growth.
- Growth regulators = Phytohormones + Synthetic Substances

  so, all phytohormones are growth regulators but **all growth regulators are not phytohormones**.

✵ **Special features of plant growth Hormones / Chemicals :**

- Plants hormones works in concentration based manner.
- Synthetic hormones or chemical are not transported by plants, so provided at the target sites.
- Synthetic hormones or chemical only induce the somatic changes not the genetic changes. So, treatment should be provided every year.
- Supra optimum concentration of any synthetic hormone/chemical leads to death of plant.
- **Fruit Thinning :** All the measures which are used to obtain the commercially valuable fruits are collectively known as Fruit thinning. Like increase in number and size of flower and fruit etc.
- **Bolting effects :** Elimination of Rosette growth (extreme dwarfism) by the application of gibberellins.
- **Lodging :** Falling of crops or plants due to less mechanical strength. Auxin prevents **lodging.**
- **Gibberellin** treatement elongates the internodes of dwarf plants (Genetic, mutational, environmental dwarf plants) not works in normal plants.
- **Auxin** and **Cytokinin** both hormones naturally and synthetically works together.
- **Richmond lang effect :** Delay in senescence due to effect of **cytokinin.**
- **Climacteric Respiration :** Ethylene is highly effective in fruit ripening. It enhance the respiration rate during ripening of the fruits. This rise in rate of respiration is called **Respiratory Climacteric**. Rapid rise in rate of respiration which later decrease during starting of ripening of fruits and senescence is due to ethylene production.
- Growth regulators are of two types -

  (1) Growth **promoters** (2) Growth **Inhibitors**

1. GROWTH PROMOTERS :

- Those hormones which increases the rate of growth are called **growth promoters**.
- Growth promoters are of following 3 types -

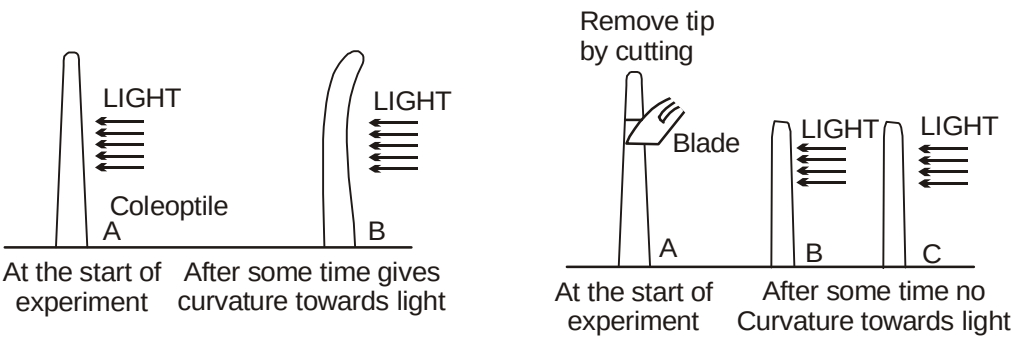
  (A) Auxin (B) Gibberellin (C) Cytokinin

A. AUXIN

(a) History :

✵ **Charles Darwin & Francis Darwin (1887) :**

- They first of all reported the presence of first growth hormone in the **coleoptile** tip of canary grass **(*Phalaris canarensis*).**
- They described the effect of **light** and **gravity** in the book **"Power of movement in plants"**.
- **Darwin** reported that coleoptile tip of canary grass bend towards light. Thus it shows phototropism.
- Thus, Darwin concluded that certain kind of substance is generated at the tip which is then transmitted to the base where growth takes place.



Discovery of Auxins (Darwin's Experiment)

✸ **Boysen-Jonsen (1913) :**

- After performing an experiment on **Avena sativa** coleoptile they found that if its tip was **cut** then its phototrophic sensitivity is **destroyed**.
- But they found that when an excised coleoptile tip was **replaced without** or **with gelatin**, **bending** resulted as in normal coleoptile.
- He further found that insertion of **mica plate prevents** curvature following **unilateral** illumination of the tip.

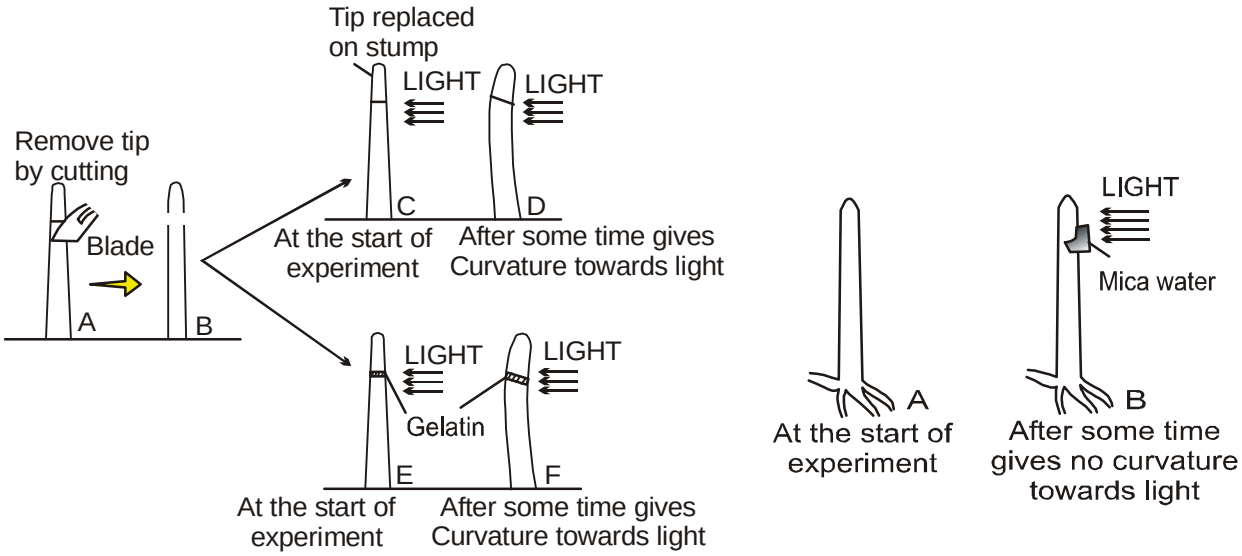
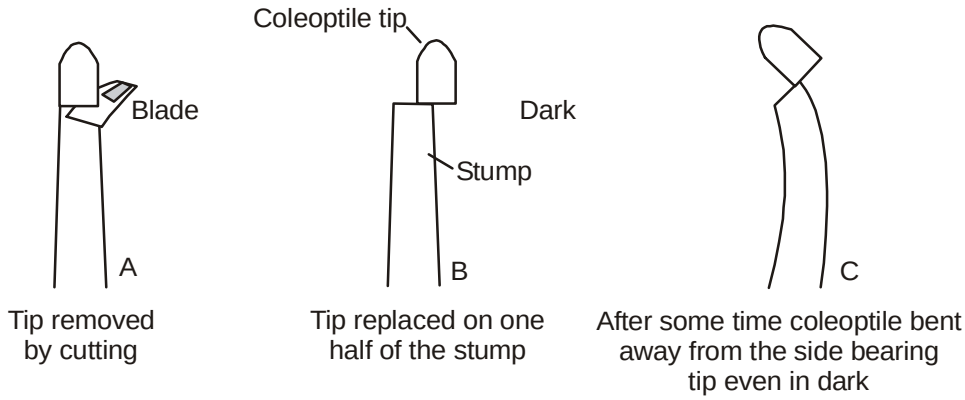


Fig : Experiments of Boysen-Jensen

✸ **Paal (1919) :**

- He found that when the excised tip is replaced on one side of **Avena** coleoptile stump then accelerated growth beneath the tip, which results in curvature, in dark.
- He gives the idea of unequal distribution of the chemical responsible for phototropism.



✸ **F.W. Went (1920) :**

- He first isolated a substance from the coleoptile tip of **Avena sativa** (Oat) and named it **auxin**.
- He placed the cut end of coleoptile tip of Oat on agar block.
- Then he placed one of the agar block on stump in ecentric position and kept it in dark for 2 hrs. He observed that **curvature** resulted in **oppsite** direction to agar block.
- Went discovered **auxin** in tip of coleoptile.
- He also stated that auxin concentration towards **non-illuminated** side is 57% and towards **illuminated** side is 27% because -

About 16% auxin is **destroyed by light**.

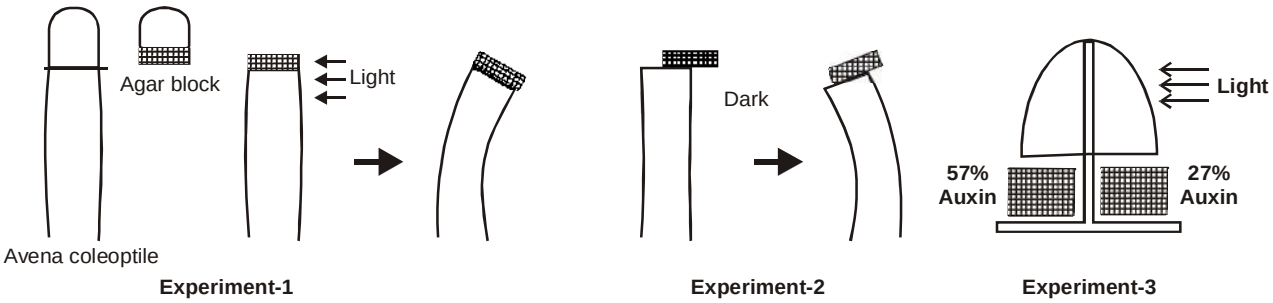


Fig.: F.W. Went's Experiment

Conclusion :-

(1) Growth is directly proportional to concentration of Auxin in agar block in limit

(2) Transport of auxin is Polar and Basipetal.

(3) High concentration of auxin towards dark side (57%) and less auxin concentration towards light side (27%). Rest of auxin is Photoxidised (16%).

- **Kogl, Haagen Smidt and Erxleben (1931) :**

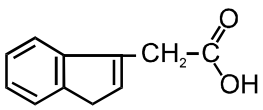
They discoveresd 3 types of auxin like substances from different sources -

(a) **Auxin-a :** It was isolated from **human urine** and was named as **Auxenotriolic acid ($C_{18}H_{32}O_5$)**.

(b) **Auxin-b :** It was isolated from **corn endosperm** (corn germ oil) and named as **Auxenolonic acid ($C_{18}H_{30}O_4$)**.

(c) **Heteroauxin ($C_{10}H_9O_2N$) :** It was also isolated from **human urine** which is now known as **Indole-3-Acetic acid (IAA)**.

- **Thimann (1935) :** isolated IAA from cultures of **Rhizopus** species.
- **Introduction of Auxin :**
- **Precursor** = Tryptophan {'**Zn**' is essential for biosynthesis}
- **Biosynthesis** = Shoot and Root apex
- **Transportation** = Polar and Basipetal, By parenchyma cells.
- **Structure of IAA is -**



IAA

Forms
- Natural Auxins = **IAA**(Indole Acetic Acid), **IBA**(Indole Butyric Acid), **PAA** (Phenoxy Acetic Acid)
- Synthetic Auxins = α, β-**NAA** (Nepthelene Acetic Acid), **IPA** (Indole Propionic Acid), **PAA**, **2**, **4-D**, **2**, **4-5-T**
- Free Auxins = Diffusible Auxin
- Bound Auxins = Binded with esters at the site of synthesis
- Antiauxin = TIBA, Morphactin, MH
  - {Inhibits polar transport of Auxin}
  - Decrease apical dominance. Increase Lateral branches
  - Decrease phototropism
  - Shortening of internodes
  - Decrease laminar area of leaves

- **Oxdation = Photooxidation, IAA oxidase**
- **Bioassay = Avena Curvature test, Root growth inhibition test.**

✸ **Physiological effects and applications of Auxin :**

(i) **Cell elongation, Morphogenesis, Apical dominance** →
- Pruning increase lateral branching
- Shortening of internodes → Use of NAA, MH in Apple, Pear
- Potato Dormancy → Use of NAA, MH

(ii) **Root formation and root growth inhibition** →
- Increase adventitious branching of roots
- Prevents lodging - IBA - Rooting hormone

(iii) Prevents abscission →
- Fruit thinning in mango.
- Collection of cotton bolls - TIBA

(iv) **Flowering and Parthenocarpy** →
- Flowering - **Femaleness** in **Bromeliaceae,** (Pineapple, Litchi) and **Cucurbitaceae.**
- Parthenocarpy in **solanaceae** and **cucurbitaceae.**

(v) **Phototropism**

(vi) Selective weed killer = Dicots weeds/broad leaf weed killer = 2, 4-D and 2, 4-5-T,
= **Dioxin/Agent orange/Jungle defoliant**

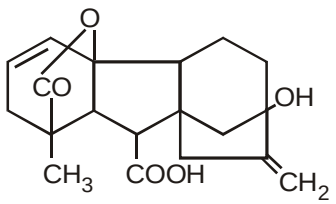
B. GIBBERELLIN (GA)

✸ **History :**

- Japanese farmers noted that some plants in rice fields were taller, thinner and paler than the normal plants and named this disease as **'bakanae disease or foolish seedling disease'**.
- **Kurosawa** and **Swada** (1926) reported that this disease was due to a fungus **Gibberella fujikuroi** (Ascomycetes) whose incomplete state is **Fusarium moniliformae** (Deuteromycetes).
- **Yabuta**, **Sumuki** and **Hyashi** (1938) isolated gibberellin from this fungus and named it as **Gibberellic acid**. It was **GA_3**.
- Untill now more than 100 GA have been discovered.

✸ **Introduction of Gibberellin :**

- **Precursor** = Acetyl-CoA {By Mevalonic acid Pathway} / Kaurene.
- **Biosynthesis** = Germinating seed, Bud, Shoot, Root, Leaves.
- **Transports** = Non Polar, By xylem and phloem.
- **Chemical structure** of Gibberellic acid is –



GA

- **Form** = GA_3 - First discovered and most common GA [Commercially]
  GA_1 and **GA_{20}** = **GA_1** first discovered GA of higher plants. Most common **GA's** of higher plants.
- **Anti GA** - Phosphon - D, Cycocel, Chlormquet, Ancymidol [A-Rest], Alar-85 (B-Nine), AMO - 1618. All are used in Bonsi.
- **Oxidation**
- **Bioassy = (i) α-amylase activity test in Barley endosperm.**
  (ii) Dwarf pea and Maize test.

✸ **Physiological effects and application of GA :**

- **Stem and internode elongation**
  - Elongation of genetic dwarf plant.
    Ex.: Pisum, Vicia, Maize, Sugarbeet.
  - **Bolting effect :** Elimination of rosette growth in cabbage.
  - Increase malting in sugarcane.
- **Seed germination**
  - Breaking seed dormancy
  - Germination of photoblastic seeds, Ex. Lettuce, Tobacco

  Increase activity of stored food hydrolysing enzymes like Amylase, Lipase, Protease.
- **Flowering and Parthenocarpy**
  - Flowering
    - Maleness in Bromeliaceae and Cucurbitaceae
    - In LDP during short day condition.
    - In vernalisation requiring plants (winter annuals, biennials) without vernalisation.
  - Parthenocarpy - In solanaceae and Cucurbitaceae.
- **Fruits and flower enlarger-** Thompson grapes / Table grapes, geranium flower.
  Pomalin (Apple enlarger) = mixture of GA (GA_4 and GA_7) + Cytokinin

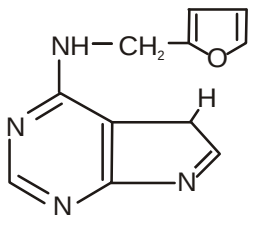
C. CYTOKININ

✸ **History :**

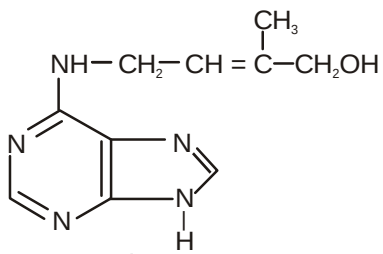
- **Miller** (1956) first isolated them from **herring fish sperm DNA** and named them as **kinetin**.
- **Letham** (1953) isolated and characterised a cytokinin called **zeatin** from **immature maize kernels**.**(corn grain oil)**
- Cytokinin name given by **F. Skoog.**
- Phytokinin term by **Osborne**.

✸ **Introduction of Cytokinin :**

- **Precursor** - Acetyl CoA [By Mevalonic acid pathway] Adenin derivatives.
- **Biosynthesis** - Root and shoot apex.
- **Transport** - Polar and Basipetal, By xylem.
- **Structure** -



Kinetin



Zeatin

- **Form** -

  Kinetin - First discovered Ck. (Only in animals).

  Zeatin - First discovered CK and most common CK of plants. Coconut milk factor - Zeatin.

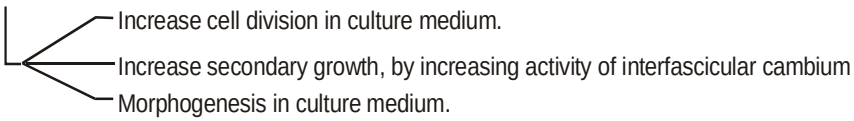
  Synthetic CK - BAP (Benzyl Amino Purine), Diphenyl Urea, thidiazuron.
- **Oxidation** - Cytokinin oxidase.
- **Bioassay** -

  (i) Chlorophyll preservation test.

  (ii) Tobacco pith cell division test.

  (iii) Radish and soyabean cotyledon cell division test.

- **Physiological effects and applications of Cytokinins :**
- **Cell division, Morphogenesis, Vascular differentiation :**



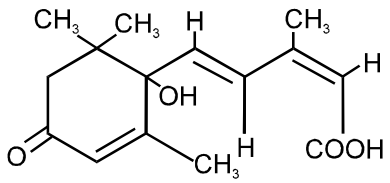
$\frac{\text{High CK}}{\text{Low Auxin}}$ = Shoot, $\frac{\text{Low CK}}{\text{High Auxin}}$ = Root, $\frac{\text{CK}}{\text{Auxin}}$ = 1 callus.

- **Promotes growth of lateral branches.**
- **Nutrients Mobilisation and delay in Senescence. Richmond Lang effect.**
  Increase Proplastid formation, Increase phloem/food conduction, increase lignin biosynthesis. Seed germination in parasitic plants without host plants. (Striga)
- **Stomatal opening.**

2. **GROWTH INHIBITORS** -
   - Growth Inhibitors are of following 2 types
     (A) ABA and (B) Ethylene

A. Abscisic Acid /ABA

- **History**
- First indication of growth inhibitors was given by **Osborne.**
- **First growth inhibitor** was identified by Bennet-Clark and Kefford (1953) from dormant potato tuber and called it **β-inhibitor**.
- **Addicott and Okhuma (1963)** obtained from mature **Cotton fruits** and named as **Abscisin II. ($C_{15}H_{20}O_4$)**
- **Waring and Robinson -** Isolated a growth inhibitor from old Betula leaves and called it **Dormin**.
- Later established that β-inhibitor, Abscisin-II and Dormin are same and called as Abscisic acid.
- **Introduction of ABA**
- **Precursor** - Acetyl Co-A {By Mevalonic acid pathway}. **Oxidation of β-carotene**.
- **Biosynthesis -** In any plants part where required.
- **Transpotation -** Not transported
- **Structure**



Chemical Structure of ABA

- **Oxidation.**
- **Bioassay.**
- **Physiological effects and applications of ABA**

- **Induced bud and seed dormacy**
  - Tuberisation of potato.
  - Inhibits activity of amylase, lipase, protease.
  - Prevents vivipary
  - Growth inhibition in duck weeds (Lemna).

- **Regulates abscission and senescence** — Inhibits cells divisionand cell elongation.; Increase activity of polysaccharide hydrolysing enzymes, pectinase, cellulase.
- **Stomatal Closing**
- **Increase geotropism in root of xerophytes.**
- **Flowering delay in LDP.**

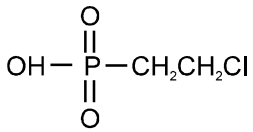
B. ETHYLENE

✸ **History**

- **H.H. Cousin** (1910) first suggested that ripened oranges are responsible for ripening of unripened bananas.
- **R.Gane** identified volatile substance as ethylene.
- Ethylene is a **gaseous** pollutant **hydrocarbon,** But **Burg** reported it as a **fruit reipening hormone.**
- **Pratt Goeschl -** Recognized ethylene as a natural plant growth regulator.

✸ **Introduction of Ethylene**

- **Precursor - Methionine.** Auxin induced ethylene production.
- **Bisynthesis -** Ripening of fruits, Senescent plant parts. Roots, Shoots,
- **Transport - Diffusion**
- **Structure : $CH_2 = CH_2$**
- **From =** Ethephon/CEPA (2-Chloroethyl phosphoric acid). - Artificial fruit ripener.
  Ascorbic acid and iodoacetate also induces its synthesis. O_2 is essential.



Ethephon

- **Oxidation** - Autocatalytic.

✸ **Physiological effects and applications of Ethylene**

- **Fruit Ripening =** Natural - Climacteric respiration.
  Artificial - Ethephon / CEPA used.
- **Regulates senescence and abscission.**
- **Flowering - Femaleness -** In *Bromeliaceae* (Pineapple, Litchi) and Cucurbitaceae.
- **Root-shoot growth -** Root (Like Auxin) : Increase formation of roots, Root hair, inhibits root growth. Shoot (Antiauxin : inhibits transports of auxin) : Decrease apical dominance, decrease stem elongation, Increase radial swelling of stem.
- **In hydrophytes -** Increase gaseous diffusion.
- **Abnormal effects :** — Increase radial swelling or horizontal growth of stems.; Epinasty of leaves.; Tightening of hooks of epicotyl and hypocotyl.

ABSCISSION

- Detachment of senescent or mature plant organs like leaves, fruits, flowers due to change in hormonal activity.
- There is a separation layer **(abscission layer)** is formed within the region of attachement of these parts. Cell wall layers and middle lamella are dissolved by the activity of **cellulase** and **pectinase** (Polysaccharide hydrolysing enzymes) during **abscission.**
- Hormone **ABA and Ethylene are main controller** of abscission process.

PLANT SENESCENCE

- Period from reproductive maturity to degredative changes during the death of an organ or plant is known as **Senescence.**
- During senescence a gradual destruction occurs in protoplasm, cell, tissue, organ or plant and functioning of the plant and plant parts.
- During the senescence, higher rate of catabolism starts, under the control of growth hormones like **ABA, ethylene.** Senescence occurs as a result of ageing and leads to death of plant parts or whole plant. (Senescence and ageing - studied in **phyto-gerontology**)
- Senescence may be of following types :

(a) **Whole plant senescence :** Ex. Tomato, Wheat, Mustard, Rice, Beans.

(b) **Organ senescence :** When plant part above ground dies (shoot) each year and root & rhizome system alive. Ex. Alfa-alfa, Sugarcane, Banana, Ginger.

(c) **Sequential or progressive leaf senescence :** Evergreen perennials show progressive or sequential senescence of older leaves, lateral organs, branches, flowers, fruits and shoot. Ex. Eucalyptus, Mango.

(d) **Simultaneous or Synchronous leaf senescence :** In perennial deciduous plants all the leaves undergo senescence and abcission at a time.

Ex. : *Dalbergia siso, Azadirachta indica, Ficus religeosa*

PLANT MOVEMENT

1. Movement of locomotion : When the whole plant, part or organs of plant move from one place to another place.

A. Autonomous :- (By internal stimulus)

(i) Amoeboid : Ex.: Gametes of Spirogyra

(ii) Ciliary movement : Ex.: Chlamydomonas, Euglena, Zoospores

(iii) Cyclosis :

(a) Rotation : Whole protoplasm moves around the one central vacuole, in one direction.

Ex.: **Hydrilla, Vallisneria cells.**

(b) Circulation : Protoplasm moves, around the different vacuoles in different directions..

Ex.: Stamenal hairs of **Tradescantia.**

B. Induced/paratonic/tactic movement : (due to **external stimulus**)

(i) Phototactic : Due to stimulus of light. Ex.: Algae - by Eye spot/Stigma

(ii) Chemotactic : Due to stimulus of chemicals. Ex.: Male gametes of lower plants (antherozoids). By **Chemical gradient sensing mechanism.**

(iii) Thermotactic : Due to stimulus of temperature. Ex.: **Chlamydomonas, Euglena.**

2. Movement of curvature : Movement of plant organs only.

A. Autonomous : Movement of variation - Dance movement by Desmodium. (Indian telegraph) due to turgor pressure change.

Epinasty & hyponasty, the growth movements in floral bud and leaves.

B. Induced/Paratonic movement : (By external stimulus, but directional)

(i) Tropic movement : Definite direction towards stimulus.

(a) Phototropism
- + ve ex : stem
- – ve ex : Root

- Definite direction in relation to light.

(b) Geotropism
- + ve ex : Root (Root cap percept stimulus)
- – ve ex : Stem & Mangrove plant roots.

- Definite direction in relation to gravity, (Root cap percept stimulus).

(c) Chemotropism : Ex.: Pollen tube & fungal hyphae

- Definite direction in relation to chemicals.

(d) Thigmotropism (haptotropism) : Ex : **Tendrils, haustoria of Cuscuta.**

- Definite direction in responce to contact or support.

(e) Hydrotropism : Ex.: Roots of seedlings

(ii) Nastic movement (External stimulus but diffused type or nondirectional) :

(a) Nyctinasty :- Ex.: Flowers, leaves, stomata, daily movement (Sleep movements)

- Due to rhythmicity of day and night.

(b) Thigmonasty or haptonasty :- Ex.: Tentacles of insectivorous plants.

(c) Chemonasty :- Ex.: Tentacles of insectivorous plants.

(d) Seismonasty :- Ex.: **Mimosa** (Touch me not plant) turgor change in pulvinus at leaf base **K^+ions** also involved in this movement.

SPECIAL POINTS

- The hormone which is produced in leaves due to effect of light and induces flowering is called **florigen**. Florigen has not been isolated yet. **Anthecin** is another hormone responsible for flowering.
- The chemical which perceives the photoperiodic stimulus in leaves is **phytochrome**.

- Many plant parts specially leaves exhibits nastic movement and involves differential growth, this type of movement is known as movement of growth. This movement is caused due to unequal growth in plant organs. Ex.: Epinasty, Hyponasty, Nutation.
- **Epinasty & Hyponasty :** Ex : Leaves, Flowers (petal) opening and closing respectively.

  Epinasty - More growth on upper surface of plant parts.

  Hyponasty - More growth on lower surface of plant parts.

  Both epinasty and hyponasty are example of autonomic growth movements.
- **Nutation :** Zig-zag growth of plant organ mainly shoot, is called as nutation.
- **Circumnutation :** Spiral growth of plants in tendrils.
- **Portulaca** is known as **compas plant.**
- **Rhizomes** diageotropic (**90º** to gravitation axis)
- **Plageotropism :** Shown by stem and root branches growing at an angle of **0-90ºC** from axis of gravity.
- **Clinostat :** Used for nullifying geotropism.
- **Hygroscopic Movement** (Mechanical movement)
  - **Xerochasy :** Due to loss of water
    Ex. : Dehiscence of legume fruits
  - **Hydrochasy :** By excess of water
    Ex. : Ruellia fruit dehiscence
- **Traumatropism :** Injury induced plant movement.
- **Climacteric fruits :** (Banana, Apple, Avocados) : Fruits, in which rate of respiration increses **(Climacteric respiration)** during their ripening **(ethylene).** Citrus is non climacteric fruit.
- The flower stalk of poppy is +vely geotropic but after the opening of flower, this stalk changes as negative geotropic.
- Formation of nodule is a combined activity of **cytokinin** (By bacteria) and **auxin** (By leguminous plant).
- **Blue light** has more effects on most of physiological and growth processess in plants except photosynthesis and photoperiodism.
- ***Arabidopsis thaliana*** (Brassicaceae) is the most widely used plant tool for the studies of devlopmental genetics and growth physiology of plants.
- **Betacyanin or Betalains :** Pigment mainly found in valcoule of **beet roots** and flower of **Bougainvellia** are differ from anthocyanin due to the presence of nitrogen (N). These pigments do **show reversibility of colour change due to p^H change.**
- **Anthocyanin** is water soluble **vacuolar** pigment, which does not involve in photosynthesis.

  Anthocyanin exhibits different colour like purple, pink, blue, scarlet etc.
- The colour of anthocyanin is sensitive to p^H change e.g. colour of anthocyanin changes from **Red (acidic p^H)** to **Violet (neutral p^H)** to **blue (in alkaline p^H).**
- **Turgorin-a** newly discovered hormone found in pulvinous leaf base regulates turgor pressure changing movements.

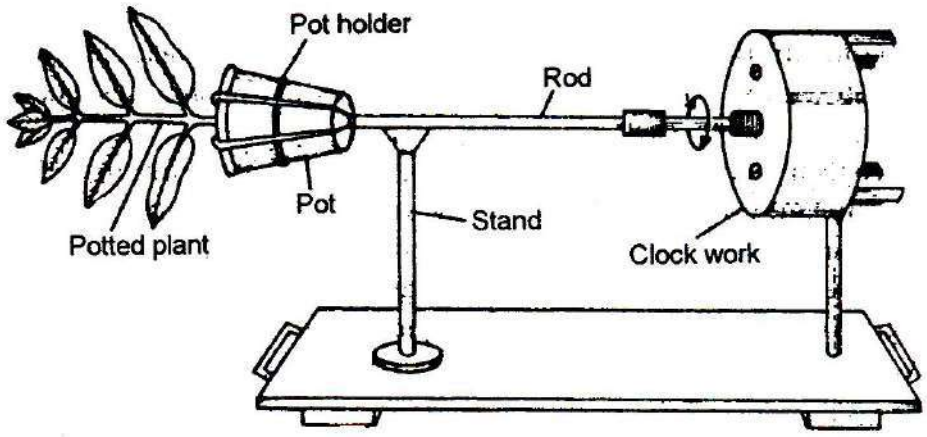
EXPERIMENT

Demonstration of Geotropism by Clinostat

Geotropic curvature results is due to unilateral gravity stimulus can be demonstrated by using a Clinostat. Clinostat consist of a disc attached to the tip of an horizontal rod, which can be rotated with the help of a clockwork.

Fix a small young potted plant on a clinostat in horizontal position and rotated, neither the root will bend down nor the stem will curve upward (Nullify the geotropism). It is because in such case the effect of gravity will be uniform all.

Round the stem and root. If however, the plant lies in horizontal position & not rotated, the roots will receive gravity stimulus only their lower sides or the effect of gravity will be unilateral. Unilateral stimulus of gravity causes unequal distribution of auxin in root tip. (more auxin on upper side than on lower side). This in turn results in more growth on the upperside and less growth on lowerside and ultimately a + ve geotropism is observed. However in case of stem the more conc. of Auxin on lower side promotes more growth on that side so stem is negative geotropic.



EXERCISE - 1

Q.1 Which breaks dormancy of potato tuber ?
(1) Gibberellin (2) IAA
(3) ABA (4) Zeatin

Q.2 In tissue culture, differentiation of shoot is controlled by-
(1) Light Intensity
(2) Temperature shock
(3) Low Auxin+High CK $\left(\text{High } \frac{\text{Cyto}}{\text{Auxin}} \text{Ratio}\right)$
(4) None

Q.3 Pineapple can made to uniform flowering by the application:-
(1) Zeatin (2) Ethylene
(3) Short day (4) Low temperature

Q.4 A natural growth regulator is-
(1) Ethylene (2) NAA
(3) 2, 4-D (4) Benzyladenine

Q.5 Among the following which helps in early ripening of fruits ?
(1) Methane (2) Ethylene
(3) CO_2 (4) CO

Q.6 Abscisic acid induces-
(1) Shoot elongation
(2) Cell elongation and cell wall formation
(3) Cell division
(4) leaf fall and dormancy

Q.7 In autumn leaf fall occurs, because-
(1) Formation of abscission layer at the base
(2) Leaf becomes heavy
(3) Leaf does not remain green
(4) Of low temperature

Q.8 The hormone produced during adverse environmental condition is-
(1) Abscisic acid
(2) N^6-Isopentanyl adenine (CK)
(3) Dichlorophenoxy acetic acid (2, 4-D)
(4) Gibberellic acid (GA)

Q.9 The which of the following is growth inhibitor-
(1) IAA (2) ABA
(3) NAA (4) GA_3

Q.10 During adverse environmental condition plants develop a stress hormone, which is ?
(1) Abscisic acid (2) Ethylene
(3) Benzyl amino purine
(4) Dichlorophenoxy acetic acid

Q.11 Abscisic acid treatment results in-
(1) Leaf expansion (2) Stem elongation
(3) Stomatal closure (4) Root elongation

Q.12 Natural cell division inducing factor occurs in-
(1) Coconut milk
(2) Immature maize seeds
(3) Both (4) Heated t - RNA

Q.13 Recognition of ethylene as a natural plant hormone was done by-
(1) Pratt Goeschl (2) Richmond Lang
(3) Sorokin (4) Haberlandt

Q.14 Seeds of Tomato do not germinate in its pulp due to-
(1) Presence of excess salts
(2) Presence of ferulic acid
(3) Absence of oxygen
(4) Presence of ABA

Q.15 Fruits ripening hormone is-
(1) Kinetin (2) Gibberellin
(3) Ethylene (4) IAA

Q.16 Morphactins are-
(1) Auxins
(2) Natural growth regulators
(3) Synthetic growth inhibitor
(4) Metabolic inhibitors

Q.17 What is a stress hormone ?
(1) Benzyl aminopurine
(2) Dichlorophenoxy acetic acid
(3) Ethylene (4) Abscisic acid

Q.18 A fungus which secretes abscisic acid is-
(1) Aspergillus (2) Gibberella
(3) Cercospora (4) Alternaria

Q.19 Seed dormancy is due to the-
(1) Ethylene (2) Abscisic acid
(3) IAA (4) Starch

Q.20 Hormone responsible for senescence-
(1) ABA (2) Auxin
(3) GA (4) Cytokinin

Q.21 Hormone responsible for vernalization-
(1) Florigen (2) Caulocaline
(3) Abscisin (4) Vernalin

Q.22 Effect of day length on plant development is called
(1) Phototropism (2) Photoperiodism
(3) Chemotropism (4) Photosynthesis

Q.23 The phenomenon of photoperiodism in plants was discovered by-
(1) Garner and Allard
(2) Steward and Salisbury
(3) Thiman and Skoog
(4) Hendricks and Borthwick

Q.24 Selaginella sperms swims towards the archaegoina, this movement is-
(1) Chemotropic (2) Chemotactic
(3) Chemonastic (4) Archaenastic

Q.25 Active form of phytochrome for seed Germination is-
(1) P_{fr}–form (2) Pr–form
(3) Both (4) None

Q.26 Long day plant's produces flowers when they exposed to-
(1) Any duration of light
(2) Light period longer than a critical day length
(3) Light period longer than 12 hrs.
(4) None of these

Q.27 Which of the following is a hypothetical hormone ?
(1) Gibberellin (2) Auxin
(3) Cytokinin (4) Florigen

Q.28 Which plant is LDP ?
(1) Tobacco (2) Glycine max.
(3) Mirabilis (4) Spinach

Q.29 In red-far red treatment response of plant depends upon-
(1) First treatment
(2) Last treatment
(3) Middle treatment
(4) Sum total of all the treatment

Q.30 Phytochrome is found in-
(1) Algae (2) Fungi
(3) Gymnosperms (4) Angiosperms

Q.31 Wheat, potato & henbane are-
(1) SDP (2) DNP
(3) LNP (4) LDP

Q.32 In short day plants (SDP) flowering is induced by
(1) Long night
(2) Photoperiod less than 12 hours
(3) Photoperiod shorter than critical value and uninterrupted long night.
(4) Short photoperiod and interrupted long night

Q.33 Which one shows red far red inter-conversions?
(1) Carotenoids (2) Cytochromes
(3) Chlorophyll (4) Phytochrome

Q.34 Physiologically active form of phytochrome is-
(1) P_{730} (2) P_{660}
(3) P_{700} (4) P_{680}

Q.35 Pneumatophore are-
(1) Positively geotropic
(2) Negative phototropic
(3) Negatively geotropic
(4) Hydrotropic

Q.36 Which one prevents photooxidation and pigment destruction-
(1) Carotene (2) Phytohormone
(3) Phycocynin (4) Phycoerythrin

Q.37 If a tree flowers thrice in a year in October, January and July in northern India, the plant is-
(1) Photo and thermo sensitive
(2) Photo and thermo insensitive
(3) Photosensitive but thermo insensitive
(4) Thermo sensitive but photo insensitive

Q.38 A long day plant is -
(1) Xanthium (2) Chrysanthemum
(3) Radish (4) Tomato

Q.39 Which is not a plant hormone-
(1) Phytochrome (2) Florigen
(3) GA (4) IAA

Q.40 A pigment concerned with both floral induction and seed germination is-
(1) Florigen (2) Chlorophyll
(3) Plastocyanin (4) Phytochrome

Q.41 Which pigment absorbs the red and far-red light ?
(1) Cytochrome (2) Phytochrome
(3) Carotenoids (4) Chlorophyll

Q.42 Mimosa pudica shows-
(1) Chemotropism (2) Nyctinasty
(3) Seismonasty (4) All the above

Q.43 The style in ***Arachis*** before fertilization is-
(1) Positive phototropic
(2) Negative phototropic
(3) Positive geotropic
(4) None of the above

Q.44 Rhizomes and runner stems are-
(1) Diageotropic (2) Apogeotropic
(3) Plagiotropic (4) Aerotropic

Q.45 Physiologically active form of phytochrome is-
(1) P_{730} (2) P_{660}
(3) P_{700} (4) P_{680}

Q.46 Low temperature is harmful for plants, because it has-
(1) Dessication effect
(2) Chilling effect
(3) Freezing effect
(4) All of these

Q.47 Greater growth on the lower surface of a bifacial leaf is-
(1) Nyctinasty (2) Photonasty
(3) Hyponasty (4) Epinasty

Q.48 Opening of flower is example of-
(1) Curvature movement
(2) Epinasty
(3) Hyponasty (4) Autonomus

Q.49 Mimose (touch me not plant) shows-
(1) Thigmotropism movement
(2) Chemotactic movement
(3) Thigmonasty (4) Seismonasty

Q.50 Movement of tendrils is-
(1) Hydrotropism (2) Chemotropism
(3) Thigmotropism (4) Geotropism

Q.51 Movement of pollen tube is-
(1) Chemotropism (2) Hydrotropism
(3) Phototropism (4) None

Q.52 Movement of male gametes in lower plants (Fern, Bryophytes) is-
(1) Thermotactic (2) Chemotropism
(3) Chemotactic (4) Phototactic

Q.53 Phototactic movements found in-
(1) Plants (2) Some Algae
(3) Bryophytes (4) Male gametes

Q.54 Negatively geotropic roots present in-
(1) Bryophytes (2) Mangrooves
(3) Pteridophytes (4) Xerophytes

Q.55 Movement can see in fungal hyphae-
(1) Chemotactic (2) Chemotropic
(3) Thigmotropism (4) None

Q.56 Cucurbitaceae is good example of-
(1) Haptotropism (2) Thigmotropism
(3) Both (4) None

Q.57 Diurnal change in flower & leafs is known as-
(1) Nyctinasty or sleep movement
(2) Haptonasty
(3) Photonasty
(4) None

Q.58 Movement of Indian telegraph plant (Desmodium) is–
(1) Movement of variation (Turgor movement)
(2) Geotropism
(3) Phototropism
(4) Movement of cyclosis

Q.59 Hydrotropism have seen in-
(1) Flowers (2) Seedlings
(3) Stem (4) None

Q.60 ***Crocus*** and ***Tulip*** flower shows response to-
(1) Water (2) Light
(3) Temperature (4) Touch

Q.61 ***Mimosa pudica*** (Sensitive plant) leafs movement due to-
(1) Nerve impulsion
(2) Delicate leafs
(3) Loss of tissue
(4) Turgor change in leaf base

Q.62 Plant hormone associated with Climacteric respiration is-
(1) Auxin (2) Cytokinin
(3) Ethylene (4) Gibberellin

Q.63 Movement of Spirogyra gametes is-
(1) Ciliary (2) Cyclosis
(3) Amoeboid (4) None

Q.64 Movement in peristome teeth is-
(1) Hydrochasy (2) Xerochasy
(3) Chemotactic (4) Chemotropism

Q.65 Haustorial movement in Cuscuta-
(1) Hapto/thigmotropism
(2) Aerotropism
(3) Hydrotropism
(4) Thermotropism

Q.66 Drosera tentacles shows-
(1) Chemonasty (2) Thigmonasty
(3) Chemotropism (4) Both (1) & (2)

Q.67 Scototropic movements induced by-
(1) Light (2) Night
(3) Touch (4) Heat

Q.68 Motor or bulliform cells In grasses shows-
(1) Growth movement
(2) Tropism
(3) Nastic movement
(4) Turgor movement

Q.69 The coiling of tendril around some base in response to touch is called:
(1) Hydrotaxis (2) Chemotaxis
(3) Thigmotaxis (4) Geotaxis

Q.70 What is the speciality of Crescograph ?
(1) Growth can be measured at the rate of per hour
(2) Growth can be measured at the rate of per minute
(3) Growth can be measured at the rate of per second
(4) Growth can be measured at the rate of per day

Q.71 Short days plants should be actually called–
(1) Long night plants
(2) Day neutral plants
(3) Photo neutral plants
(4) Light unaffected plants

Q.72 The effect of red light in short day plants can be nullified by –
(1) Orange light (2) Far red light
(3) Blue light (4) All the above

Q.73 Which is the critical period in short day plants ?
(1) Duration of light
(2) Duration of darkness
(3) Duration of both
(4) None of the above

Q.74 Which pigment induces formation of florigen in short day plants ?
(1) P_r (2) P_{fr}
(3) Both of above (4) None of the above

Q.75 Which pigment induces synthesis of florigen in long day plants ?
(1) P_r (2) P_{fr}
(3) Both of above (4) None of the above

Q.76 Which plant harmone is effective for inducing flowering in LDP under short day conditions?
(1) Auxin (2) Gibberellin
(3) Cytokinin (4) None of the above

Q.77 Which is active form out of P_r and P_{fr} ?
(1) P_r
(2) P_{fr}
(3) Both equally active
(4) None of the above

Q.78 Phytochrome is related to –
(1) Seed germination in salad
(2) Inhibition of albinism and development of chloroplast
(3) Expansion of leaves in dicots
(4) All the above

Q.79 Who discovered vernalization ?
(1) Lysenko (2) Went
(3) Boysen & Jenson (4) Darwin

Q.80 Went found that curvature of coleoptile is –
(1) Directly proportional to concentration of auxin
(2) Inversely proportional to concentration of auxin
(3) Not affected by concentration of auxin
(4) None of the above

Q.81 In which plant Went discovered auxin ?
(1) Phalaris canarienses
(2) Avena sativa
(3) Mirabilis jalapa
(4) Oryza sativa

Q.82 How the polar transport of auxins occurs ?
(1) From tip towards base
(2) From base towards tip
(3) From centre towards lateral side
(4) From lateral side towards centre

Q.83 Dormancy in potato can be induced by –
(1) IBA (2) NAA
(3) Maleic hydrazide (4) All the above

Q.84 Parthenocarpy can be induced by –
(1) IAA (2) NAA
(3) IBA (4) All the above

Q.85 Testing of biologically active substances on living beings is called –
(1) Biological testing (2) Utility testing
(3) Bio-assay (4) Active assay

Q.86 The auxins which can't diffuse are called –
(1) Unbound/free (2) Bound
(3) Dependent (4) None of these

Q.87 What was used by the name "Agent Orange" by America to defoliate forests of Vietnam ?
(1) 2-4 D (2) 2-4-5T
(3) Both (1) and (2) (4) None of these

Q.88 It is essential for synthesis of auxin –
(1) Mn (2) Zn
(3) Ca (4) Mg

Q.89 What is the reason of bakane disease of rice ?
(1) Bacteria (2) Mycoplasma
(3) Fungus (4) Virus

Q.90 Gibberellins are found in –
(1) Algae, fungi and bacteria
(2) Bryophytes, pteridophytes and gymnosperms
(3) Angiosperms (4) All the above

Q.91 Gibberellin is synthesized in –
(1) Rhizome & root tip
(2) Young developed leaves
(3) Young expanded leaf
(4) All the above

Q.92 Gibberellin is formed from –
(1) Acetyl CoA (2) Methionine
(3) Isoprene (4) None of these

Q.93 Which of these effect is due to gibberellins ?
(1) Internode elongation
(2) Bolting
(3) Breaking of dormancy
(4) All the above

Q.94 In which plants, flowering can be induced by gibberellins even in the absence of appropriate photo period required for them ?
(1) In LDP (2) In SDP
(3) In LDP & SDP (4) None of these

Q.95 Due to the effect of which substance flowering can be induced even in the absence of vernalisation ?
(1) Gibberellin (2) Auxin
(3) Cytokinin (4) Ethylene

Q.96 Which enzyme is synthesized de-novo in aleurone layers of germinating seeds due to the effect of gibberellins ?
(1) α-Amylase (2) Protease
(3) Lipase (4) None of the above

Q.97 What is the chemical name of Kinetin ?
(1) 6-(4 hydroxy 3-methyl trans 2-butene aminopurinol)
(2) 6-furfuryl aminopurine
(3) Dimethyl allyl adenine
(4) None of the above

Q.98 Which one acts as cytokinins ?
(1) Diphenyl urea
(2) Indoleacetic acid
(3) Phosphon-D
(4) None of the above

Q.99 Due to which hormone effect, seeds of Striga asiatica can be germinated without coming in contact with their host ?
(1) Auxin (2) Gibberellin
(3) Cytokinin (4) Ethylene

Q.100 Delay of senescence is called –
(1) Richmond effect
(2) Lang effect
(3) Richmond–Lang effect
(4) None of the above

Q.101 What happens during delay of senescence ?
(1) Chlorophyll breakdown stops in the treated area
(2) Transfer of proteins, amino acids and auxins towards the treated area
(3) More protein synthesis in the treated area
(4) All the above

Q.102 Who gave the name cytokinin ?
(1) Miller (2) Letham
(3) Skoog (4) None of the above

Q.103 Which is called the fruit ripening hormone ?
(1) Auxin (2) Gibberellin
(3) Ethylene (4) All the above

Q.104 Ethylene synthesis occur in –
(1) Fruit (2) Stem
(3) Leaf (4) All the above

Q.105 What is the precursor of ethylene ?
(1) Tryptophan (2) Ethene
(3) Methionine (4) None of the above

Q.106 Which are the climactric fruits ?

(1) Fruits forming auxins in more quantity during fruit ripening

(2) Fruits forming ethylene in more quantity during fruit ripening

(3) Fruits forming gibberellin in more quantity during fruit ripening

(4) Fruits forming cytokinin in more quantity during fruit ripening

Q.107 Ethylene synthesis is induced by –

(1) Auxin (2) Gibberellin

(3) Cytokinins (4) ABA

Q.108 Which of the following effects is related to ethylene ?

(1) Origin of root from graft

(2) Origin of lateral root

(3) Origin of root hair

(4) All the above

Q.109 The increase in rate of respiration during ripening of fruits is called –

(1) Fruit ripening respiration

(2) Climactric respiration

(3) Maturation respiration

(4) Climax respiration

Q.110 Chemically abscisic acid is –

(1) Terpenoid

(2) Fatty acid

(3) Precursor of typical fat

(4) Steroid

Q.111 Synthesis of abscisic acid occurs in –

(1) Leaves (2) Stem

(3) Seeds and fruits (4) All the above

Q.112 Abscission in leaves occurs due to –

(1) Abscissic acid

(2) Ethylene

(3) Combined effect of both

(4) None of the above

Q.113 Which effect is due to abscisic acid ?

(1) Induction of dormancy in buds and seeds

(2) Inhibition of growth

(3) Senescence

(4) All the above

Q.114 Which type of movement is exhibited by male gametes of Bryophytes and Pteridophytes when moving towards archegonial neck ?

(1) Photonastic (2) Chemonastic

(3) Chemotropic (4) Chemotactic

Q.115 What is it called when the plant remains fixed and the organ/part changes its position ?

(1) Fixed movement

(2) Curvature movement

(3) Tactic movement

(4) Nastic movement

Q.116 What is the special feature of growth movements ?

(1) They are irreversible

(2) They are reversible

(3) They are found only in flat organs

(4) None of the above

Q.117 In which organ circumnutation found ?

(1) In stem (2) In tendril

(3) In leaves (4) In flowers

Q.118 What is the reason of phototropism ?

(1) More distribution of auxin

(2) Less distribution of auxin

(3) Uneven distribution of auxin

(4) Rapid synthesis of auxin

Q.119 How is distribution of auxin affected by light?

(1) Less toward dark, more towards light

(2) Less toward light, more towards dark

(3) More toward light, zero towards dark

(4) None of the above

Q.120 Which type of geotropic effect is exhibited by secondary roots ?

(1) Orthogeotropism (2) Plageotropism

(3) Dia geotropism (4) All the above

Q.121 Which type of geotropism is shown by ginger (rhizome) –

(1) Diageotropism (2) Ortho-geotropism

(3) Plageotropism (4) All the above

Q.122 Which of the following structures have negative geotropism ?

(1) Coralloid roots of Cycas

(2) Pneumatophores

(3) Most stems

(4) All the above

Q.123 The coiling of tendril around the support is a type of –
(1) Thigmonastic movement
(2) Thigmotropism
(3) Geotropism (4) Phototropism

Q.124 The reason for automatic movement of variation is –
(1) Osmosis (2) Turgor
(3) Imbibition (4) All the above

Q.125 Automatic movement of variation can be seen in–
(1) Mimosa pudica (2) Desmodium gyrans
(3) Both of above (4) Acacia arabica

Q.126 Turning of sunflower head towards sun is –
(1) Photonastic movement
(2) Phototatic movement
(3) Phototropic movement
(4) None of the above

Q.127 What is it called, when there is no effect of the direction of the stimulus on movements ?
(1) Tactic movement (2) Tropic movement
(3) Nastic movement (4) None of the above

Q.128 Which type of movement is found in leaves of members of Leguminosae ?
(1) Thermonastic (2) Photonastic
(3) Nyctynastic (4) All the above

Q.129 Which movements occur to capture insects in insectivorous plants ?
(1) Thigmotropic (2) Chemotropic
(3) Chemonastic (4) Seismonastic

Q.130 Chemonasty is found in –
(1) Drosera (2) Dionea
(3) Nepenthes (4) All the above

Q.131 Which is called the compass plant ?
(1) Lactuca sativa (2) Lactuca scariola
(3) Sunflower (4) All the above

Q.132 Sleep movements (nyctinasty) of legume plants is–
(1) Turgor movement
(2) Growth movement
(3) Hygroscopic movement
(4) Movement of locomotion

ANSWER KEY

EXERCISE - 1

Q.1	1	Q.2	3	Q.3	2	Q.4	1	Q.5	2	Q.6	4	Q.7	1
Q.8	1	Q.9	2	Q.10	1	Q.11	3	Q.12	3	Q.13	1	Q.14	2
Q.15	3	Q.16	3	Q.17	4	Q.18	3	Q.19	2	Q.20	1	Q.21	4
Q.22	2	Q.23	1	Q.24	2	Q.25	1	Q.26	2	Q.27	4	Q.28	4
Q.29	2	Q.30	4	Q.31	4	Q.32	3	Q.33	4	Q.34	1	Q.35	3
Q.36	1	Q.37	2	Q.38	3	Q.39	1	Q.40	4	Q.41	2	Q.42	4
Q.43	1	Q.44	1	Q.45	1	Q.46	4	Q.47	3	Q.48	2	Q.49	4
Q.50	3	Q.51	1	Q.52	3	Q.53	2	Q.54	2	Q.55	2	Q.56	3
Q.57	1	Q.58	1	Q.59	2	Q.60	3	Q.61	4	Q.62	3	Q.63	3
Q.64	2	Q.65	1	Q.66	4	Q.67	2	Q.68	4	Q.69	3	Q.70	3
Q.71	1	Q.72	2	Q.73	2	Q.74	1	Q.75	2	Q.76	2	Q.77	2
Q.78	4	Q.79	1	Q.80	1	Q.81	2	Q.82	1	Q.83	4	Q.84	4
Q.85	3	Q.86	2	Q.87	3	Q.88	2	Q.89	3	Q.90	4	Q.91	4
Q.92	1	Q.93	4	Q.94	1	Q.95	1	Q.96	1	Q.97	2	Q.98	1
Q.99	3	Q.100	3	Q.101	4	Q.102	3	Q.103	3	Q.104	4	Q.105	3
Q.106	2	Q.107	1	Q.108	4	Q.109	2	Q.110	1	Q.111	4	Q.112	3
Q.113	4	Q.114	4	Q.115	2	Q.116	1	Q.117	2	Q.118	3	Q.119	2
Q.120	2	Q.121	1	Q.122	4	Q.123	2	Q.124	2	Q.125	2	Q.126	3
Q.127	3	Q.128	4	Q.129	3	Q.130	4	Q.131	2	Q.132	1		

EXERCISE - 2

Q.1 Avena coleoptile test to find out the quantity of growth promoting hormones was discovered by –
(1) F,W, Went (2) L.J. Oudus
(3) K.V. Thimann (4) F. Skoog

Q.2 Primary precursor of I.A.A. is–
(1) Phenyl alanine (2) Tyrosine
(3) Tryptophan (4) Leucine

Q.3 The biological activity of I.A.A. is tested by–
(1) α - amylase test
(2) Avena curvature test
(3) Soybean callus test
(4) Xanthium leaf disc test

Q.4 Indole, 3 acetic acid, called as auxin was first isolated from–
(1) Human urine (2) Corn germ oil
(3) Fusarium (4) Rhizopus

Q.5 Which of the following effects of auxins is of wide application?
(1) Induction of fruit development
(2) Induction of root initiation
(3) Prevention of abscission
(4) All of the above

Q.6 Stem elongation is affected by–
(1) Gibberellin and florigen
(2) Auxin and gibberellin
(3) Florigen and kinin
(4) Kinin and auxin

Q.7 Apical dominance means–
(1) Suppression of growth of apical bud by axillary buds
(2) Suppression of growth of axillary buds by the presence of apical bud
(3) Stimulation of growth of axillary buds by removal of apical bud
(4) Inhibition of growth of axillary buds by removal of apical bud

Q.8 Auxin inhibits the growth of–
(1) Apical bud
(2) Lateral axillary buds
(3) Roots on stem cutting
(4) Parthenocarpic development of fruits

Q.9 Induction of rooting in stem cutting by auxin treatment would be beneficial in which of the following–
(1) Marchantia (2) Wheat
(3) Cuscuta (4) Bougainvillea

Q.10 Which of the following is not natural occuring plant hormone?
(1) 2, 4-D (2) GA_2
(3) Gibberellin (4) I.A.A

Q.11 Seedless fruits can be obtained by treating the unpollinated ovaries with–
(1) Colchicine (2) Sucrose solution
(3) Hormones (4) Pure lanolin

Q.12 Leaf fall occurs when the content of–
(1) Auxin increase
(2) Auxin decreases
(3) Abscisic acid decreases
(4) Gibberellic acid decreases

Q.13 Substance which originate at the tip of stem to control growth–
(1) Vitamins (2) Enzymes
(3) Food materials (4) Auxins

Q.14 Which of the growth substance acts as a stimulant during nodule formation in leguminous plant–
(1) Ethylene (2) ABA
(3) IAA (4) Morphactin

Q.15 Auxanometer is meant for measuring–
(1) Respiratory activity
(2) Photosynthetic activity
(3) Growth activity
(4) Osmotic pressure

Q.16 Apical dominance in higher plants is due to–
(1) Phytohormones (2) Enzymes
(3) Carbohydrates (4) Photoperiodism

Q.17 Parthenocarpy is the production of–
(1) Fruits with pollination
(2) Fruits with out fertilization
(3) Seeds with fertilization
(4) Only seeds and no fruits

Q.18 Auxin is mainly produced by–
(1) Apical root meristem
(2) Root cambium
(3) Apical shoot meristem
(4) Phloem in shoot tip

Q.19 Indole acetic acid generally inhibits the growth of –
(1) Roots (2) Leaves
(3) Shoots (4) Plants in general

Q.20 Fruit drop is caused by–
(1) From the shoot tip in the downward direction
(2) From the root tip in the upward direction
(3) Through vascular systems in plants
(4) By a special transport system in the root

Q.21 Fruit drop is caused by–
(1) Less auxin in fruit than in stem
(2) More auxin in fruit than in stem
(3) Equal distribution of auxin in stem and fruit
(4) Absence of auxin in stem and fruit

Q.22 In plants growth is–
(1) Restricted to certain regions or structure
(2) Irreversible
(3) Change in size
(4) All the above

Q.23 Which one of the following is motivation force for growth–
(1) Turgor pressure
(2) Root pressure
(3) Atmospheric pressure
(4) Osmotic pressure

Q.24 Growth is primarily affected by two climatic factors which are?
(1) Light and temperature
(2) Temperature and relative humidity
(3) Light and wind
(4) Rainfall and temperature

Q.25 Which of the following instrument can be used to record plant growth by seconds?
(1) Arc auxanomemter
(2) Arc indicator
(3) Space marker disc
(4) Crescorgraph

Q.26 In a growing plant, the first phase during the process of growth is–
(1) Cell division
(2) Cell enlargement
(3) Cell differentiation
(4) Cell maturation

Q.27 The classical experiments on growth were performed by–
(1) Lamarck & Boysen Jensen
(2) Boysen Jensen & Darwin
(3) Darwin and Lamarch
(4) Darwin and Paal

Q.28 The natural plant hormones were first isolated from–
(1) Cotton fruits, spinach leaves and rice plant
(2) Avena coleoptiles, spinash leaves and fungus Gibberella
(3) Human urine and corn germ oil
(4) Human urine and rice plant

Q.29 Which one of the following nutrients is concerned with the growth of the plants in view or their role in synthesis of auxin–
(1) S (2) Mn
(3) Zn (4) K

Q.30 Plants bend toward the light because–
(1) They need light for photosynthesis
(2) They need light for respiration
(3) Light attracts them
(4) Cells on the shaded side elongate more

Q.31 Auxins are abundantly produced in–
(1) Root
(2) Meristematic region of root
(3) Shoot
(4) Meristematic region of shoot

Q.32 Clinostat is used in study for–
(1) Photosynthesis (2) Respiration
(3) Geotropism (4) Osmosis

Q.33 Which of the following exerts profound effect on the reproductive growth of a flowering plant–
(1) Quality of light
(2) Quantity of light
(3) Direction of light
(4) Duration of light cycles

Q.34 What is the cause of excurrent habit in pinus–
(1) Presence of gibberellin
(2) Presence of apical dominance
(3) High concentration of cytokinin
(4) High concentration of ABA

Q.35 Which of the following hormone is concerned chiefly with root initiation?
(1) IBA (2) GA_3
(3) ABA (4) Kinetin

Q.36 If the tip of a seeding is cut off growth as well as bending ceases because it hampers–
(1) Respiration
(2) Photosynthesis
(3) Perception of light stimulus
(4) Transpiration

Q.37 What causes a green plant to bend towards light as it grows ?
(1) Because green plants need light to carry on photosynthesis
(2) Because green plants are phototropic
(3) Light stimulates plant cells on the lighted side to grow faster
(4) Auxin accumulates on the shaded side

Q.38 An apparatus used to demonstrate phototropism is–
(1) Luxmeter (2) Solarometer
(3) Clinostate
(4) Heliotrophic chamber

Q.39 phytohormone term was coined by–
(1) Gregory and Purvis
(2) F.W. Went
(3) Thieman
(4) L.J. Audus

Q.40 Growth hormone acts–
(1) Always as growth promotors
(2) Always are growth inhibitors
(3) Some as promotors and some as inhibitors
(4) Rarely as growth inducers

Q.41 The movement of auxin is largely–
(1) Acropetal (2) Basipetal
(3) Lateral (4) Centripetal

Q.42 The formula of Auxin-A is–
(1) $C_{18}\ H_{30}\ O_7$ (2) $C_{18}\ H_{22}\ O_5$
(3) $C_{12}\ H_{30}\ O_6$ (4) $C_{20}\ H_{30}\ N_5$

Q.43 Which growth hormone is responsible for apical dominance–
(1) Auxin (2) Cytokinin
(3) Gibberellin (4) Ethylene

Q.44 2, 4-D is a synthetic–
(1) Auxin (2) Gibberellin
(3) Cytokinin (4) Florigen

Q.45 Which of the following induces femaleness in plants?
(1) Auxin & ethylene
(2) Ethanol
(3) ABA (4) Gibberellin

Q.46 Which of the following prevents the fall of fruits?
(1) GA_3 (2) NAA
(3) Ethylene (4) Zeatin

Q.47 Which of the following is weed killer?
(1) 2, 4-D (2) NAA
(3) GA (4) ABA

Q.48 Which one is prevents over-ripening of banana and browning of cut fruits?
(1) Gibberellic Acid
(2) Indole-3 Acetic Acid
(3) Ascorbic Acid (4) Abscisic Acid

Q.49 Which weedicide can defoliate the complete forest?
(1) 2, 4-D (2) MH
(3) AMO - 1618 (4) ABA

Q.50 Agent orange is–
(1) Biodegradable insecticide
(2) Dioxin weedicide
(3) Biofertilizer (4) Biopesticide

Q.51 Phytotron is a device by which?
(1) Induce mutation breeding in wheat
(2) Electron bombarding system
(3) Plants are grown in controlled environment
(4) Heavy water plants

Q.52 Lateral axillary buds are not allowed to grow by–
(1) Auxin (2) Ethylene
(3) Gibberellin (4) Cytokinin

Q.53 Richmond– Lang effect is due to
(1) Cytokinin (2) Auxin
(3) ABA (4) All the above

Q.54 A hypothetical chemical believed to be involved in flowering is–
(1) Gibberellin (2) NAA
(3) Florigen (4) IAA

Q.55 DCMU is a herbicide which kills the plant by–
(1) Inhibiting photolysis of water as it is a strong inhibitor of pigment system II
(2) Inhibiting CO_2 function as it is a strong inhibitor of pigment system II
(3) Checking respiration
(4) Destroying Chloroplast

Q.56 Supra optima (more than 10 PPM) concentration of Auxins–
(1) Promotes flowering
(2) Kill the plant
(3) Prevents shortening of the internodes
(4) Promotes growth in both stem and roots apex

Q.57 Growth curve is–
(1) S-shaped (2) Sigmoid
(3) L-Shaped (4) Both 1 & 2

Q.58 Which of the following auxins are widely used as herbicides–
(1) 2, 4-D and 2, 4, 5-T
(2) 2, 4-D and cytokinin
(3) 2, 4-D and 2, 4-T
(4) 2, 4, 5-T and GA

Q.59 The compounds that inhibit the action of auxin are known as–
(1) Antiauxins (2) Auxins promotors
(3) Auxin precursors (4) Both 1 & 2

Q.60 Premature fall of fruit can be stopped by–
(1) Auxin (2) GA_3
(3) ABA (4) None of these

Q.61 Photoperiodic stimulus is picked up by–
(1) Phytochrome (2) Phytohormone
(3) Enzyme (4) Vernalin

Q.62 Parthenocarpy can be achieved by–
(1) Zeatin (2) ABA
(3) Auxins (4) Kinetin

Q.63 IAA was isolated by–
(1) Kogl and Erxleben
(2) Kogl and Haagen Smit
(3) Erxleben and Haagen Smit
(4) Kogl, Darwin and Haagen Smit

Q.64 Maximum of growth occurs in–
(1) Exponential phase
(2) Decline phase
(3) Stationary phase (4) Lag phase

Q.65 Cholodnyl-Went theory is related with–
(1) Turgor movement
(2) Chemotropism
(3) Phot-tropism
(4) Phototropism & Geotropism

Q.66 Which of the following plant hormone substitutes for long photoperiod in flowering plant–
(1) Auxin (2) Gibberellin
(3) Cytokinin (4) Ethylene

Q.67 Gibberellin stimulates flowering in–
(1) The plants growing in japanese farms
(2) The short day plants
(3) The long day plants
(4) Day neutral plants

Q.68 Internodal elongation is stimulated by–
(1) Auxin (2) Cytokinin
(3) Gibberellin (4) Phenol

Q.69 Cytokinin–
(1) Is a hormone whose main function is to induce the cell division
(2) Is the process of cell division
(3) Refers to cell division
(4) Causes dormancy

Q.70 The excised leaf does not turn yellow if it is induced to root. The is attributed to synthesis in the root of–
(1) Ethylene (2) Cytokinins
(3) Gibberellins (4) Auxins

Q.71 Hormone involved in photoperiodism is–
(1) IAA (2) Gibberellin
(3) Kinetin (4) 2, 4-D

Q.72 Gibberellin was first extracted from–
(1) Fusarium moniforme = Gibberella fujikuroi
(2) Gellidium
(3) Gracillaria
(4) Aspergillus

Q.73 Bolting hormone is–
(1) Auxin (2) Gibberellin
(3) ABA (4) Ethylene

Q.74 The plant hormone, which synthesized in root and translocated to aerial parts is–
(1) Auxin (2) Cytokinin
(3) Traumatin (4) Morphactins

Q.75 The elongation of genetically dwarf plants is brought about by application of–
(1) Cytokinins (2) Gibberellins
(3) X-Rays (4) Vitamin-C

Q.76 Gibberellin was isolated from–
(1) An alga (2) A fungus
(3) A bacterium (4) A virus

Q.77 Gibberellins could be extracted from–
(1) Rice
(2) Fungus/Fusarium moniliformis
(3) More healthy plants
(4) Diseased plants

Q.78 Gibberellins are–
(1) Growth inhibitors
(2) Growth promotor
(3) Not concerned with growth at all
(4) Of little potential in agriculture

Q.79 Gibberellins do not cause–
(1) Shortening of genetically tall plants
(2) Stimulation of seed germination
(3) Promotion of parthenocarpy
(4) Induction of α-amylase synthesis in barley

Q.80 Gibberellic acid has been successfully employed to induce flowering in–
(1) Short day plants under long day condition
(2) In long day plants under short day condition
(3) For some plants
(4) None of the above

Q.81 The growth regulator that retards ageins of plant organ is-
(1) Auxin (2) Gibberellin
(3) Cytokinin (4) Abscisic acid

Q.82 Which of the following hormones can replace vernalization ?
(1) Cytokinins (2) Auxins
(3) Ethylene (4) Gibberellin

Q.83 Which of the following breaks the dormancy of seeds ?
(1) IAA (2) GA_3
(3) Ethylene (4) All the above

Q.84 First natural cytokinin was discovered by-
(1) Miller (2) Letham
(3) Calvin (4) Govindii

Q.85 The first cytokinin was discovered by-
(1) Skoog (2) Went
(3) Addicot (4) Miller

Q.86 Richmond lang effect is-
(1) The effect of kinetins in delaying senescence
(2) The effect of auxin on root and shoot formation
(3) The effect of traumatic acid in wound formation
(4) None of these

Q.87 Which of the following is a coconut milk factor ?
(1) Auxin (2) ABA
(3) Morphactin (4) Cytokinin

Q.88 Which of the following induces morphogenesis in tissue culture ?
(1) Gibberellin (2) Cytokinin
(3) IAA (4) Ethylene

Q.89 The habit of Cabbage plant can be changed drastically by the application of -
(1) Auxin (2) Gibberellin
(3) Cytokinin (4) ABA

Q.90 In germinating seeds Amylase, Proteases, Lipases are stimulated by)-
(1) Auxin (2) Gibberellin
(3) Cytokinin (4) Ethylene

Q.91 Which of the following hormones is known to promote maleness in flowering plants ?
(1) Gibberellic acid (2) Kinetin
(3) IAA (4) 2, 4-D

Q.92 Richmond lang effect due to cytokinins pertains to
(1) Root formation
(2) Apical dominance
(3) Delay of senescence
(4) Leaf formation

Q.93 The gibberellin which is of wide distribution in higher plants are-
(1) GA_{29} (2) GA_{32}
(3) GA_1 (4) GA_{22}

Q.94 The most common cytokinin is-
(1) IAA
(2) Kinetin
(3) Isopentanyl adenine
(4) Dehydrozeatin

Q.95 Which one of the following is a gaseous plant hormone ?
(1) Auxin (2) Gibberellin
(3) Ethylene (4) Cytokinin

Q.96 Pomalin is sprayed over apple to increase fruit size, it is-
(1) Auxin
(2) Mixture of auxin and gibberellin
(3) Mixture of auxin and cytokinin
(4) Mixture of cytokinin and gibberellin

Q.97 Apical dominance can be overcome by application of-
(1) Auxin (2) Gibberellin
(3) Cytokinin (4) Florigen

Q.98 In plants natural cytokinin was discovered by-
(1) Skoog & Miller (2) Letham
(3) Benson & Calvin (4) Thimann & went

Q.99 The activity of α-amylase in the endospore of barley germinating seed is induced by-
(1) Ethylene (2) Cytokinin
(3) IAA (4) Gibberellin

Q.100 Dormancy of seed is broken by-
(1) Auxin (2) Gibberellins
(3) Ethylene (4) Cytokinin

ANSWER KEY

EXERCISE - 2

Q.1	1	Q.2	3	Q.3	2	Q.4	1	Q.5	4	Q.6	2	Q.7	2
Q.8	2	Q.9	4	Q.10	1	Q.11	3	Q.12	2	Q.13	4	Q.14	3
Q.15	3	Q.16	1	Q.17	2	Q.18	3	Q.19	1	Q.20	1	Q.21	1
Q.22	4	Q.23	1	Q.24	1	Q.25	4	Q.26	1	Q.27	2	Q.28	3
Q.29	3	Q.30	4	Q.31	4	Q.32	3	Q.33	4	Q.34	2	Q.35	1
Q.36	3	Q.37	4	Q.38	4	Q.39	3	Q.40	3	Q.41	2	Q.42	2
Q.43	1	Q.44	1	Q.45	1	Q.46	2	Q.47	1	Q.48	3	Q.49	1
Q.50	2	Q.51	3	Q.52	1	Q.53	1	Q.54	3	Q.55	1	Q.56	2
Q.57	4	Q.58	1	Q.59	1	Q.60	1	Q.61	1	Q.62	3	Q.63	2
Q.64	1	Q.65	4	Q.66	2	Q.67	3	Q.68	3	Q.69	1	Q.70	2
Q.71	2	Q.72	1	Q.73	2	Q.74	2	Q.75	2	Q.76	2	Q.77	2
Q.78	2	Q.79	1	Q.80	2	Q.81	3	Q.82	4	Q.83	2	Q.84	2
Q.85	4	Q.86	1	Q.87	4	Q.88	2	Q.89	2	Q.90	2	Q.91	1
Q.92	3	Q.93	3	Q.94	3	Q.95	3	Q.96	4	Q.97	3	Q.98	2
Q.99	4	Q.100	2										

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Plant hormones are : -
[Uttaranchal PMT 2004]
(1) Growth regulators
(2) Growth promoters
(3) Growth inhibitors
(4) None of above

Q.2 The most common auxin is : -
[Uttaranchal PMT 2004]
(1) GA (2) ABA
(3) Kinetin (4) IAA

Q.3 Gibberellin promotes cell division and elongation in : - **[Uttaranchal PMT 2004]**
(1) Leaves (2) Roots
(3) Shoots (4) All of these

Q.4 The deteriorative processes in plants, that naturally terminate their functional life, are collectively called : -
[Uttaranchal PMT 2004]
(1) Wilting (2) Abscission
(3) Plasmolysis (4) Senescence

Q.5 Which of the following is used for ripening of fruits **[Uttaranchal PMT 2004]**
(1) Auxin (2) ABA
(3) Ethylene gas (4) Cytokinin

Q.6 Induction of flowering in plants by low temperature treatment is called :
[Uttaranchal PMT 2005]
(1) Vernalization (2) Photoperiodism
(3) Cryobiology (4) Chilozology

Q.7 Plant growth is : **[Uttaranchal PMT 2004]**
(1) Limited (2) Unlimited
(3) Diffused (4) Both (1) & (2)

Q.8 Hormone produced during leaf fall is :
[Uttaranchal PMT 2005]
(1) IAA (2) ABA
(3) Florigen (4) Kinetin

Q.9 Climacteric fruit shows :
[Uttaranchal PMT 2004]
(1) High respiration rate at ripening
(2) Sudden change in taste
(3) Sudden change in colour and shape
(4) None of the above

Q.10 Phytochrome is present in : **[MP PMT 2007]**
(1) Vascular cryptogams
(2) Prokaryotes
(3) Brain cell
(4) Kidney cell

Q.11 Genetically dwarf plant can be converted into a plant of normal height with the application of:
[Uttaranchal PMT 2006]
(1) Auxin (2) Gibberellin
(3) Cytokinins (4) Auxin

Q.12 A phytohormone involved in the de novo synthesis of α-amylase in germinating seeds is:
[Uttaranchal PMT 2006]
(1) Auxin (2) Gibberellin
(3) Ethylene (4) Cytokinin

Q.13 Phytochrome is responsible for :
[West Bengal JEE 2007]
(1) Photosynthesis (2) Flowering
(3) Fruit formation (4) Respiration

Q.14 Which of the following is a gaseous hormone:
[West Bengal JEE 2007]
(1) Ethylene
(2) Cytokinin
(3) Both ethylene and auxin
(4) Gibberellin

Q.15 The pineapple which under natural conditions is diffcult to blossom has been made to produce fruits throughout the year by the application of:
[West Bengal JEE 2007]
(1) IAA, IBA
(2) NAA, 2,4-D
(3) Phenyl murcuric acid
(4) Cytokinins

Q.16 Most of the plants are seasonal due to :
[C.G. PMT 2004]
(1) Photoperiodism (2) Phototropism
(3) Photosynthesis (4) Photolysis

Q.17 Certain chemical susbtances having profound effect on plant growth are called :
[C.G. PMT 2004]
(1) Catalyic agents (2) Phytohormones
(3) Enzymes (4) Compost

Q.18 Phytochrome was discovered by : **[C.G. PMT 2005,06]**

(1) W. Went
(2) Garner and Allard
(3) F.F. Blackman
(4) Borthwick and Handricks

Q.19 The activity of α-amylase in the endosperm of barley germinating seed in induced by : **[C.G. PMT 2005]**

(1) Ethylene (2) Cytokinin
(3) IAA (4) Gibberellin

Q.20 A pigment concerned with floral induction is **[C.G. PMT 2005]**

(1) Florigen (2) Chlorophyll
(3) Plastocyanin (4) Phytochrome

Q.21 Gibberellins were first discovered in fungal genus **[C.G. PMT 2006]**

(1) Mucor (2) Rhizopus
(3) Agaricus (4) Fusarium

Q.22 The presence of auxins in a solution could be tested **[C.G. PMT 2006]**

(1) Avena sativa stem tip test
(2) Carbon tetrachloride test
(3) Iodine test (4) Defoliation test

Q.23 Auxanometer is used to measure : **[Jharkhand 2005]**

(1) Length (2) Width
(3) Depth (4) Growth

Q.24 The pigment sensitive for red and far red light is **[Jharkhand 2005]**

(1) Chlorophyll (2) Phytochrome
(3) Cytochrome (4) Carotene

Q.25 Hormone which breaks seed dormancy is : **[Jharkhand 2005]**

(1) Auxin (2) Gibberellin
(3) Ethylene (4) Cytokinin

Q.26 Which one of the following is not a synthetic auxin **[Jharkhand 2002]**

(1) 2, 4-D (2) 2-4-5-T
(3) NAA (4) IAA

Q.27 Which plant hormone causes fruit ripening : **[Bihar 2004]**

(1) IAA (2) Cytokinin
(3) Ethylene (4) GA

Q.28 Which hormone is responsible for apical growth **[Bihar 2004]**

(1) IAA (2) ABA
(3) GA (4) All of these

Q.29 Abscisic acid controls : **[Bihar 2002]**

(1) Cell elongation and cell wall formation
(2) Shoot elongation
(3) Leaf fall and dormancy
(4) Cell division

Q.30 Which hormone is used to induce ripening in banana **[Bihar 2002]**

(1) Cytokinin (2) Ethylene
(3) ABA (4) GA_3

Q.31 Which among the following is a synthesis plant hormone : **[Bihar 2001]**

(1) IAA (2) GA
(3) 2, 4-D (4) ABA

Q.32 Richmond-Lang effect is shown by : **[UP CPMT 2001]**

(1) Auxins (2) Sugars
(3) Zeatin (4) Gibberellins

Q.33 Ethylene gas is used for : **[UP CPMT 2001]**

(1) Growth of plants
(2) Delaying fruit's abscission
(3) Ripening of fruits
(4) Stopping the leaf abscission

Q.34 Auxanometer is used to detect : **[UP CPMT 2002]**

(1) Respiration (2) Transpiration
(3) Plant movement (4) Growth

Q.35 Which of the following plant hormone is extracted from fungus : **[UP CPMT 2003]**

(1) Ethylene (2) Gibberellin
(3) Cytokinin (4) 2, 4 D

Q.36 Highest concentration of auxin is found in : **[UP CPMT 2003]**

(1) Root and Shoot tips
(2) Leaves and Fruits
(3) Mid stem portion (4) None of these

Q.37 Ethylene is used for : **[UP CPMT 2001]**

(1) Decreases the senescence
(2) Increases the hights of stem
(3) Ripening of fruits
(4) Prevention of leaf fall

Q.38 The movement of pollen tube is called : **[UP CPMT 2003]**

(1) Chemotropism (2) Thermotaxis

(3) Thermonastic (4) Hydrotropism

Q.39 Phytotron is : **[UP CPMT 2003]**

(1) A controlled condition chamber for plants

(2) Leaf culture process

(3) Special culture of seeds

(4) Root culture process

Q.40 Phytochrome occurs in two forms. It's stable form is : **[UP CPMT 2004]**

(1) P_{fr} forms (2) P_r forms

(3) Both forms (4) None of these

Q.41 Which pigment is resposible for flowering in plant **[UP CPMT 2006]**

(1) Phytochrome (2) Cytochrome

(3) Anthocyanin (4) xanthophyll

Q.42 Process of vernalization can be induced by : **[UP CPMT 2007]**

(1) Cytokinin (2) Auxin

(3) Phototropin (4) GA

Q.43 Which of the following plant is LDP **[MP PMT 2007]**

(1) Xanthium (2) Soyabean

(3) Wheat (4) Tobacco

Q.44 Phototropism is due to the hormone **[MP PMT 2007]**

(1) IAA (2) GA

(3) 2-4 D (4) Cytokinin

Q.45 Photoperiodism affects : **[MP PMT 2001]**

(1) Vegetative growth

(2) Internode elongation

(3) Seed germination

(4) Reproductive growth

Q.46 Apical dominance is not affected by : **[MP PMT 2001]**

(1) Indoleacetic acid (2) Gibberellins

(3) Indoleacetaldehyde

(4) Indolebutyric acid

Q.47 The activity of α-amylase in the endosperm of barley germinating seed is induced by : **[MP PMT 2002]**

(1) Ethylene (2) Cytokinin

(3) I.A.A. (4) Gibberellin

Q.48 A pigment concerned with both floral induction and seed germination is : **[MP PMT 2007]**

(1) Florigen (2) Chlorophyll

(3) Plastocyanin (4) Phytochrome

Q.49 Which of the following may be the substitute of photoperiodism : **[MP PMT 2005]**

(1) Humidity (2) Temperature

(3) Mineral nutrients (4) Soil moisture

Q.50 Phytohormone commonly called stress hormone is **[MP PMT 2006]**

(1) Auxin (2) Abscissic acid

(3) Gibberellin (4) Cytokinins

Q.51 Fruit ripening can be hastened by treatment with **[MP PMT 2006]**

(1) IAA (2) Florigen

(3) Ethylene (4) Cytokinin

Q.52 Opening of floral bud is an example of **[UP CPMT 2002]**

(1) Induced movement

(2) Hyponastic movement

(3) Epinastic movement

(4) Cleistogamous movement

Q.53 Prunning of plants promotes branching, because the axillary buds get sensitized to- **[AIIMS - 2004]**

(1) Ethylene (2) Gibberellin

(3) Cytokinin (4) IAA

Q.54 Cell elogation in internodal regions of the green plants takes place due to- **[AIPMT - 2004]**

(1) Ethylene (2) Indole acetic acid

(3) Cytokinin (4) Gibberellins

Q.55 One set of a plant was grown at 12 hrs. day and 12 hours night period cycles and it flowered. While in the other set night phase was interrupted by flash of light and it did not flower. Under which one of the following catagories will you place this plant **[AIPMT - 2004]**

(1) Short day (2) Long day

(3) Darkness neutral (4) Day neutral

Q.56 The maximum growth rate occurs in- **[AIPMT - 2004]**

(1) Exponential phase (2) Stationary phase

(3) Senescent phase (4) Lag phase

Q.57 The ability of the Venus Flytrap to capture insects is due to- **[AIPMT - 2005]**
(1) Chemical stimulation by the prey
(2) A passive process requiring no special ability on the part of the plant
(3) specialized "muscle-like" cells
(4) rapid turgor pressure changes

Q.58 Why is vivipary an undesirable character for annual crop plants ? **[AIPMT-2005]**
(1) It reduces vigour of the plant
(2) The seeds cannot be stored under normal conditions for the next season.
(3) The seeds cannot exhibit long dormancy
(4) It adversely affects the fertility of the plant.

Q.59 Gibberellins can promote seed germination because of their influence on:**[AIPMT-2005]**
(1) Rate of cell division
(2) Production of hydrolyzing enzymes
(3) Synthesis of abscisic acid
(4) Absorption of water through hard seed coat.

Q.60 I.A.A. mainly inhibits growth of- **[RPMT-2005]**
(1) Root (2) Leaf
(3) Shoot
(4) Generally whole plant

Q.61 Movement due to external stimuli is known of- **[RPMT-2005]**
(1) Autonomic movement
(2) Paratonic movement
(3) Ameboid movement
(4) Excretory movement

Q.62 How does pruning help in making the hedge dense **[AIPMT-2006]**
(1) The apical shoot grows faster after pruning
(2) It releases wound hormones
(3) It induces the differentiation of new shoots from the rootstock
(4) It frees axillary buds from apical dominance

Q.63 Parthenocarpic tomato fruits can be produced by? **[AIPMT-2006]**
(1) raising the plants from vernalized seeds
(2) treating the plants with phenylmercuric acetate
(3) removing androecium of flowers before pollen grains are released
(4) treating the plants with low concentrations of gibberellic acid and auxins

Q.64 An enzyme that can stimulate germinationof barley seeds is- **[AIPMT-2006]**
(1) Prptease (2) Invertase
(3) α-amylase (4) Lipase

Q.65 Opening of floral buds into flowers, is a type of : **[AIPMT-2007]**
(1) Autonomic movement of growth
(2) Autonomic movement of locomotion
(3) Autonomic movement of variation
(4) Paratonic movement of growth

Q. 66 Which one of the following pairs, is not correctly matched ? **[AIPMT-2007]**
(1) IAA - Cell wall elongation
(2) Abscisic acid - Stomatal closure
(3) Gibberellic acid - Leaf fall
(4) Cytokinin - Cell division

Q.67 The wavelength of light absorbed Pr form of phytochrome is- **[AIPMT-2007]**
(1) 620 nm (2) 640 nm
(3) 680 nm (4) 720 nm

Q.68 "Foolish seeding" disease of rice led to the discovery of - **[AIPMT-2007]**
(1) IAA (2) GA
(3) ABA (4) 2, 4-D

Q.69 Senescence as an active developmental cellular process in the growth and functioning of a flowering plant, is indicated in- **[AIPMT-2008]**
(1) Annual plants (2) Floral parts
(3) Vessels and tracheid differentiation
(4) Leaf abscission

Q.70 Importance of day length in flowering of plants was first shown in- **[AIPMT-2008]**
(1) Cotton (2) Petunia
(3) Lemna (4) Tobacco

Q.71 One of the synthetic auxin is : - **[AIPMT-2009]**
(1) IBA (2) NAA
(3) IAA (4) GA

Q.72 Which one of the following acids is a derivative of carotenoids ? **[AIPMT-2009]**
(1) Abscisic acid (2) Indole butyric acid
(3) Indole-3-acetic acid
(4) Gibberellic acid

Q.73 Phototropic curvature is the result of uneven distribution of- **[AIPMT-2010 (Pre)]**

(1) Cytokinins (2) Auxin

(3) Gibberellin (4) Phytochrome

Q.74 Photoperiodism was first characterised in- **[AIPMT-2010 (Pre)]**

(1) Tomato (2) Cotton

(3) Tobacco (4) Potato

Q.75 Coiling of garden pea tendrils around any support is an example of- **[AIPMT-2010 (Pre)]**

(1) Thigmotropism (2) Thermotaxis

(3) Thigmotaxis (4) Thigmonasty

Q.76 One of the commonly used plant growth hormone in tea plantations is- **[AIPMT-2010 (Mains)]**

(1) Absicisic acid

(2) Zeatin

(3) Indole-3-acetic acid

(4) Ethylene

Q.77 Root development is promoted by : **[AIPMT-2010 (Mains)]**

(1) Auxin (2) Gibberellin

(3) Ethylene (4) Absicisic acid

Q.78 Through their effect on plant growth regulators, what do the temperature and light control in the plants ? **[AIPMT Mains 2012]**

(1) Apical dominance

(2) Flowering

(3) Closure of stomata

(4) Fruit elongation

Q.79 Which one of the following generally acts as an antagonist to gibberellins ? **[AIPMT Mains 2012]**

(1) Zeatin (2) Ethylene

(3) ABA (4) IAA

Q.80 Vernalisation stimulates flowering in : **[AIPMT Mains 2012]**

(1) Zamikand (2) Turmeric

(3) Carrot (4) Ginger

ANSWER KEY

EXERCISE - 3

Q.1	1	Q.2	4	Q.3	4	Q.4	4	Q.5	3	Q.6	1	Q.7	4
Q.8	2	Q.9	1	Q.10	1	Q.11	2	Q.12	2	Q.13	2	Q.14	1
Q.15	1	Q.16	1	Q.17	2	Q.18	4	Q.19	4	Q.20	4	Q.21	4
Q.22	1	Q.23	4	Q.24	2	Q.25	2	Q.26	4	Q.27	3	Q.28	1
Q.29	3	Q.30	2	Q.31	3	Q.32	3	Q.33	3	Q.34	4	Q.35	2
Q.36	1	Q.37	3	Q.38	1	Q.39	1	Q.40	2	Q.41	1	Q.42	4
Q.43	3	Q.44	1	Q.45	4	Q.46	2	Q.47	4	Q.48	4	Q.49	2
Q.50	2	Q.51	3	Q.52	3	Q.53	3	Q.54	4	Q.55	1	Q.56	1
Q.57	4	Q.58	2	Q.59	2	Q.60	1	Q.61	2	Q.62	4	Q.63	4
Q.64	3	Q.65	1	Q.66	3	Q.67	2	Q.68	2	Q.69	4	Q.70	4
Q.71	2	Q.72	1	Q.73	2	Q.74	3	Q.75	1	Q.76	2	Q.77	1
Q.78	2	Q.79	3	Q.80	3								

EXERCISE - 4

These questions consist of two statements each, printed as "ASSERTION" and "REASON". While answering these Questions you are required to choose any one of the following responses.

(1) If both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.

(2) If both Assertion and Reason are True but Reason is not correct explanation of the Assertion

(3) If Assertion is True but the Reason is False.

(4) If both Assertion and Reason are false.

Q.1 **A :** Ethylene is a gaseous phyto hormone.
R : It promotes ripening of fruits.

Q.2 **A :** Plants usually bend towards the source of light.
R : Shoot apex shows positive phototropism due to unequal distribution ofr auxin.

Q.3 **A :** Lateral branches grow well when apical bud is removed.
R : Effect of Auxin is finished.

Q.4 **A :** Some plants flower only in summer.
R : Such plants are always LDP.

Q.5 **A :** **Xanthium** will not flower if the long dark period is interrupted by red light.
R : **Xanthium** is a long night plant.

Q.6 **A :** GA Induces the germination of seeds in plants.
R : GA activates the enzyme Amylase.

Q.7 **A :** Florigin is called as hypothetical hormone.
R : Florigin is inhibitory to flowering.

Q.8 **A :** Ethylene is a plant hormone, which can transfer from one plant to another plants.
R : Ethylene is a gaseous hormone in plants.

Q.9 **A :** ABA play an important role in plants during water stress.
R : ABA promotes stomatal closing during water stress.

Q.10 **A :** Some plants flower only in summer & some only in winters.
R : Such plants require specific air currents for flowering.

Q.11 **A :** Leaves of **Mimosa** plants droopes after touching.
R : Phytochrome is necessary for flowering in **Mimosa** plant.

Q.12 **A :** α-amylase activity test, used for bioassay of Gibberellins.
R : Gibberellins inhibit the activity of α-amylase in barley endosperm.

Q.13 **A :** Senescence is induced by the application of cytokinins in plants.
R : Cytokinin promotes the degradation of chlorophylls & nucleic acids.

Q.14 **A :** The plant hormones diffuse from site of origin.
R : Plant hormones are growth promoters and growth inhibitors.

Q.15 **A :** **Avena** colepotile curves towards light.
R : Hormone Gibberellin produced in **Avena** coleoptile for light stimulus.

Q.16 **A :** Auxin hormone resposnible for apical dominance.
R : Apical dominance is genetical phenomenon.

Q.17 **A :** Gibberellin hormone is antitranspirant.
R : Gibberellin closes the stomata.

Q.18 **A :** Gibberellin is a bolting hormone.
R : Gibberellin induces parthenocarpy in fruits.

Q.19 **A :** Flowering is inhibited in LDP by interruption of long night by red light.
R : LDP requires P_R for flowering.

Q.20 **A :** Cytokinins called as stress hormone.
R : Cytokinins induce flowering.

Q.21 **A :** Brief exposure of red light in dark phase of **Maryland** & Biloxy soyabean plants inhibits flowering.
R : These are SNP.

Q.22 **A :** Bolting effect in plants is performed by G.A.
R : G.A. induces internode elongation.

Q.23 **A :** Morphactins are growth inhibitors.
R : Morphactins are artificial or synthetic hormones.

Q.24 **A :** LDP does not flower if dark period is interrupted by red light.
R : They can synthesize Pr in red-light.

Q.25 **A :** **Xanthium** (Cocklebur) does not flower if dark phase is interrupted by exposer of red light.
R : **Xanthium** is a LNP.

Q.26 **A :** Florigen is a hypothetical hormone.
R : Florigen synthesised in leaves.

Q.27 **A :** Movement under the effect of gravity is called geotropism.
R : Tendrils of cucurbits exhibit geotropism.

Q.28 **A :** Flowering in tobacco is inhibited if dark phase is interrupted by red light.
R : Tobacco is a short day plant.

Q.29 **A :** Ethylene is unique plant hormone, which can reach from one plant to another plant by air.
R : Ethylene is gaseous hormone.

Q.30 **A :** Gibberellins induce seed germination in plants.
R : GA activates the genes for synthesis of protease & amylase.

Q.31 **A :** Rosette habit of cabbage can be eliminate by gibberellins.
R : Gibberellin induces α-amylase.

Q.32 **A :** ABA used in dry farming or desert farming.
R : ABA reduces transpiration.

Q.33 **A :** Napthalene acetic acid used for elimination of genetic dwarfism in plants.
R : This chemical increase the size of internode.

Q.34 **A :** Plant growth is localised and irregular.
R : Plant growth is reversible.

Q.35 **A :** Coconut milk factor can be used in tissue culture.
R : Coconut milk factor performs activity like cytokinin.

ANSWER KEY

EXERCISE - 4

Q.1	2	Q.2	1	Q.3	1	Q.4	3	Q.5	1	Q.6	1	Q.7	3
Q.8	1	Q.9	1	Q.10	3	Q.11	2	Q.12	3	Q.13	4	Q.14	2
Q.15	3	Q.16	3	Q.17	4	Q.18	2	Q.19	4	Q.20	4	Q.21	3
Q.22	1	Q.23	2	Q.24	4	Q.25	1	Q.26	2	Q.27	3	Q.28	1
Q.29	1	Q.30	1	Q.31	2	Q.32	1	Q.33	4	Q.34	3	Q.35	1

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

AIIMS SPECIAL

Q.1 The shade of a tree is cooler than the shade of a roof due to

(1) Transpiration (2) Guttation
(3) Photosynthesis (4) Green leaves

Q.2 Translocation of organic materials is best explained by

(1) Imbibition theory (2) Active transport
(3) Mass flow hypothesis
(4) Transpiration pull

Q.3 The process of the escape of liquid from the tip of uninjured leaf is called

(1) Guttation (2) Transpiration
(3) Evaporation (4) Evapo-transpiration

Q.4 Rate of transpiration can be measured by

(1) Ganong's potometer (2) Porometer
(3) Auxanometer (4) Respirometer

Q.5 Wooden doors swell up and get stuck during the rainy season. This is due to the phenomenon of

(1) Imbibition (2) Endosmosis
(3) Capillarity (4) Deplasmolysis

Q.6 In plants, water moves from

(1) Less negative to more negative gradi.ent
(2) More negative to less negative gradient
(3) Same gradients
(4) None of these

Q.7 Stomata opens

(1) In day time - for gaseous exchange
(2) In day time - no gaseous exchange
(3) In night time only - for gaseous exchange
(4) In night time only - no gaseous exchange

Q.8 If turgor pressure becomes equal to the wall pressure, then

(1) Water leaves the cell
(2) Water enters the cell
(3) No exchange of water takes place
(4) Solute goes from the cell into water

Q.9 The function of leghaemoglobin during biological nitrogen fixation in root nodules of legumes is to

(1) Convert atmospheric N_2 to NH_3
(2) Convert ammonia to nitrite
(3) Transport oxygen for activity of nitrogenase
(4) Protect nitrogenase from oxygen

Q.10 Photosynthetic pigments in chloroplast are embedded in the membrane of

(1) Thylakoids (2) Matrix
(3) Chloroplast envelope
(4) Photoglobin

Q.11 How many quanta of light are required to evolve one oxygen molecule in photosynthesis?

(1) Three (2) Eight
(3) Four (4) Two

Q.12 Carbon dioxide is necessary for photosynthesis. The chemical used to remove this gas most effectively from entering a control apparatus is

(1) Calcium oxide
(2) Distilled water
(3) Potassium hydroxide solution
(4) Sodium carbonate

Q.13 During photosynthesis, oxygen in glucose comes from

(1) Oxygen in air (2) Water
(3) Carbon dioxide (4) Both (2) & (3)

Q.14 The molar ratio of chlorophyll and xanthophyll is

(1) 4 : 1 (2) 3 : 1
(3) 1 : 1 (4) 2 : 1

Q.15 The C_4-plants differ from C_3-plants with reference to the

(1) Substrate that accepts CO_2 in carbon assimilation
(2) Type of end product
(3) Type of pigment involved in photosynthesis
(4) Number of ATP that are consumed in preparing sugar

Q.16 Which of the following prevents the photo-oxidation and destruction of chlorophylls?

(1) Phycoerythrin (2) Phytochrome
(3) Phytohormone (4) Carotenoids

Q.17 The molecule which mainly absorb light energy and convert it to chemical energy in photosynthesis are

(1) Chlorophyll c (2) Chlorophyll a
(3) Chlorophyll b (4) Xanthophyll

Q.18 Photorespiration, usually occurs in

(1) One-cell organelles
(2) Two cell organelles
(3) Three cell organelles
(4) Four cell organelles

Q.19 Blackmann's law is related to

(1) Respiration (2) Transpiration
(3) Root pressure (4) Photosynthesis

Q.20 Classical experiment to prove essentiality of CO_2 for photosynthesis was given by

(1) Amon (2) Von Moll
(3) Calvin et. al. (4) Hill

Q.21 Photosynthetic bacteria do not contain

(1) Quantasome (2) PS-I and PS-II
(3) PS-II (4) PS-I

Q.22 The photo respiratory carbon-oxidation cycle involves the interaction of

(1) Chloroplast (2) Mitochondria
(3) Peroxisomes (4) All of these

Q.23 Photorespiration in C_3 plants starts from

(1) Phosphoglycerate (2) Phosphoglycolate
(3) Glycerate (4) Glycine

Q.24 Hill reaction occurs in

(1) High altitude plants
(2) Total darkness
(3) Absence of water
(4) Presence of ferricyanide

Q.25 Which one of the following categories,of organisms do not evolve oxygen dui-ing photosynthesis?

(1) Red algae
(2) Photosynthetic bacteria
(3) C_4 plants with Kranz anatomy
(4) Blue green algae

Q.26 Aerobic respiration produces more usable chemical energy than fermentation, because fermentation involves

(1) Formation of lactic acid
(2) Complete oxidation of food
(3) Partial oxidation of food
(4) Evolution of CO_2 and alcohol

Q.27 How many types of cytochromes are involved in the thylakoid electron transport chain?

(1) Five (2) Two
(3) Six (4) Four

Q.28 First step of utilisation of glucose in metabolism is

(1) Glycogen (2) ATP
(3) Pyruvic acid
(4) Glucose-6-phosphate

Q.29 The high energy bonds of ATP are between

(1) C - O (2) O - P
(3) C - N (4) C - C

Q.30 In respiration from 180 gm of glucose which of the following is formed?

(1) 264 gm CO_2 + 190 gm H_2O + 391 kcal
(2) 264 gm CO_2 + 108 gm H_2O + 686 kcal
(3) 390 gm CO_2 + 108 gm H_2O + 686 kcal
(4) 390 gm CO_2 + 264 gm H_2O + 391 kcal

Q.31 Glycolysis is found in cytoplasm of virtually all types of aerobic/anaerobic cells. In this process, glucose is converted into a compound which is

(1) PEP (2) Acetyl CoA
(3) Pyruvic acid (4) Citric acid

Q.32 The leaves of *Mimosa pudica* drop down, when touched due to

(1) Seismonasty (2) Photonasty

(3) Epinasty (4) Nyctinasty

Q.33 A pigment, which absorbs red and far red light, is

(1) Cytochrome (2) Phytochrome

(3) Xanthophyll (4) Carotene

Q.34 The growth hormones, responsible for 'bolting', are

(1) Coumarins (2) Auxins

(3) Gibberellins (4) Kinetins

Q.35 Decapitation of plant leads to the activation of axillary buds due to

(1) Increase in cytokinins

(2) More light availability

(3) Auxin translocation

(4) All of these

Q.36 The movement of lamina lobe of *Dionaea* is.

(1) Thigmonastic (2) Photonastic

(3) Seismonastic (4) Thermonastic

Q.37 Which of the following reduces plant growth and induces dormancy?

(1) Cytokinin (2) Auxin

(3) Xylene (4) Abscisic acid

Q.38 Apical dominance can be overcome by application

(1) Auxin (2) Cytokinin

(3) Florigen (4) Gibberellin

Q.39 Coiling of a tendril around a support is an example

(1) Photonasty (2) Thigmotropic

(3) Nyctinasty (4) Chemotropic

Q.40 Induction of flowering by low temperature in plants is

(1) Cryobiology (2) Vernalization

(3) Phototropism (4) Pruning

Q.41 Which of the following statements are correct regarding short day plants (SOPs)?

(1) They flower when night length is longer

(2) They are the same as long as long day plants

(3) They do not have a critical photoperiod

(4) All of these are correct

Q.42 Which of the following statements about phytochrome is true?

(1) P_r absorbs yellow light and becomes P_{fr}

(2) P_r absorbs red light and becomes P_{fr}

(3) P_{fr} absorbs red light and becomes P_r

(4) P_{fr} absorbs yellow light and becomes P_r

Q.43 Pruning of plants promote branching because the axillary buds get sensitized.to

(1) Ethylene (2) Gibberellin

(3) Cytokinin (4) Indole acetic acid

Q.44 Gibberellins can promote seed germination because of their influence on

(1) Rate of cell division

(2) Production of hydrolyzing enzymes

(3) Synthesis of abscisic acid

(4) Absorption of water through hard seed coat

Q.45 *Avena* curvature test is a bioassay for examining the activity of

(1) Auxins (2) Gibberellins

(3) Cytokinins (4) Ethylene

INSTRUCTIONS FOR Q.46 TO Q.70

In the following questions (46 to 70), a statement of assertion (A) is followed by a statement of reason (R)

(1) If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark (1).

(2) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark (2).

(3) If Assertion is true statement but Reason is false, then mark (3).

(4) If both Assertion and Reason are false statements, then mark (4).

Q.46 **A :** Submerged plants get CO2 in the form of carbonates and bicarbonates.

R : Stomata are not present in submerged plants.

Q.47 **A :** Light is very important external factor of transpiration.

R : Light induces stomatal opening and darkness stomatal closure. Thus the rate of transpiration increases in light and decreases in dark.

Q.48 **A :** Stomata remain open during day.

R : Stomata help in exchange of gases.

Q.49 **A :** A plant girdled upto bast will die.

R : Water transportation will cease.

Q.50 **A :** If you burn a plant, its nitrogen component is given off as ammonia and other gases.

R : Hydroponics does not allow plants to grow well if they are supplied with all the mineral nutrients they need.

Q.51 **A :** Rhizobial aggregates have been observed at distinct sites on curled root hairs.

R : The infection thread is formed by a process of invagination of the hair cell layer in the region of curling.

Q.52 **A :** Deficiency of sulphur causes chlorosis in plants.

R : Sulphur is a constituent of chlorophyll, proteins and nucleic acids.

Q.53 **A :** Nitrogen-fixing bacteria in legume root nodules survive in oxygen-depleted cells of nodules.

R : LeghE\amoglobin completely removes oxygen from the nodule cells.

Q.54 **A :** Action spectrum of photosynthesis compares well with the absorption spectrum of chlorophyll.

R : Chlorophyll is the only pigment which can absorb light energy.

Q.55 **A :** Plants possessing C_4-pathway of carbon fixation have a higher net primary productivity than the C_3-pathway possessing plants.

R : For each unit weight of fixed carbon, C_4-pathway possessing plants require less water than the C_3-pathway possessing plants.

Q.56 **A :** The 'absorption spectrum' of chlorophyll *'a'* shows close correlation with its 'action spectrum'.

R : Chlorophyll a is present in both the pigment systems I and II.

Q.57 **A :** C_4-plants photosynthesize more efficiently than C_3-plants.

R : C_4-plants have a shorter carbon dioxide fixation cycle.

Q.58 **A :** In bacteria, photosynthesis occurs by utilizing wavelengths longer than 700 nm.

R : Here the reaction centre is B-890.

Q.59 **A :** When six molecules of carbon dioxide participate in photosynthesis, 12 molecules of NADPH + H^+ and 18 ATP are used up, forming one hexose molecule.

R : The photosynthetic light reaction results in the (I) formation of ATP and $NADPH_2$.

Q.60 **A :** *Rhoeo* leaves contain anthocyanin pigments in epidermal cells.

R : Anthocyanins are accessory photosynthetic pigments.

Q.61 **A :** Cyclic pathway of photosynthesis first appeared in some eubacterial species.

R : Oxygen started accumulating in the atmosphere after the non-cyclic pathway of photosynthesis evolved.

Q.62 **A :** C_4 photosynthetic pathway is more efficient than the C_3 pathway.

R : Photorespiration is suppressed in C_4 plants.

Q.63 **A :** Under conditions of high light intensity and limited CO_2 supply, photorespiration has a useful role in protecting the plants from photo-oxidative damage.

R : If enough CO_2 is not available to utilize light energy for carboxylation to proceed, the excess energy may not cause damage to plants.

Q.64 **A :** Photosynthetically, C_4 plants are less efficient than C_3 plants.

R : The operation of C_4 pathway requires the involvement of only bundle-sheath cells.

Q.65 **A :** The aerobic respiration is bioenergetically more efficient than the anaerobic glycolysis.

R : The aerobic respiration occurs in the mitochondria, while glycolysis is purely cytosolic.

Q.66 **A :** Photomodulation of flowering is a phytochrome regulated process.

R : Active form of phytochrome (Pfr) directly induces floral induction in shoot buds.

Q.67 **A :** A correct concentration of auxin and cytokinin is required for the development of root and shoot in a callus.

R : When the ratio of kinetin to auxin is high, then only shoots develop. But when the ratio is low then only roots develop.

Q.68 **A :** Auxiliary buds, in actively growing herbaceous plants generally remain dormant.

R : This is due to apical dominance which is under the influence of auxins.

Q.69 **A :** Plants also have hormones called as phytohormones.

R : They increase the rate of reactions and thus always accelerate growth and other related changes.

Q.70 **A :** Senescence is the time when age associated defects are manifested.

R : Certain genes may be undergoing sequential switching on and off during one's life.

ANSWER KEY

Q.1	1	Q.2	3	Q.3	1	Q.4	1	Q.5	1	Q.6	1	Q.7	1
Q.8	3	Q.9	4	Q.10	1	Q.11	2	Q.12	3	Q.13	3	Q.14	2
Q.15	4	Q.16	4	Q.17	2	Q.18	3	Q.19	4	Q.20	2	Q.21	3
Q.22	4	Q.23	2	Q.24	4	Q.25	2	Q.26	3	Q.27	2	Q.28	4
Q.29	2	Q.30	2	Q.31	3	Q.32	1	Q.33	2	Q.34	3	Q.35	1
Q.36	1	Q.37	4	Q.38	2	Q.39	2	Q.40	2	Q.41	1	Q.42	2
Q.43	3	Q.44	2	Q.45	1	Q.46	2	Q.47	1	Q.48	2	Q.49	3
Q.50	3	Q.51	2	Q.52	3	Q.53	4	Q.54	3	Q.55	2	Q.56	2
Q.57	3	Q.58	1	Q.59	2	Q.60	3	Q.61	2	Q.62	1	Q.63	3
Q.64	4	Q.65	2	Q.66	3	Q.67	1	Q.68	1	Q.69	3	Q.70	1

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CIRCULATORY SYSTEM

INTRODUCTION

Each and every cell of the body requires consistent supply of O_2, food etc. for energy. Similarly toxic substances like CO_2, ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

TYPES OF CIRCULATION

Numerous types of fluid circulation are found in animals which are as follows-

1. Intracellular circulation

(i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.

(ii) In all living cells and unicellular organism intracellular circulation is found.

(iii) Cyclosis helps in uniform distribution of material like O_2, food within the cell.

(iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

2. Extracellular circulation

(i) Circulation which occurs outside of the cell is called extracellular circulation.

(ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

Water circulation : Such type of circulation is found in **sponges** and ***Hydra***.

Parenchymal circulation : Such type of circulation is found in **flatworm**.

Pseudocoelomic fluid circulation : Such type of circulation is found in **roundworm**.

BLOOD VASCULAR SYSTEM

- Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

Note :

(i) Annelida are the 1st metazoans to have a well developed circulatory system.

(ii) ***Nereis*** among Annelida and ***Amphioxus*** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

I. Open circulatory system

(i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.

(ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

II. Closed circulatory system

(i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

(ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.

(iii) In all vertebrate animals closed circulatory system is found.

(iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body".

Open circulatory system	Closed circulatory system
(1) In open circulatory system blood flows through large open spaces and channels called lacunae and sinuses among the tissues.	(1) In closed circulatory system blood flows through a closed system of chambers called heart and blood vessels.
(2) Tissues are in direct contact with the blood.	(2) Blood does not come in direct contact with tissue.
(3) Blood flow is very slow and blood has very low pressure.	(3) Blood flow is quite rapid and blood has a high pressure.
(4) Exchange of gases and nutrients takes place directly between blood and tissues.	(4) Nutrients and gases pass through the capillary wall to the tissue fluid from where they are passed on to the tissues.
(5) Less efficient as volume of blood flowing through a tissue cannot be controlled as blood flows out in open space.	(5) More efficient as volume of blood can be regulated by the contraction and relaxation of the smooth muscles of the blood vessels.
(6) Open circulatory system is found in higher invertebrates like most arthropods such as prawn, insects, etc., and in some molluscs.	(6) Closed circulatory system is found in echinoderms, some molluscs, annelids and all vertebrates.
(7) Respiratory pigment, if present, is dissolved in plasma; RBCs are not present.	(7) Respiratory pigment is present and may be dissolved in plasma but is usually held in RBCs.

(1) Blood circulatory system : It consist of : - Blood, Bloood vessels, Heart.

(2) Lymphatic system : It consist of lymiph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

The study of blood vascular system or circulatory system is called-**Angiology.**

PHYSIOLOGY OF BLOOD CIRCULATION

- **GENERAL FACTS**

(i) Physiology of blood circulation was at first described by **Sir William Harvey**.

(ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.

(iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit.**

(iv) Single heart circuit is found in fishes having two chambered called **venous heart**.

The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.

(v) Double heart circuit is found in birds and mammals due to complete division of ventricle.

(vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

- **SYSTEMIC CIRCULATION**

(i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.

(ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

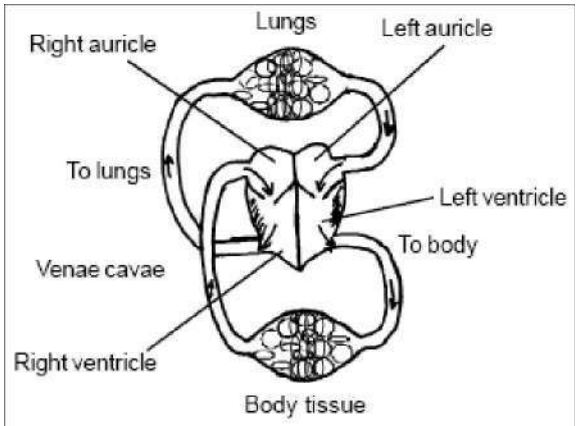


Fig. Blood flow in a bird and a mammal

PULMONARY CIRCULATION

(i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.

(ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

HEART OF VERTEBRATES

- **Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

Note :

In lung fishes 3 chambered heart is found.

- **Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

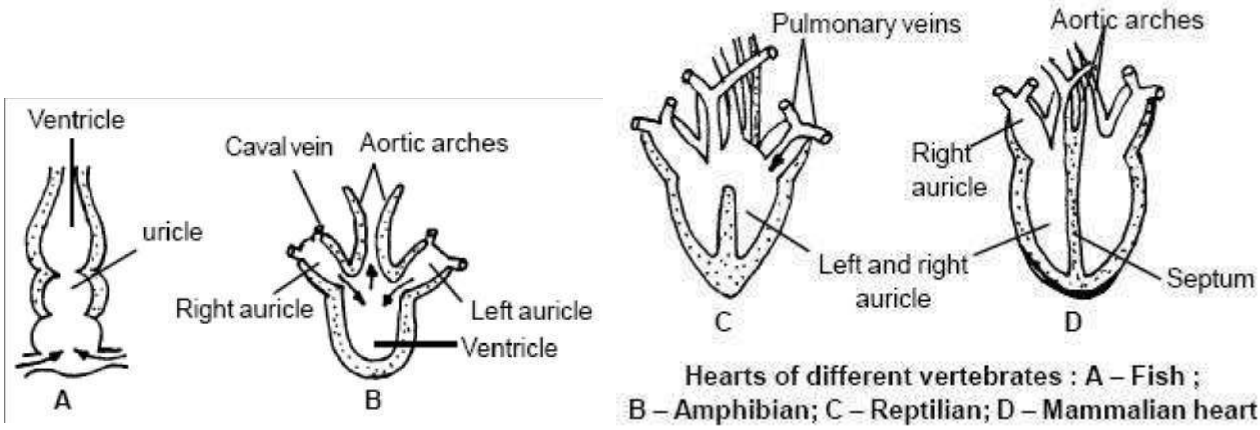
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

- **Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



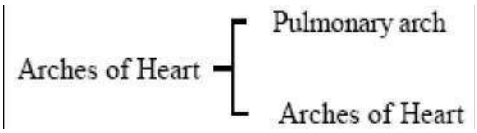
Hearts of different vertebrates : A – Fish ; B – Amphibian; C – Reptilian; D – Mammalian heart

Note :

(i) In crocodile and alligators ventricle is completely divided.

- **Sinus Venosus And Conus Arterious -** Sinus venousus and conus arterious are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postacavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.
- Due to the separation of ventricle and the absence of Conus-arterius in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.
- **Anatomical Landmarks :**

Coronary artery	–	Supplies blood to HEART
Vasso-Vassorium	–	Blood vessels which supply blood to wall of blood vessels
Bicuspid valve	–	Mitral vavle (Between L.A. & L.V.)
Tricuspid valve	–	(Between R.A. & R.V.)
Haversian valve	–	[On the end of opening of precavals]
Eustachian valve	–	On opening of postcavals.
Semilunar valve	–	At opening of Aorta and ventricles
Thebesian valve	–	Coronayr valve = at opening of coronary sinus
Columane carnae	–	Finger like projection from ventricle walls
Papillary muscles	–	Present at tip of columnae carnae
Chorda tendiane	–	Arise from papillary muscles and keep the valves in proper position.



Lacteals → Lymph capillaries of intestinal villi

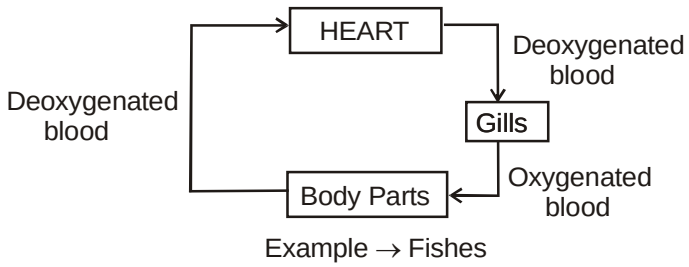
Lymphatic system present in class Amphibia is of **open type.**

Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit** & **man**

Payer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

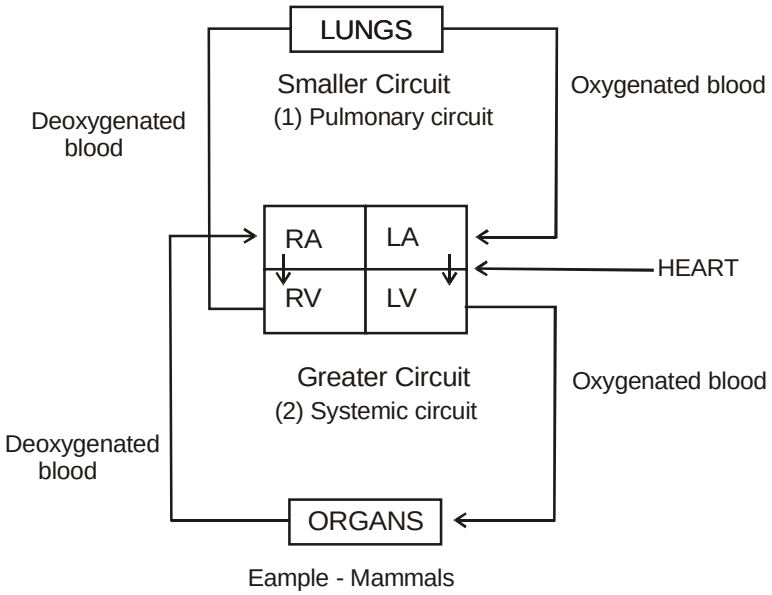
DOUBLE CIRCULATION OF HEART

- **Single Circuit :**



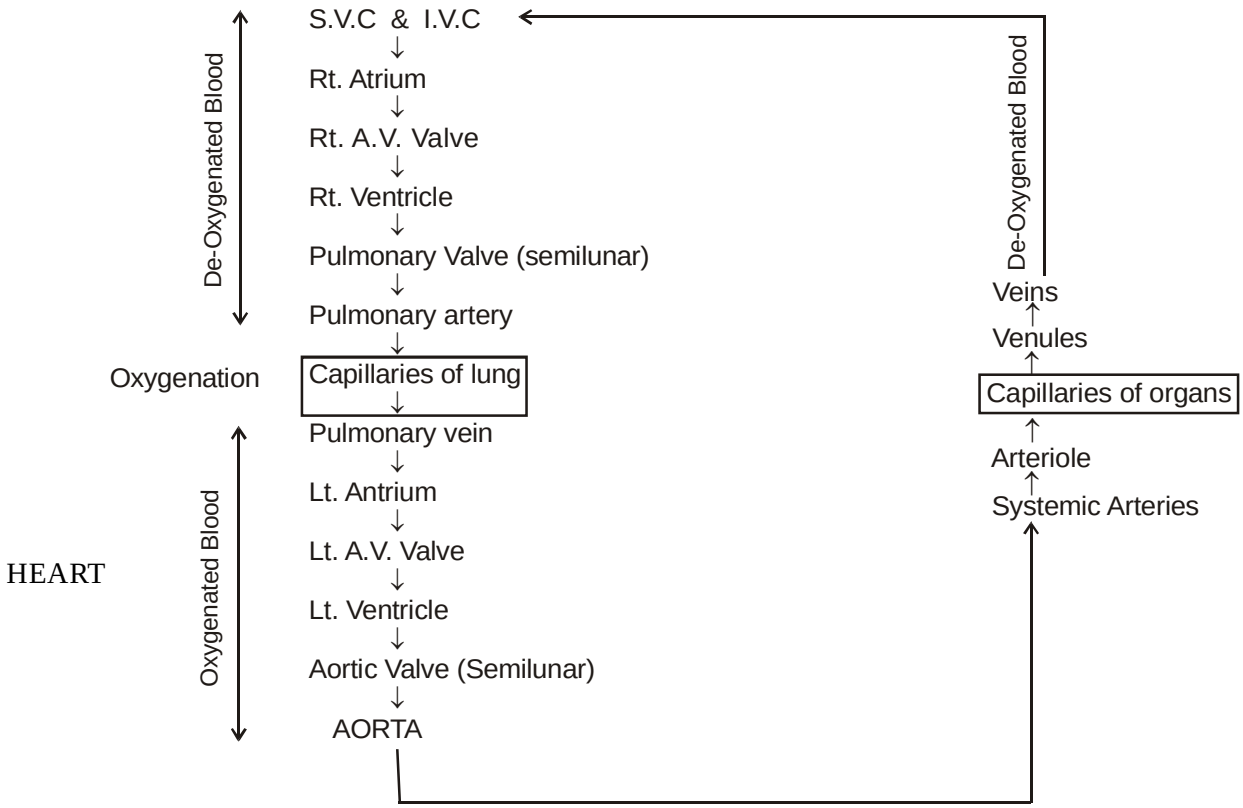
Example → Fishes

- **Double Circuit :**

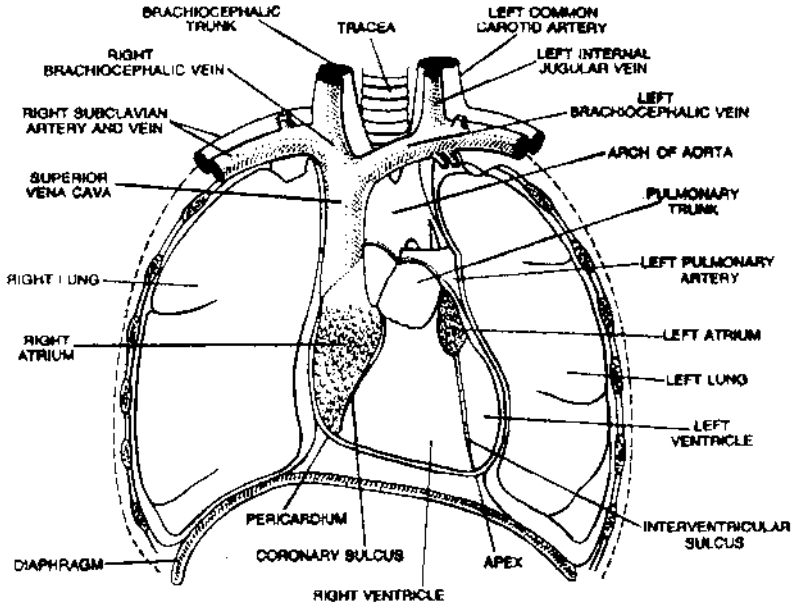


Eample - Mammals

- **Path of Blood in Double Circuit (Man)**



HEART



Location of Heart

STURCTURE OF HEART

Position, Size and Shape

(i) Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.

(ii) It is present in the mediastinal space of thoracic cavity in between the lungs.

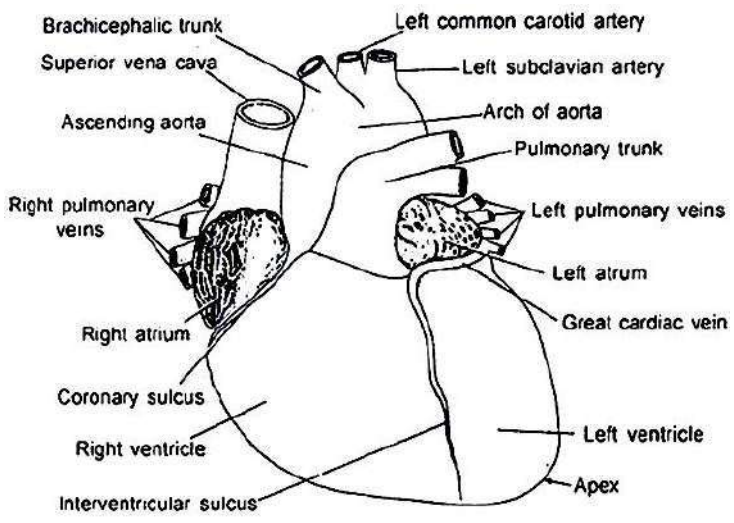
(iii) Human heart 12 cm in length and 9 cm in breath.

(iv) Its weight varies in males from 280-340 gm and in female from 230-280 gm.

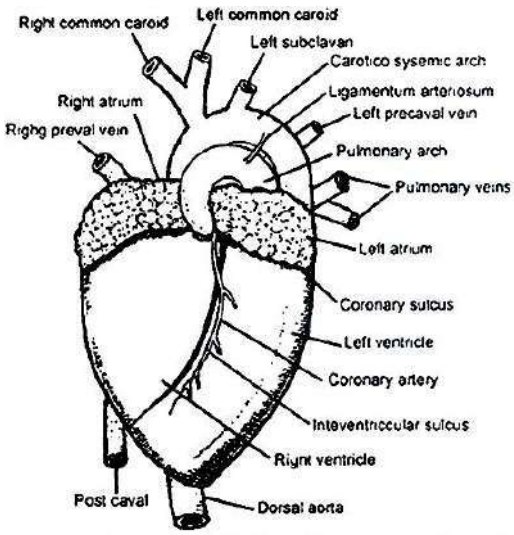
(v) Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left

(vi) It is covered by a two layered sac called **pericardium.** Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock, it also allows free movement of the heart.



External features of Man's heart (ventral view)



External features of Rabbit's heart (ventral view)

The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus.** This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

(a) Auricles - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus,** which is shifted slighty towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

(b) Ventricles - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood thoughout the body while right ventricle has to pump blood only to the lungs.

- **Systemic heart -** Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the ***systemic circulation,*** therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.
- **Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in ***pulmonary circulation*** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

- **Blood supply of heart (Coronary circulation)**

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

- **Ischemic heart diseases**

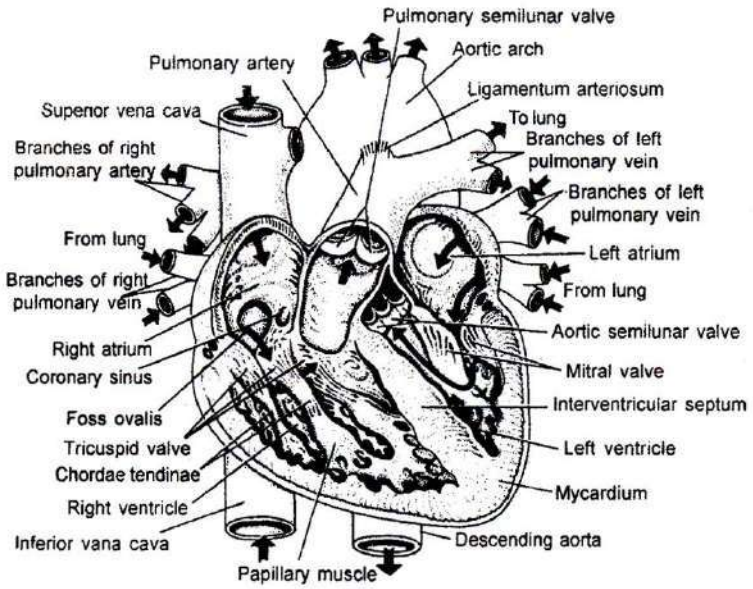
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhertion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris.** This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhertion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood suppply in such cases.

In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

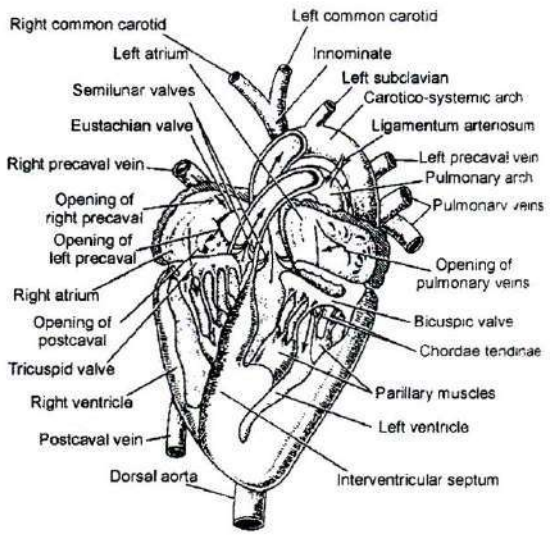
Myocardial Infarction (M.I.) - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to restablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as HEART ATTACK in common language.

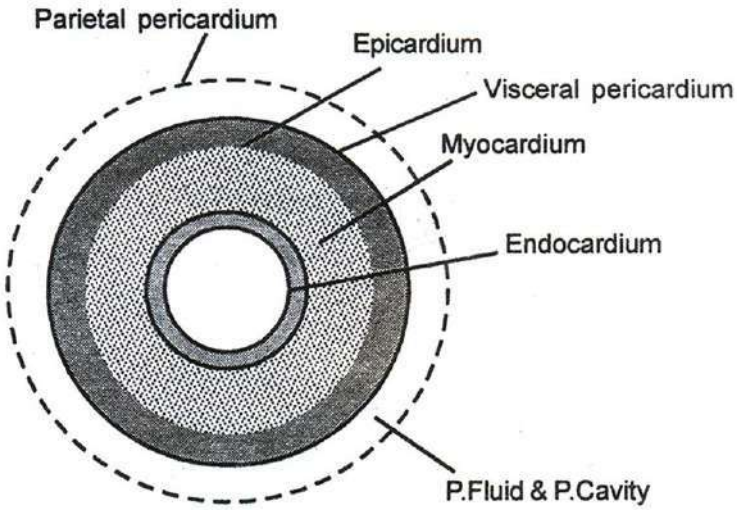
A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)



Horizontal longitudinal section of Man's heart (ventral view)



Horizontal longitudinal section of Rabbit's heart (ventral view)



Internal Structure of Heart

- The internal structrue of heart is discussed under following headings :

1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

(i) Epicardium - outermost layer, mesodermal in origin. Made of simple squamous epithelium.

(ii) Myocardium - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.

(iii) Endocardium - innermost layer, endodermal in origin. Made of simple squamous epithelium.

2. Partitions of heart :

- **Interauricular septum –** it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression **(Fossa Ovalis)** is present on its Posterior part. It is remainant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the It. Atrium from rt Artium through foramen ovale.

- **Interventricular septum –** it is separates the two ventricles. It is shifted slightly towards right. Therefore left venrticle is larger than right ventricle.
- **Auriculoventricular septum –** it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are samaller than ventricles.

3. Chambers

- The mammalian heart has four chambers.

(i) **Right Auricle or Atrium -** Inlet : it receives on **S.V.C.,** one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & It.) in case of rabbit).

SVC = superior vena cava = anterior vena cava =precava ; **IVC =** inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & It. Coronary veins and drains it in the right auricle.

Outlets : this impure blood drains through the right AV foramen into the right ventricle.

(ii) **Right ventricle -**

- **Inlets :** receives impure blood through right AV foramen from right auricle.
- **Outlets :** drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

(iii) **Left Auricle -**

- **Inlets :** receives oxygenated blood from lungs via pulmonary vein
- **Outlets :** this pure blood is drained into left ventricle through left AV foramen.

(iv) **Left Ventricle -**

- **Inlets :** receives pure blood through left AV foramen from left auricle.
- **Outlets :** drains pure blod into the Aorta from where it is supplied to systemic organs.

4. Walls

- **Auricles -**

The inner wall surface here presents a series of transverse muscular ridges called ***musculi pectinati.*** They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).

- **Ventricles -**

The inner wall is rough due to presence of muscular ridges ***trabeculae carnae*** or ***columnae carnae.*** These continue as ***papillary muscles***, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by ***chordae tendinae.*** These chorda tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

5. Valves

- **Rt. Atrium -**

All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversion valve (absent in rabbit).** The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve.**

- **Ventricles -**

  The inner wall is rough due to presence of muscular ridges ***trabeculae carnae*** or ***columnae carnae.*** These continue as ***papillary muscles***, whose one end is attached to the ventricular wall and the other end connected to the cusps of AV valves by ***chordae tendinae.*** These chorda tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction.

- **Lt. Atrium -**

  At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.

- **AV formen -**

  The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve.** (also called as the **Mitral valve**).

- **Rt.Ventricle -**

  Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**

- **Lt.Ventricle -**

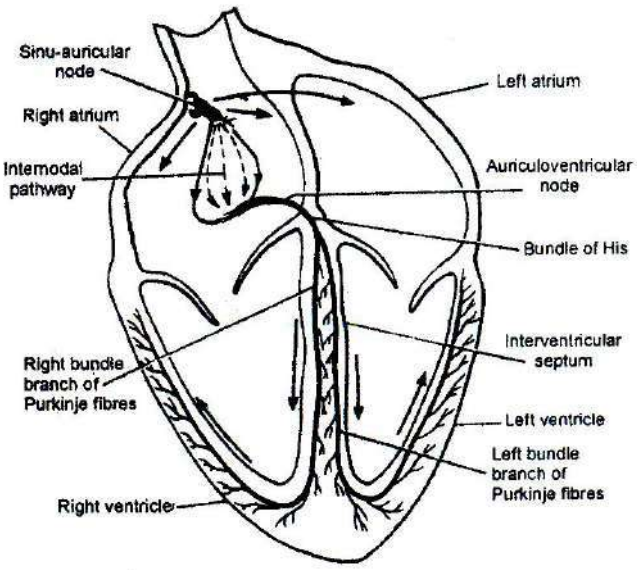
  Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

  From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum.** Ligamentum arteriosum is the remainant of **ductus arteriosus.** ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

CONDUCTION PATHWAY

The Conducting system of Heart :

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and posses special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the follwoing parts.

S.A. Node (Pacemaker)

↓

Inter nodal pathway

↓

A.V. Node

↓

Bundle of His

↓

Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node.

(1) Sinuatrial node (SA node). It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute. and initiates heart beat.

(2) Internodal pathway. it is the network of neuromuscular pathway that connects the SA node to the AV node.

(3) Atrioventricular node (AV Node). It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.

(4) Bundle of His (AV Bundle) . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.

(5) The Purkinje fibres. These are distributed through the endocardium of the ventricles and propogate the impulse in the entire ventricle musculature.

Why SA node is called the pacemaker of the heart ?

Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum is case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.

WORKING OF HEART

Heart Beat

- Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat.** The rate of heart beat in an adult male is on the averge 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).
- Heart beat is entirely controlled by nervous supply in arthopods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart.** In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart.** Human heart is myogenic.

Differences between Neurogenic and Myogenic Hearts

	Neurogenic Heart	Myogenic Heart
1.	Impulse of heart beat comes from outside heart.	The impulse of heart develops within the heart.
2.	Impulse is generated by nervous system.	Impulse is generated by a special muscular tissue.
3.	Nerve fibres are spread over the heart to bring about contracton and expansion.	There are special conducting muscles fibres for spreading the impulse.
4.	Heart will stop beating if removed from the body	It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions.

Each heart beat has two components, **systole** and **diastole.** Systole represents contraction while diastole represents expansion or distension of heart chambers.

Heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

REGULATION OF HEART BEAT

- The rate of heart beat is regulated by two mechanism.

(A) Nervous regulation **(B)** Hormonal regulation

(A) NERVOUS REGULATION

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

(I) Cardioinhibitory centre (CIC) **(II)** Cardioacceleratory centre (CAC)

(I) Cardioinhibitory centre

(i) It decreases rate of heart beat.

(ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasymphathetic nerve fibre.

(iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

(II) Cardioacceleratory centre

(i) It accelerates the rate of heart beat.

(ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.

(iii) It increase rate of heart beat.

(B) HORMONAL REGULATION

(i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.

(ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

- **Note :**

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

Key Points

Hormonal control	Adrenaline	– ↑ Rate
	Nor adrenaline	– ↑ Rate
	Vagal stimulation releases Acetyl choline	– ↓ Rate
Autonomonic Nervous System	Sympathetic	– ↑ Rate
	Parasympathetic	– ↓ Rate

TACHYCARDIA

- It is the condition where heart rate exceeds 90 per minute for an average adult.

Common causes of tachycardia :

(i) Tachycardia. Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, whihc in turn directly increases its excitability and rhythm.

(ii) Stimulation by sympathetic nerves. Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.

(iii) Weak condition of the heart. Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.

(iv) Circulatory Shock/loss of blood. When a patient looses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.

(v) Exercise. Physical exhertion cause in increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.

(vi) Sinus tachycardia. Increased frequency of impulse discharges from the SA node will in run increase the heart rate.

BRADYCARDIA

- It is the condition where the heart rate falls below 60 per minute in an average adult.

Common causes of bradycardia :

(i) Temperature. Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its Excitability and rhythm.

(ii) Stimulation by parasympathetic Vagus. Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).

(iii) Stronger condition of the heart. The athelete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athelete is at rest, this exessive quantity of pumped blood causes a negative feed back response resulting in bradycardia when he is at rest.

(iv) Rest. When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.

(v) Sinus bradycardia. Peduced frequency of impulse discharge from SA node will reduce the heart rate.

The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1

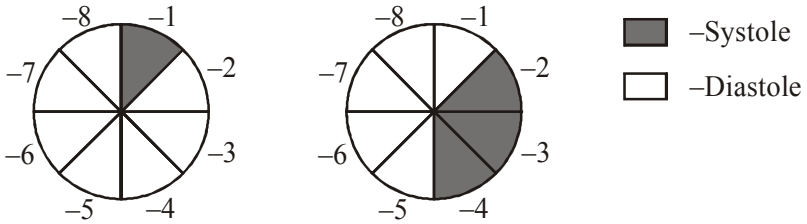
CARDIAC CYCLE

The cardiac events that occur from the begining of one heart best to begining of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than 1/10th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the artia to contract ahead of the ventricles, there by pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the artria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

- **Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throught out the life. In resting stage of man in 1 minute the heart beats around **72** times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.
- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is 60/72 = 0.8 seconds.

Cardiac Events

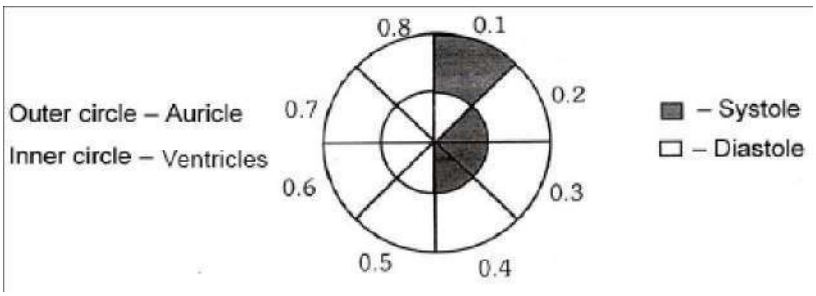


Atria **Ventricles**

Joint Diastole. 8 – .4 = 4 sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -			
(1) Auricular systole	=	0.1 sec	0.8 sec
(2) Auricular diastole	=	0.7 sec	
(3) Ventricular systole	=	0.3 sec	0.8 sec
(4) Ventricular diastole	=	0.5 sec	

- Following events are related to the Cardiac-cycle -



Common diagram showing events of both auricle & ventricles

(1) **''Ventricular-systole''** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.

(a) **''Isometric-contraction''** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the " Cuspid valves" close producing "LUBB" sound.

(b) **''Period of Ejection''** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.

- Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.

(c) **''Protodiastole'' -** Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.

(d) **''Isometric Relaxation'' -** When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.

(2) **''Ventricular Diastole'' -** Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.

- Ventricular-diastole has two sub-stages -

(a) **''Rapid in-flow'' -** After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.

(b) **''Diastasis'' -** After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.

(3) **''Auricle-Systole'' -** Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.

(4) **''Auricle-Diastole'' -** Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

Volumes of blood related with cardiac cycle.

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 mililitres. This volume is known as ***end diastolic volume.*** Then as the ventricles empty during systole, the volume decrease by 70 mililitres, which is called the ***stroke volume.*** (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 mililitres and is called ***end systolic volume.***

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction.** (usually around 60% or 7/12). EF = SV/EDV

- **Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

  Cardiac output = stroke volume x heart rate.
- End diastolic volume $\Rightarrow$ 120 ml.
- End systolic volume $\Rightarrow$ EDV – SV = 50 ml (approx)

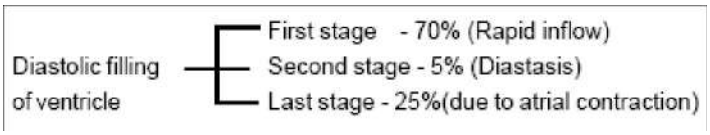
  Stroke Volume = EDV– ESV = 70 ml (approx)

Filling of Heart (Ventricles) :

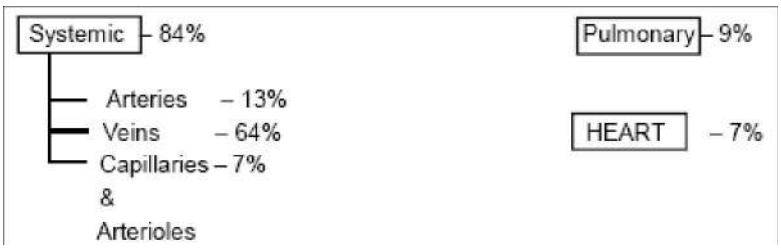
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atrial into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



Distribution of blood in Body



Distribution of Blood Flow in various organs at rest in Man

Brain	–	700 ml/mt	(14%)	approx
Heart	–	300 ml/mt	(7%)	
Muscles	–	1200 ml/mt	(20%)	
Skin	–	500 ml/mt	(8%)	
Kidney	–	1100– 1300 ml/mt	(20–25%)	
Abdominal organs	–	1400 ml/mt	(20–25%)	
Others	–	600 ml/mt	(10%)	
Total		5800 ml/mt	100%	

HEART-SOUND

(1) Ist Sound – This is a contraction sound which denotes the begining of ventricle-contraction. it arises due to closing of mitral vave and the tricuspid valve. It is weak and appears in the form of **''Lubb''** (L - U - B - B)

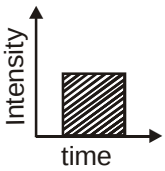
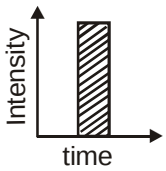
(2) IInd Sound – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of **''Dup''** . It is shriller than the Ist sound and takes less time.

- These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called **''Stethoscope.''**
- The study of heart-sounds by marking them on a Graph is termed as **''Phona-Cardiography''**
- The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

  The graph which is marked by the machine due to the voltage difference is termed as the **"E.C.G."** **''or''**

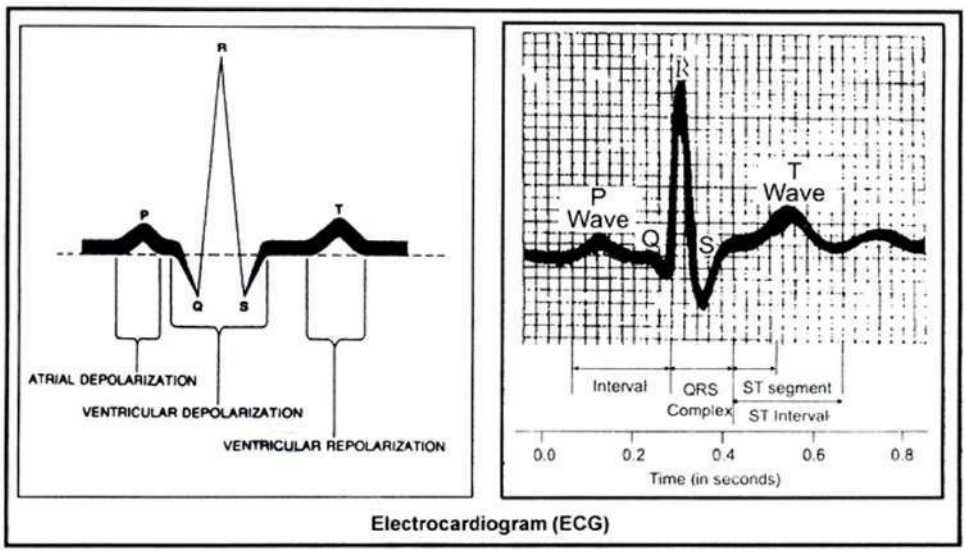
  Electro Cardio Gram'' and this process is termed as **''Electro Cardio Graphy''**
- It was first of all recorded by ***''Waller''***
- **''Einthovan''** is known as the father of Electro Cardio Graphy.

HEART SOUND

I Heart Sound	II Heart Sound
1. LUBB 	DUP 
2. DULL ; Prolonged	Sharp, Shorter timed, High pitch
3. Systolic (Ventricular) onset	Diastolic Sound
4.. Caused by vibrations due to Closure of AV valves	Caused by Closer of Semilunar valves

NORMAL ELECTROCARDIOGRM (E.C.G.)

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conduced to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



Electrocardiogram (ECG)

Components of a normal ECG

- **Waves** :

  ''P'' wave – it represents auricular depolarisation which is follwed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

  "QRS complex'' – it represents ventricular depolarisation which is followed by ventricular contraction

  ''T'' wave – it represents ventricular repolarisation during which the ventricles relax

- **Intervals**

  P-Q interval – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

  S-T interval – time period between ventricular depolarisation and ventricular repolarisation.

  P-P, R-R inverval : The interval between any two successive similar wave denotes time taken for one heart beat.

BLOOD PRESSURE

DEFINITION

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

TYPES

Arterial blood pressure is of two types :

- **Systolic blood pressure**

(i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).

(ii) In normal adult person at resting condition it is about **120 mm of Hg** .

(iii) It is **higher limit of arterial blood pressure**.

- **Diastolic blood pressure**

(i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

- **Measurement of blood pressure**

(i) Blood pressure is measured by an instrument called **Sphygmomanometer**.

(ii) It was discovered by **Karat koff in (1905)**.

(iii) At first **Hales** measured B.P. of horse.

- **Factor influencing the blood pressure**

(i) Increase in Age - B.P. increase

(ii) Thickening of arteries - B.P. increase

(iii) Due to obesity - B.P. increase

(iv) Constriction of blood vessel - B.P. increase

(v) Due to fear, tension, anxiety, B.P. increase.

- **Pulse**

(i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.

(ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.

(iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.

(iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

Disorders related to the Circulatory System :

- **Hypertension :**

It is also called **high blood** pressure. Hypertension or high blood pressure is the occurrence of persistent

systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

Secondary hypertesion is due to an underlying cause like Hormonal or obstructional. **Primary hypertension** is also called **essential hypertension.** 90% fo the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

- **Hypotension :** It is also called **low blood pressure.** Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, amaemia and deficient diet.
- **Atherosclerosis :** It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.
- **Arteriosclerosis :** It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. Arteriosclerosis occurs more in elderly persons.
- **Varicose Veins :** On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dialated,torturous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

BLOOD VESSELS

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- Normally artery carries pure blood from heart to the different organs of the body.
- Veins carry impure blood from body organs to the heart.
- Capillaries are present in the organs, and these are the vessels through which exhange takes place.

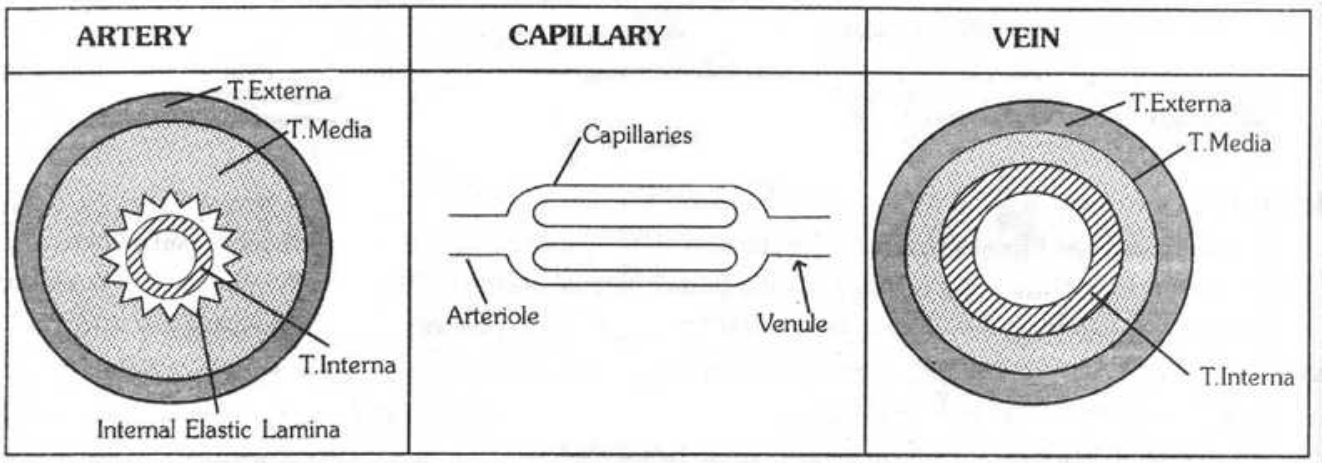
Anatomy of arteries and veins : Normally there are three layers are found in the walls of blood vessels -

(i) **Tunical externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media :** It is a thick laye of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna :** This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsable.**
- The walls of veins are thin, less muscular **non elastic** and **collapsible.**
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum.**



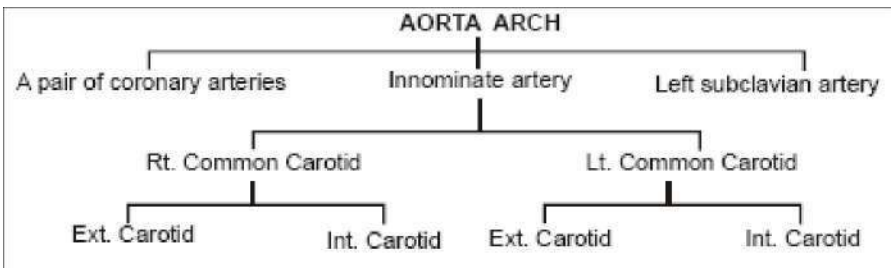
	ARTERY		VEIN
1.	It carries blood from the heart to the organs.	1.	It carries blood from organs to the heart
2.	All the arteries carry pure blood except pulmonary artery which carries impure blood.	2.	All the veins carry impure blood except pulmonary vein which carries pure blood.
3.	Blood flows with a high pressure & speed.	3.	In the vein, blood flows with a low pressure & speed
4.	Arteries are deeply situated in the body.	4.	Veins are superficial just below the skin.
5.	The walls of arteries are thick and tough.	5.	The walls of veins are thin and soft.
6.	Their lumen is constricted.	6.	Their lumen is wide.
7.	Valves are absent in the walls of arteries.	7.	Walls of veins contain valves.
8.	These are pinkish or bright red in colour.	8.	These are deep red or bluish in colour
9.	Arteries do not collapse when empty, because	9.	Veins usually collapse when empty.
10.	Their tunica media layer is much thicker as compared to veins.	10	Their tunica media layer of wall is thinner as compared to arteries.

ARTERIAL SYSTEM IN MAN & RABBIT

(Flow chart)

(1) Pulmonary artery - Supplies deoxygented blood to lung divdies in Rt & Lt

(2)



(3) Rt. Subclavian - (From Rt. Commo Carotid)

Rt. Vertebral

Rt Internal mammary

Rt. Brachial

(4) Lt. Subclavian - (From aortic arch)

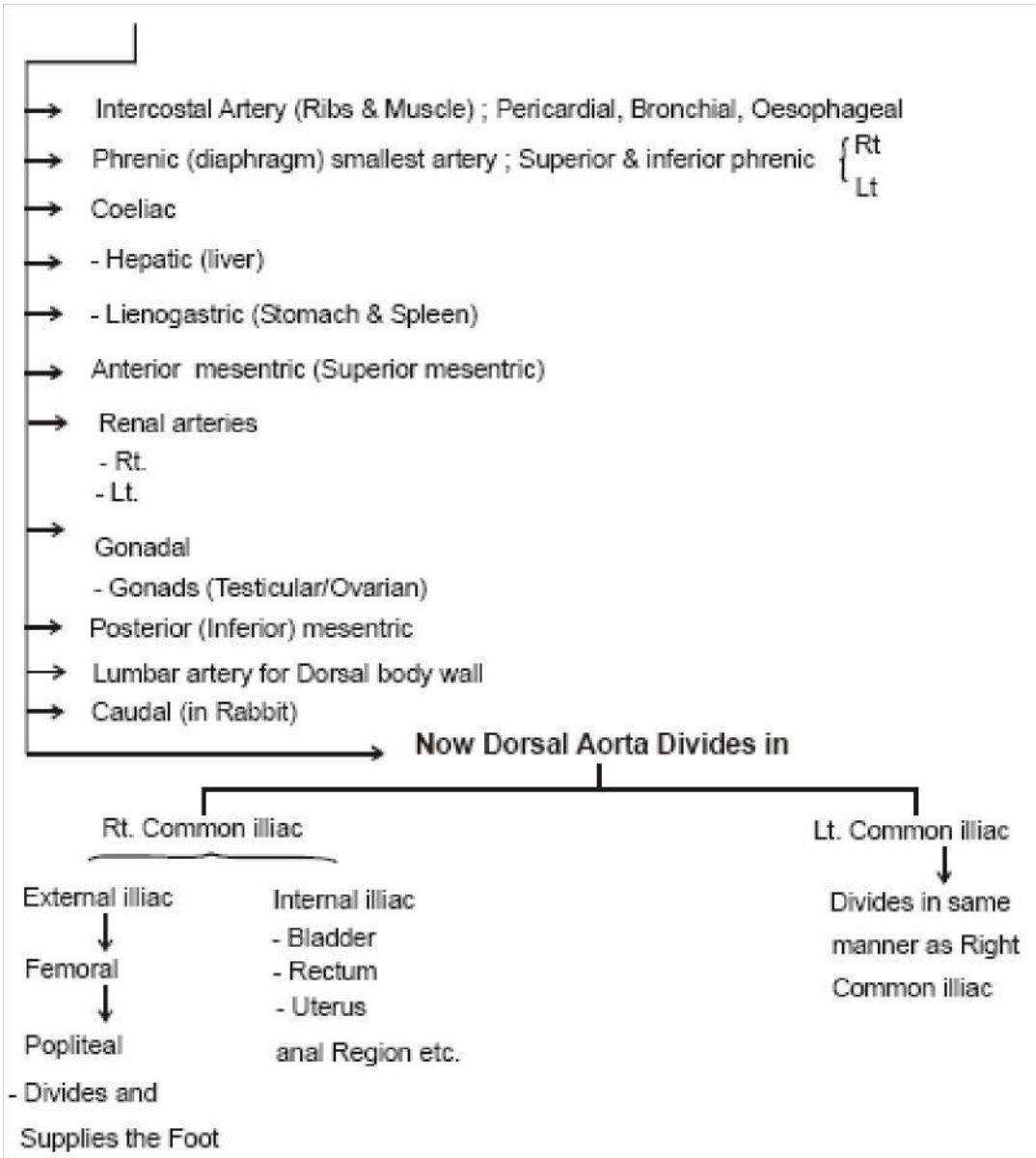
Lt. Vertebral

Lt. Internal. mammary

Lt. Brachial

(5) Dorsal Aorta (Descending Aorta) - (From aortic arch)

ARTERIAL SYSTEM IN MAN



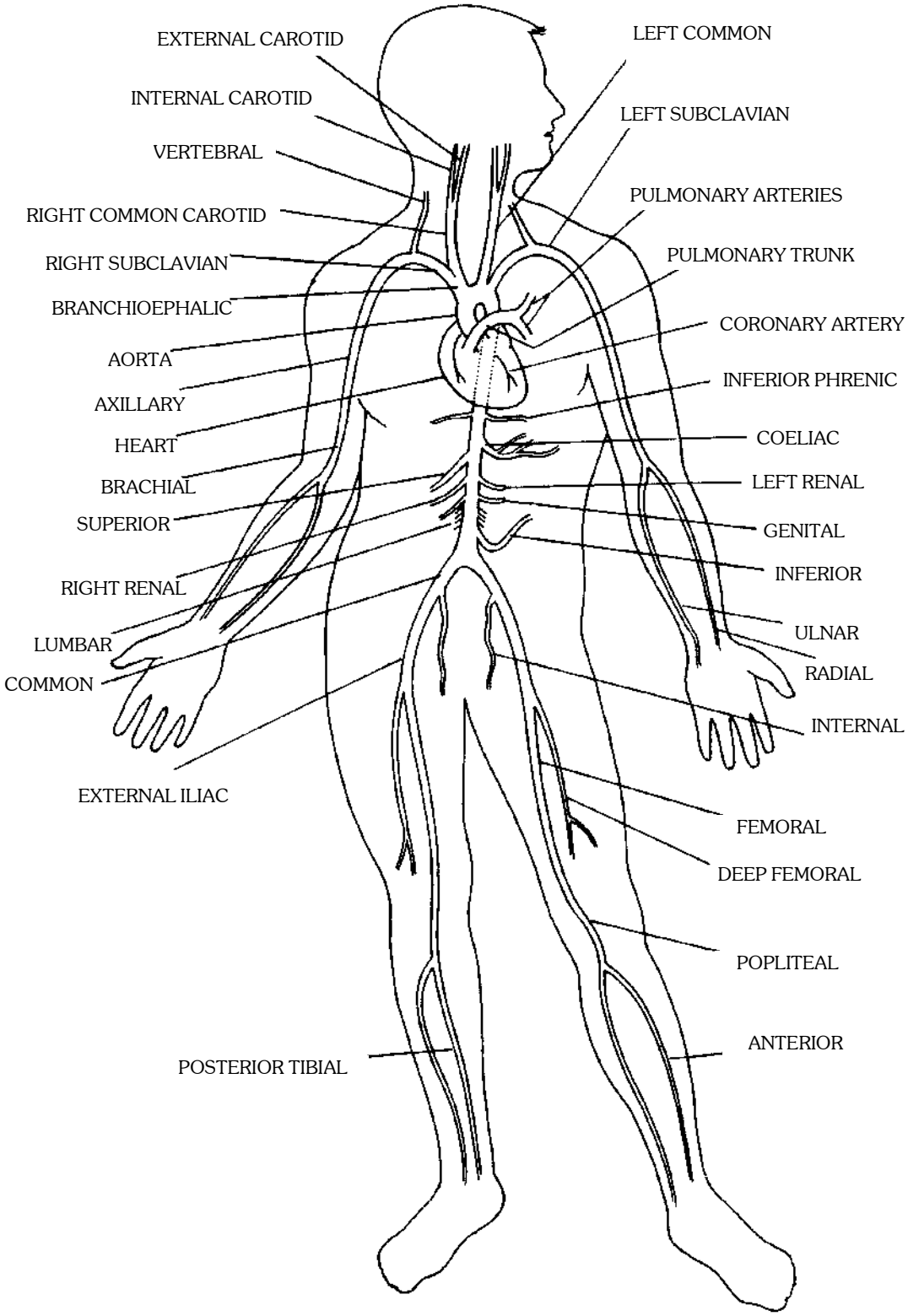


Fig. – Arterial system in human body

- **Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aora from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left venricle. Ascending aorta has a swelling at its base known a **aortic sinus.** Two **coronary arteries,** right and left, develop from it to suppply oxygenated blood to heart walls.

   Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

   The descending aotra has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

   Abdominal aorta gives out following branches.

(i) **Inferior phrenic** to the inferior surface of diaphragm.

(ii) **Coeliac artery** or **trunk** with lieno gastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.

(iii) **Superior mesenteric** to small intestine.

(iv) Two **supra-renals** to adrenal glands

(v) Two **renals** to two kidneys.

(vi) Two **gonadals,** ovarian in case of females and testicular in case of males.

(vii) **Inferior mesenetric** to large intestine.

(viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Adominal aorta now divides into two common **iliacs,** left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region External iliac passes into lower limb of its side.

- **Caudal artery -** In Rabbit the posterior most part of dorsal aorta enters into the tail in the form a single caudal artery after the common iliac arteries have already separated.

VENOUS SYSTEM IN MAN RABBIT

- **Heart Receives**

(1) One superior vena cava (Two in rabbit)

(2) One inferior vena cava

(3) Pulmonary veins

(4) Coronary veins through coronary sinus

[A] Superior vena Cava (Anterior) Receives

- Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- Two internal jugular (Rt & Lt)
- Subclavian (Rt & Lt)
- Anterior intercostal (RT & Lt)
- Internal mammary (Rt & Lt)

  Azygous vein (RT. Side only)
- Hemiazygous vein (Lt. side only) opens in Azygous vein

[B] Inferior Vena cava I.V.C. (Posterior)

- Post Intercostal vein
- Hepatic portal (to liver)
- Gonadal
- Ext & Int. iliac
- Phrenic
- Renal
- ilio lumbar
- Veins from lower leg.

- **Venous System :**

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

1. **PulmonaryVeins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
2. **Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.

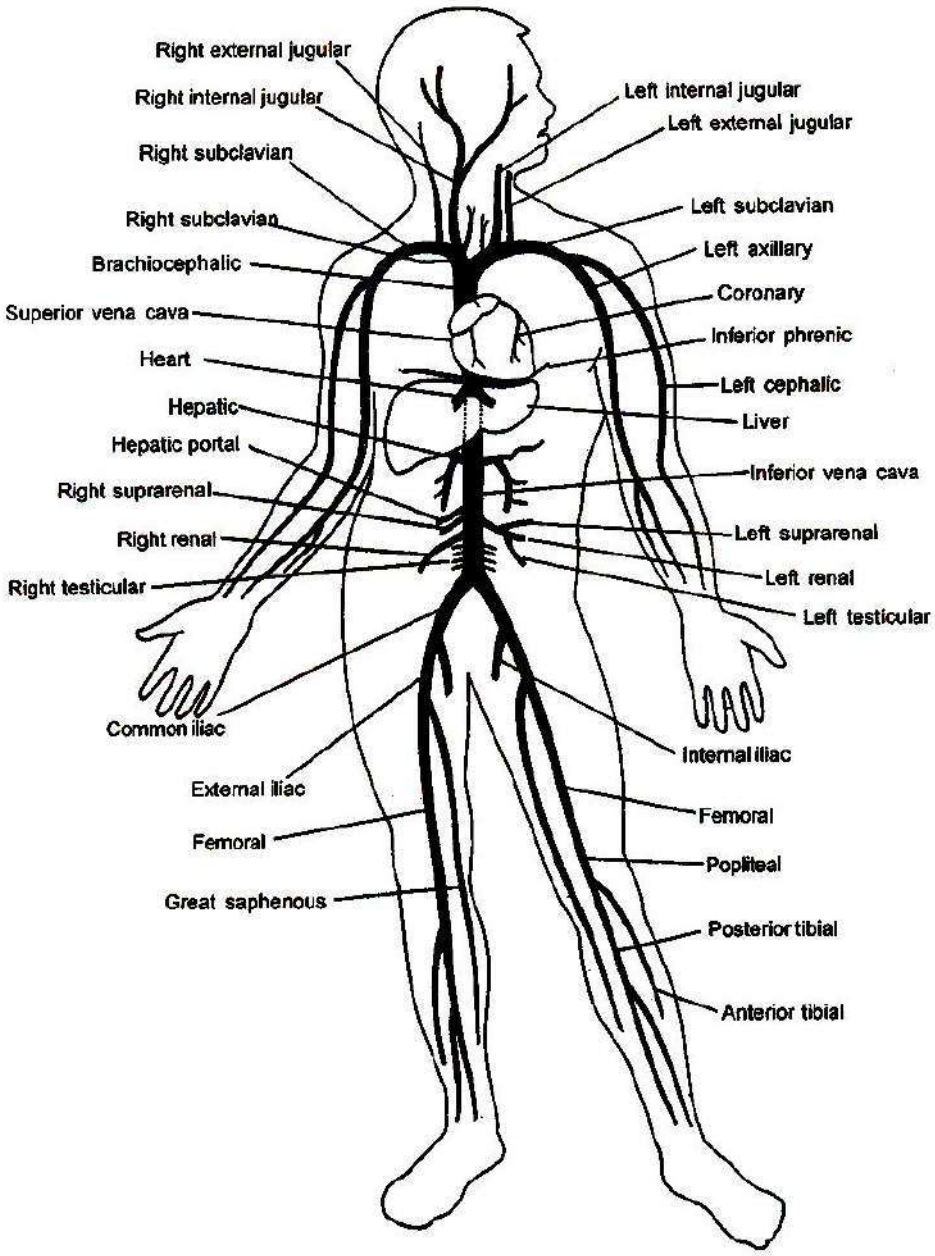


Fig. Venous System in Male Human Being

3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins.** Each branchiocephalic vein is formed of a juglar vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins form kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrrenic veins from inferior face of the diaphgragm. Inferior vena cava opens into righ atrium.
5. **Azygous vein.** An axygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left sdie which opens into azygous vein through a transverse connection An accessory Hami Azygous vein also drains blood for left upper part into Azygous.
   Azygous and hemizygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

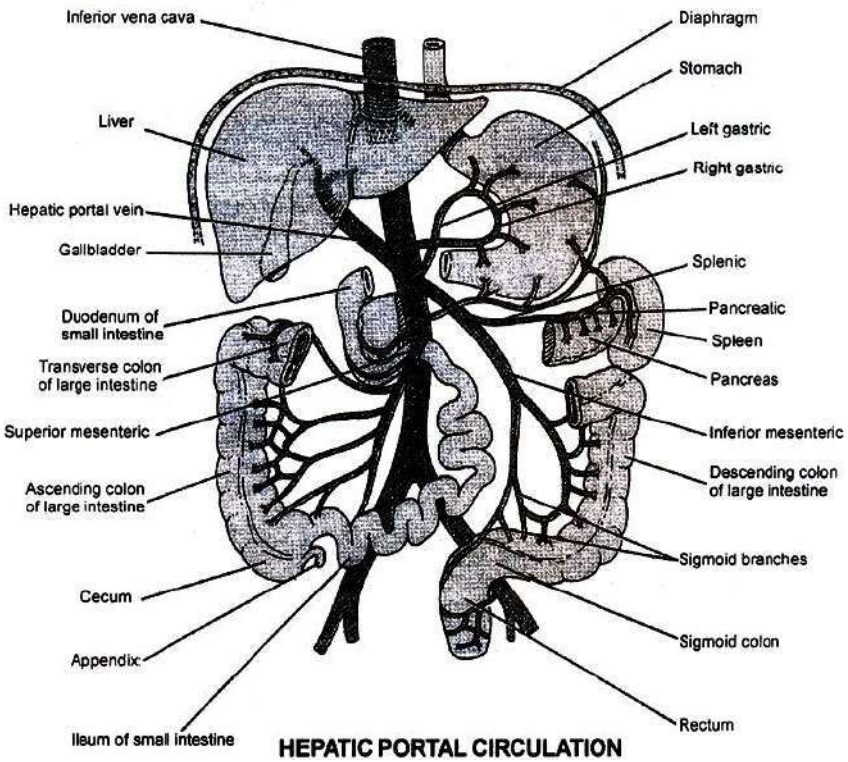
PORTAL SYSTEM

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system.**

- it is of following types -
  (i) Renal portal system
  (ii) Hepatic portal system
  (iii) Hypophysial portal system

(I) Renal portal system - Veins which collect blood from posterior parts of the body and legs combine to forms a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog

- In mammals, renal portal system is absent.
  In Frog both the portal systems; renal portal system and hepatic portal system are present.



HEPATIC PORTAL CIRCULATION

(II) Hepatic Portal System - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

(i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.

(ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.

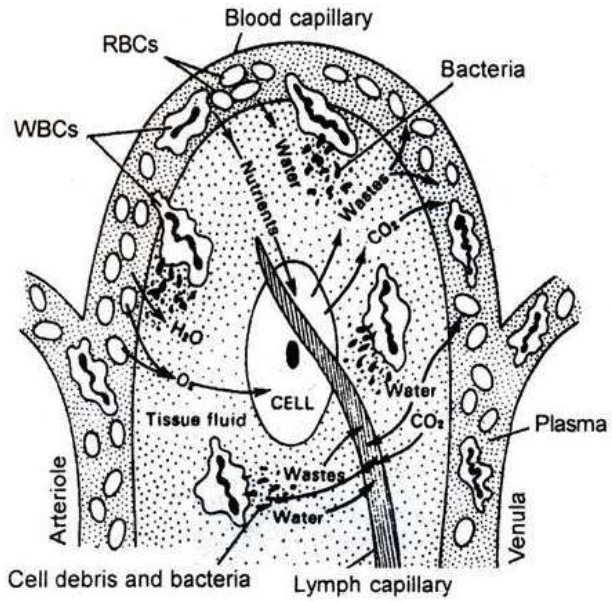
(iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.

(iv) Cystic vein from gall bladder.

(v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenatd blood of liver, portal blood is recollected by venules which form hepatic veins.

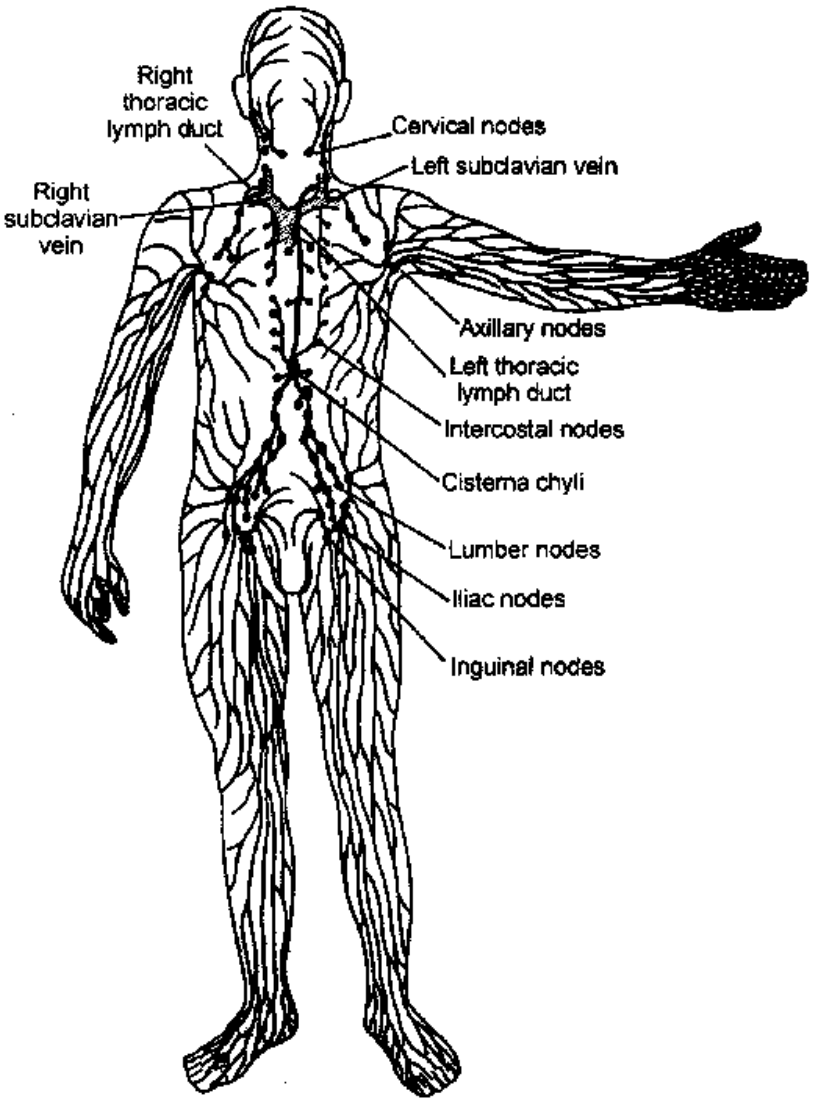
(III) Hypophysial Portal System - It is a portal system formed by a vein from hypothalamus which breaks up into capilliaries in hypophysis or pituitary gland. The vein is called **hypophysial portal vein.** It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophysial portal system is a short circuit arrangement. Hypothalamus produces a number or hormones for controlling endocrine activity of adenohypophysis. They are pored into blood in hypothalamus. The same is directly drained by hypophysial portal vein into adenohypophysis.



Chemical exchange between blood, tissue fluid and tissue cells

- **Lymphatic Circulatory System -** Here a different kind of circulating fluid (lymph) transferres CO_2 and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filteration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originte from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.
- **The Lymph :** From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filterd out fluid, vertebrates possess an additional independent system of pipelines, called **lymphatic system.** This system begins in tissue fluid

with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaris from the interstituium is called **lymph.**



Lymphatic system of mammals shown in man (ventral view)

Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood presssure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filteration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs, O_2 and nutrients in tissue fluid.

- The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.

- Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood

Blood	Lymph
1. It forms circulatory system.	1. It forms lymphatic system.
2. R.B.Cs. present	2. R.B.Cs. absent
3. Neutrophills more	3. Lymphcytes in largest amount
4. Soluble proteins in large amount but insoluble proteins in small amount.	4. Soluble proteins in small amount but in soluble insoluble proteins in large amount.
5. O_2 & nutrients in large amount but CO_2 very less.	5. O_2 & nutrients in small amount CO_2 in large amount.
6. It is of red colour.	6. It is of colourless, just like water.

LYMPH VESSELS

- Lymph capllaries combine together to form lymph vessels in rabbit/man
- Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- Lymph vessels combine to from two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

– **Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

– **Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- Lymphatic capillaries of intestinal villi are called **lacteals.**Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle.** This chyle drains into cisterna chyli.

– **Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are relatedd to lymph capillaries and lymph vessles. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

(a) Lymph node - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

- Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
2. Filter and clean the lymph.
3. Synthesize the antibodies.
4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them

- Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

SPLEEN ::

Lymph glands includes spleen and thymus.

Spleen Structure

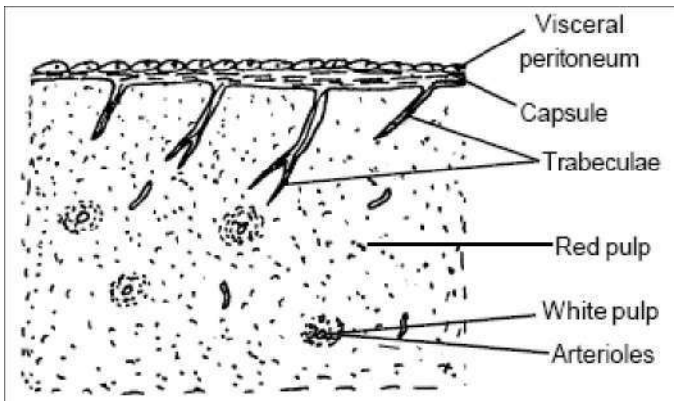


Fig. A part of T. S. of Spleen

(i) Spleen is dark red elongated structure lying behind the human stomach.
(ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
(iii) Capsule further remain covered by **visceral peritoneum**.
(iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
(v) Red and white pulp are found in spleen these are known as **splenic pulp**.
(vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
(vii) The spleen also contain **macrophages**.

Functions

(i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
(ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
(iii) Spleen is 1st reservior blood, so it is called **blood bank**.
(iv) Spleen produces lymph.
(v) Spleen also stores iron.
(vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

General information related with spleen

(i) Spleen is lymphoid gland.
(ii) It is mesodermal in origin.
(iii) It is largest lymph gland.
(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

Note :

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

IMPORTANT POINTS

- Lymphatic system in class amphibia is of open type.
- Lymph sinuses are the large spaces containing lymph. These are present in frog but absent in mammals.
- Lymph heart - The heart which collects lymph.
- In frog, lymph hearts are two pairs - an anterior pair and a posterior pair which collect lymph from respective regions. There are no lymph hearts in mammals.
- The process of lymph formation is called Transudation.
- Lymph serves to return the interstitial fluid to the blood.
- Oedema (Edema) or Dropsy - A local swelling due to the accumulation of tissue fluid in tissues caused by the defective circulation of blood or lymph.
- Lymph nodes are secondary lymphatic organs because they harbour lymphocytes. Primary lymphoid organs are bone marrow and thymus.
- Lymph nodes are maximum in armpits and groin.
- Spleen is called "first reservoir" of blood while liver is called "second reservoir" of blood.
- Spleen, liver and kidneys - all are called filter apparatus of blood.
- Diseasess where there is more destruction of RBCs such as malaria, banti disease, there is enlargement of spleen called as splenomegaly.
- Thymus is concerned with the immunological reactions.
- In AIDS, there occurs generalised swelling of all lymph nodes.
- Spleen is absent in cyclostomes.
- **Cardiology -** Study of heart.
- **Pericarditis -** Inflammation of pericardium.
- **Endocarditis -** Inflammation of endocardium, generally caused due to the rheumatic fever.
- **Frank-Starling law -** Within certain physiological limits, the heart pumps all the blood that comes in it.
- Largest sized heart is found in Blue whale.
- Papillary muscles of ventricles are found only in the heart of mammals.
- Valves in heart were first reported by Fabricious.
- World's first heart transplant was performed by Dr. Christian Barnard on 55-year old Louis Wash kansky in Cape town, South Africa in the year 1967.
- India's first heart transplant was conducted by cardiac surgeon Dr. P. Venu Gopal in a 42-year old man Mr. Devi Ram on 3rd August, 1994 at AIIMS, Delhi.
- **Cardiomegaly -** Enlargement of heart.
- **Myocardial Ischaemia -** Deficient blood supply to heart muscle leading to angina pectoris.
- **Angina pectoris -** Severe but temporary heart pain of short duration which is usually felt in front of the chest and may pass into the arms.
- **Coronary thrombosis -** Formation of blood clot in coronary arteries of heart causing death of tissue and leading to heart attack or MI.
- **Coronary sclerosis -** Narrowing of coronary arteries leading to severe chest pain (Angina pectoris).
- **Rheumatic heart Disease (RHD) -** Defects in heart valve due to toxins produced by throat infection caused by streptococcus leading to rheumatic fever.
- **Coronary angiography -** X-ray of the arteries, supplying the heart, after injecting them with radio-opaque material.

EXERCISE - 1

1. Poikilothermic (cold blooded) or exothermic animals are those in which
(1) Body freezes
(2) Body temperature remains constant
(3) Body temp. changes according to sur roundings
(4) None of the above

2. An open circulatory system occurs in
(1) Man (2) Reptiles
(3) Animals (4) Insects

3. William Harvey is known for the discovery of
(1) Blood transfusion
(2) Blood clotting
(3) Blood circulation
(4) Blood purification

4. The blood vascular system of mammals is known as double vascular system because
(1) A group of veins carry oxygenated and other group conduct deoxygenated blood
(2) Oxygenated blood runs from heart to different organs by one set of veins while deoxygenated blood runs from heart to lung by another set
(3) The two different systems never meet
(4) All of the above

5. Which one of the following does not have an open circulatory system
(1) Chelone (2) Cockroach
(3) Frog's tadpole (4) (1) and (2) both

6. Mammals are said to have a "double circulatory system". This means
(1) That the blood vessels are paired
(2) That there are two types of blood vessels attached to every organ; an artery and a vein
(3) That there are two system; one from the heart to the lungs and back to the heart and other to and from rest of the body
(4) That the blood circulates twice as quickly

7. The heart of fish is different from the other group because
(1) It has lymph only
(2) It pumps only arterial blood
(3) It pumps only venous blood
(4) It pumps only lymph

8. The heart of a crocodile consists of
(1) A single auricle and two ventricles
(2) Two auricles and a single ventricle
(3) Two auricles and two ventricles
(4) A single auricle and a single ventricle

9. Open vascular system is found in
(1) Man (2) Fish
(3) Prawn (4) Snake

10. In amphibia, the heart has
(1) Two auricles and two ventricle
(2) Two auricles and one ventricle
(3) One auricle and two ventricles
(4) One auricle and one ventricle

11. Single circuit circulatory system is characteristic of
(1) Fishes (2) Amphibians
(3) Aves (4) Mammals

12. Double circuit circulation is seen in
(1) Humans and rabbit
(2) Pigeon and rat
(3) Lizard and crocodile
(4) All of the above

13. In the evolution of animals a heart to pump the blood is found for the first time in
(1) Annelids (2) Roundworms
(3) Arthropods (4) Flat worms

14. Regarding blood circulation, it may be said that in Pheretima the dorsal vessel is a
(1) Collecting vessel in first two segments and distributing vessel in other
(2) Distributing vessel in first five segments and collecting vessel in other
(3) Collecting vessel in first thirteen segments & distributing vessel in intestinal region
(4) Distributing vessel in first thirteen segments & collecting vessel in intestinal region

15. Identify the animal which has neurogenic heart
(1) Rat (2) Rabbit
(3) Hamster (4) Periplaneta

16. Which of the following has myogenic heart
(1) Frog (2) Humans
(3) Rabbit (4) All of the above

17. Which of the following chordata does not have a heart
(1) Petromyzon (2) Lung fishes
(3) Branchiostoma (4) Herdmania

18. Heart beat can be recorded and displayed as
(1) ECG (2) EEG
(3) ERG (4) EMG

19. Innervation of heart in the intact animals is primarily meant for
(1) Initiation of heart beat
(2) Regulation of heart beat
(3) Release of acetylcholine only
(4) Release of adrenalin only

20. Purkinje's fibres are special types of
(1) Muscle fibres located in heart
(2) Nerve fibres located in cerebrum
(3) Connective tissue fibres joining one bone to another bone
(4) Sensory fibres extending from retina into optic nerve

21. Identify the cardiac inhibitor
(1) Y-aminobutyric acid
(2) 5' Hydroxytryptamine
(3) Adrenaline (4) Acetylcholine

22. Identify the wrong statement
(1) The arterial and venous pressure of blood constitutes the blood pressure
(2) Defective heart valve are the cause of heart murmur
(3) When the semilunar valves close the DUP sound is produced
(4) Contraction of right ventricle pumps blood into pulmonary vein

23. Identify the correct statement
(1) The lubb-dup sound of heart beat is due to closure of mitral-tricuspsid valve followed by semilunar valve
(2) The passage of blood from post caval to diastolic right auricle is due to gravity
(3) One heart beat in man lasts for 0.2 sec.
(4) Pulmonary artery originates from left ventricle

24. Regulation of heart beat in mammals is due to
(1) The volume of blood in the circulatory system
(2) The presence of excess of oxygen in blood
(3) The presence of thyroxine in blood
(4) The presence of pacemaker in the heart

25. Purkinje's fibres of the vertebrate heart are modified
(1) Parasympathetic nerves
(2) Sympathetic nerves
(3) Motor nerves (4) Muscle cells

26. The nerve like modified muscle in the right auricle is known as
(1) Lymph node
(2) Atrio-ventricular node
(3) Pacemaker
(4) Bulbus arteriosus

27. Pace maker of the heart is
(1) S.A. node (2) A.V. node
(3) A.V. septum (4) I.A. septum

28. The first heart sound is
(1) 'Lubb' sound at the end of systole
(2) 'Dub' sound at the end of systole
(3) 'Lubb' sound at the beginning of systole
(4) 'Dub' sound at the beginning of systole

29. How many times does the heart of humans beat per minute
(1) 80 (2) 120
(3) 72 (4) 60

30. The heart of a healthy man beats normally per minute
(1) 60-70 times (2) 70-80 times
(3) 80-90 times (4) 85-95 times

31. Heart beat can be initiated by
(1) Sinu-auricular node
(2) Sinu-ventricular node
(3) Sodium ion
(4) Purkinje's fibres

32. Which one is the correct route through which pulse making impulse travels in the heart
(1) SA node $\rightarrow$ Purkinje fibres $\rightarrow$ Bundle of His $\rightarrow$ AV node $\rightarrow$ Heart muscles
(2) AV node $\rightarrow$ SA node $\rightarrow$ Purkinje fibres $\rightarrow$ Bundle of His $\rightarrow$ Heart muscles
(3) AV node $\rightarrow$ Bundle of His $\rightarrow$ SA node $\rightarrow$ Purkinje fibres $\rightarrow$ Heart muscles
(4) SA node $\rightarrow$ AV node $\rightarrow$ Bundle of His $\rightarrow$ Purkinje fibres $\rightarrow$ Heart muscles

33. The rate of heart beat per minute is highest in case of
(1) Elephant (2) Whale
(3) Man (4) Mouse

34. The viscosity of blood is important in maintaining
(1) Acid-base balance
(2) Diastolic blood pressure
(3) Systolic blood pressure
(4) Osmotic pressure

35. Regulation of heart beat in mammals is due to
(1) Presence of excess of oxygen in blood
(2) The presence of pacemaker in the heart
(3) The presence of thyroxin in blood
(4) The volume of blood in the circulatory system

36. Pace maker of the heart is situated
(1) In wall of right atrium close to eusta chian valve
(2) On intra-auricular septum
(3) On inter-venticular septum
(4) In wall of left atrium close to the open ing of pulmonary veins

37. Stimulation of the vagus nerve will make the heart beat
(1) Faster (2) 70 times/minute
(3) Slower (4) Normal

38. During systole
(1) Auricles and ventricles contract simultaneously
(2) Auricles and ventricles contract separately
(3) Only auricles contract
(4) Only ventricles contract

39. What is the maximum efficiency of heart
(1) 10 - 15 % (2) 20 - 25 %
(3) 40 - 60 % (4) 100 %

40. Blood leaving and moving to heart has higher concentration of
(1) Glucose (2) Urea
(3) Bile (4) Erythrocytes

41. If the vagus branch of frog is stimulated, the heart will show
(1) Stoppage of heart beat
(2) Decreased heart beat
(3) Increased heart beat
(4) No change

42. Artificial pace maker is transplanted in
(1) Inter ventricular septum
(2) Below the collar bone
(3) Inter auricular septum
(4) Right auricle

43. The rate of heart beat is controlled by
(1) CNS (2) SN
(3) CN
(4) Autonomic nervous system

44. Bundle of HIS is found in
(1) Muscles (2) Brain
(3) Heart (4) Liver

45. In rabbit oxygenated blood flows from
(1) Left auricle to left ventricle during auricular systole
(2) Right auricle to right ventricle during ventricular systole
(3) Right ventricle to aorta during ventricular systole
(4) Pulmonary vein to left auricle during auricular systole

46. Systole refers to the contraction of
(1) SA node (2) AV node
(3) Major arteries (4) Atria and ventricles

47. Heart beat is initiated by
(1) AV node (2) SA node
(3) Purkinje fibres (4) Papillary muscles

48. Impulse originating from sinu-atrial node are transmitted to the
(1) Atrio-ventricular node
(2) Bundle of His
(3) Pacemaker (4) Purkinje system

49. Heart beats are controlled by a nodal tissue which is composed of
(1) Purkinje fibres (2) Myonemes
(3) Collagen fibres (4) Telodendrites

50. During diastole
(1) Blood enters lungs
(2) Blood leaves the ventricle
(3) Blood leaves the heart
(4) Blood enters the heart

51. During systole of ventricle
(1) Blood enters the heart
(2) Blood leaves the heart
(3) Blood leaves the ventricle
(4) Blood enters lungs

52. Acetylcholine is secreted by
(1) Adrenal cortex (2) Adrenal medulla
(3) Parasympathetic neuron
(4) Sympathetic neuron

53. Heart beat originates from
(1) Pacemaker (2) Cardiac muscles
(3) Left atrium (4) Right ventricle

54. Heart beat of humans is controlled by
(1) Sympathetic and parasympathetic ner vous system
(2) Medullary hormones
(3) Hypothalamus (4) (1) and (2)

55. Which one of the following is a matching pair
(1) Lubb - sharp closure of AV valves at the beginning of ventricular systole
(2) Dupp - sudden opening of semilunar valves at the beginning of ventricular diastole
(3) Pulsation of the radial artery-valves in the blood vessels
(4) Initiation of the hear beat Purkinje fibres

56. First heart sound occurs at
(1) Opening of semilunar valve
(2) Closing of semilunar valve
(3) Onset of auricular systole
(4) Sudden closure of A.V. valves

57. The pace-setter in the heart is called
(1) Purkinje fibres
(2) Sino-aterial node (SAN)
(3) Papillary muscle
(4) Atrio-ventricular node (AVN)

58. Apex beat of heart is synchronous with
(1) First sound (2) Second sound
(3) Third sound (4) Fourth sound

59. The typical Lubb-Dup sounds heard in the heart beat of a healthy person are due to
(1) Closing of the tricuspid and bicuspid value
(2) Blood flow through the aorta
(3) Closing of the tricuspid and semilunar valves
(4) Closing of the semilunar valves

60. If heart of a mammal was injected with 2% solution, then
(1) Heart beat will increase
(2) Heart beat will decrease
(3) Heart beat will stop
(4) No effect

61. The auriculo-ventricular node in human heart was discovered by
(1) Hiss (2) Loewis
(3) Ringer (4) William Harvey

62. The murmuring sound in heart takes place due to
(1) The defective and leaking valve
(2) The thrombosis in coronary artery
(3) Defect in SA node
(4) The arterial pulse

63. The beating of heart of man is heared on the left side because
(1) The left ventricle is towards the left side
(2) Both the ventricles are towards the left side
(3) Entire heart is on the left side
(4) The aorta is on the left side

64. The cardiac output of human heart per min is
(1) 4320 ml (2) 5000 ml
(3) 1500 ml (4) 2000 ml

65. What is the volume of blood drained by heart in one ventricular stroke
(1) 1 ml (2) 800 ml
(3) 500 ml (4) 80 ml

66. In terms of heart function, epinephrine is antagonistic to
(1) Norepinephrine (2) Acetylcholine
(3) Dopamine (4) Prostaglandin

67. The heartbeat is regulated by
(1) Pacemaker (2) Vagus nerve
(3) Sympathetic nerve (4) All the above

68. Which of the animal has only deoxygenated blood in its heart
(1) Scoliodon (2) Rabbit
(3) Pigeon (4) Snake

69. Blood returns from lungs to heart through
(1) Right auricle (2) Right ventricle
(3) Left ventricle (4) Left auricle

70. In the heart of mammal the bicuspid valve is situated between
(1) Left auricle and left ventricle
(2) Post caval and right caval
(3) Right auricle and left auricle
(4) Right ventricle and pulmonary aorta

71. Nature of valves in the heart is
(1) Membranous (2) Muscular
(3) Tendinous (4) Ligamentous

72. Chordae tendinae are found in
(1) Ventricle of heart (2) Atria of heart
(3) Joints (4) Ventricle of brain

73. Covering of heart is called
(1) Pericardium (2) Peritoneum
(3) Perineurium (4) Periostium

74. The middle layer of heart is known as
(1) Endocardium (2) Pericardium
(3) Epicardium (4) Myocardium

75. Post caval in right auricle is guarded by
(1) Eustachian Valve (2) Bicuspid valve
(3) Tricuspid valve
(4) Atrio-ventricular valve

76. Tricuspid valve are present between
(1) Right auricle and right ventricle
(2) Sinous venosus and right auricle
(3) Left auricle and left ventricle
(4) Superior and inferior vena cava

77. Auricles of human heart contains
(1) Columnae carnae (2) Chordae tendenae
(3) Papillary muscles (4) Purkinje's fibres

78. Right auricle of mammalian heart receives blood from
(1) Sinus vinosus (2) Pulmonary veins
(3) Precavals (4) Pre and postcavals

79. During ventricular diastole
(1) The auricles relax (2) The heart contracts
(3) The heart pumps blood
(4) The ventricles relax

80. In rabbit, the four chambered heart promotes
(1) Double circulation
(2) Single circulation
(3) Systematic circulation
(4) Venous circulation

81. Trilobed valve present between right atrium and ventricle in mammalian heart is
(1) Triac (2) Triad
(3) Tricuspid or besian (4) Trigeminal

82. For reaching left side of heart, blood must pass through
(1) Liver (2) Kidneys
(3) Lungs (4) Brain

83. Which one of the statement is correct with reference to the circulation of blood in a mammal
(1) Left auricle receives oxygenated blood from the lungs
(2) Pulmonary artery returns oxygenated blood from the lungs to the left auricle
(3) Pulmonary vein carries venous blood from right auricle to lungs
(4) Venous blood is returned to the left auricle

84. Mixing up of arterial and venous blood does not take place in a heart having
(1) Two chambers (2) Four chambers
(3) Three chambers (4) None of the above

85. Tricuspid valve is present in
(1) Right auricle (2) Right ventricle
(3) Left ventricle (4) Left auricle

86. Mitral valve in mammals guards the opening between
(1) Stomach and intestine
(2) Pulmonary vein and left auricle
(3) Right auricle and right ventricle
(4) Left auricle and left ventricle

87. Tunica media of an elastic artery is made up of mainly
(1) Smooth muscle fibre
(2) Loose alveolar tissue
(3) Elastic fibres
(4) Collagen fibres

88. Which of the following statements is false

(1) Blood from the right side of the heart is carried to the lungs by the pulmonary artery

(2) The term 'pleura' refers the double layered covering of the kidney

(3) Pancreas is both an exocrine and endocrine gland

(4) Scurvy is caused by the deficiency of vitamin C

89. Histology of heart superficially shows the following structure except

(1) Endocardium (2) Cardiac muscle

(3) Fibrous pericardium

(4) Tunica intima

90. Cardiac muscle is composed of

(1) Striated, branched and voluntary muscle fibres

(2) Unstriated (smooth), spindle shaped and voluntary muscle fibres

(3) Unstriated (smooth), spindle shaped and involuntary muscle fibres

(4) Striated, branched and involuntary muscle fibres

91. How much of the total blood volume is present in heart

(1) 2.5 % (2) 17 %

(3) 9 % (4) 15 %

92. Bicuspid valve is also called as

(1) Mitral valve (2) Eustachean valve

(3) Pulmonary valve (4) Ventricular valve

93. Largest heart is found in

(1) Elephant (2) Giraffe

(3) Crocodile (4) Lion

94. Which of the following has the thickest wall

(1) Left auricle (2) Left ventricle

(3) Right auricle (4) Right ventricle

95. The blood returning to the heart from lungs via pulmonary vein has more

(1) RBC per ml of blood

(2) Haemoglobin per ml of blood

(3) Oxygen per ml of blood

(4) Nutrient per ml of blood

96. Which of the following structure is absent in rabbit's heart

(1) Left auricle (2) Left ventricle

(3) Sinus venosus (4) Pace maker

97. Heart of elephant is

(1) Neurogenic (2) Myogenic

(3) Both (1) and (2) (4) None of these

98. What is correct about sinus venosus

(1) It is situated on dorsal surface of rabbit heart

(2) It is situated ventrally in frog heart

(3) It sends blood to dorsal aorta

(4) It opens into right auricle

99. The wall of heart is made up of

(1) Epicardium (2) Myocardium

(3) Endocardium (4) All of the above

100. Pylangium is part of

(1) Truncus arteriosus (2) Left atrium

(3) Right atrium (4) Ventricles

101. The contraction of the heart of frog commences from

(1) Sinus venosus

(2) Right auricle

(3) Left auricle

(4) Interauricular septum

102. Heart is simple tubular and ventral in

(1) Urochordata (2) Cyclostomata

(3) Cephalochordata (4) Vertebrate

103. Valve of Thebesius occurs in the heart of

(1) Fish (2) Frog

(3) Rabbit (4) Chameleon

104. Heart of prawn carries

(1) Oxygenated blood

(2) Deoxygenated blood

(3) Mixed blood

(4) No blood

105. In frog's heart, there are muscular ridges which consist of fibres called

(1) Myonemes

(2) Purkinjee fibres

(3) Telodendria

(4) Columneae carnae

106. Even the ventricles of reptiles are partitioned but there is mixing of blood

(1) Due to common ejection and entrance of blood in lungs

(2) Auricles are non-separated

(3) Heart is partially four-chambered

(4) None of these

107. In the mammalian heart, ventricular filling of blood takes place due to

(1) Relaxation of right ventricle

(2) A higher blood pressure in right auricle

(3) Adequate blood in the right auricle (4) All the above actions

108. The thick muscular projections on the walls of the ventricle are called

(1) Chordae tendinae (2) Columnae carnae

(3) Conus arteriosus

(4) Truncus arteriosus

109. Atherosclerosis refers to the ailment of

(1) Lungs (2) Heart

(3) Kidney (4) Liver

110. Inter-auricular septum in the embryonic stages has a/an

(1) Fossa ovalis (2) Fenestra ovalis

(3) Fenestra rotunda

(4) Inter-auricular aperture

111. The sinu-auricular valve occurs

(1) In the sinus venosus

(2) In the edges of sinu-auricular aperture

(3) In the truncus arteriosus

(4) At the auriculo-ventricular aperture

112. The coronary sinus in the heart is situated along its

(1) Left margin (2) Right margin

(3) Diaphragmatic surface

(4) Lower boarder of the heart

113. Purkinje fibre is found in

(1) Conduction system of heart

(2) Brain

(3) Nephrons of kidneys

(4) Sensation of skin

114. Neurogenic heart is characteristic of

(1) Lower vertebrates (2) Humans

(3) Rat (4) Rabbit

115. Eustachian valve which is of no significance in the adult mammal, is a vestigial organ, a vestige of

(1) Spiral valve (2) Sinus venosus

(3) Sino-auricular valve

(4) Semilunar valve

116. Which is not true for cardiac muscles

(1) Presence of intercalated disc

(2) Striated nature

(3) Involuntary

(4) Voluntary

117. The pericardium and the pericardial fluid help in

(1) Protecting the heart from friction, shocks and keeps it moist

(2) Pumping the blood

(3) Receiving the blood from various parts of the body

(4) None of the above

118. The atrio-ventricular valves of the heart is prevented from turning inside out by tough strands of connective tissue is called as

(1) Tendinous cords (2) Tricuspid

(3) Pocket valve (4) Mitral valve

119. Wenckebach phenomenon is seen in

(1) Complete heart block

(2) Partial heart block

(3) Ventricular fibrillation

(4) Myocardial infarction

120. Since it is the sinu-auricular node which initiates the impulses the heart of mammal is called

(1) Cholinergic (2) Adrenergic

(3) Neurogenic (4) Myogenic

121. Which one of the following doctors performed the first heart transplant

(1) Hargovind Khorana

(2) Christian Bernard

(3) Watson (4) William Harvey

122. The tricuspid valve is present at the origin of

(1) Carotid arch (2) Pulmonary arch

(3) Truncus arteriosus (4) Systemic arch

123. Bicuspid and tricuspid valve are supported by

(1) Columnae carnae (2) Endocardium

(3) Chordae tendinae (4) Epicardium

124. What happens if the sympathetic nervous system is stimulated

(1) Heartbeat increases

(2) Cardiac output decreases

(3) Blood pressure is lowered

(4) Pulse becomes erratic and falls steadily

125. Sinus venosus is spread over

(1) Dorsal surface of the heart of frog

(2) Dorsal surface of the heart of rabbit

(3) Ventral surface of the heart of frog

(4) Ventral surface of the heart of rabbit

126. Right chamber of Atria have :

(1) Semilunar valve (2) Bundle of Hiss

(3) Cordiactendinae (4) S.A. Node

127. In India first successful heart transplant was performed at

(1) Escorts Hospital, New Delhi

(2) Apollo Hospital, Madras

(3) AIIMS, New Delhi

(4) Batra Hospital, New Delhi

128. First successful heart transplant was conducted by

(1) Dr. N. Trihan (2) Dr. Venugopal

(3) Dr. M.S. Mani (4) Dr. Gambhir

129. Foramen of panizzae is found in the heart of

(1) Frog (2) Pigeon

(3) Crocodile (4) Rabbit

130. What is not true about the pace maker

(1) It initiates and maintains heart beat at the rate of 72/min.

(2) It is present in the right auricle

(3) Its activity is modulated by various chemicals

(4) It is not a characteristic of myogenic heart

131. What is true about the pace maker present in human heart

(1) Initiates and regulates heart beat

(2) Increases cardiac output

(3) Is not affected by acetylcholine

(4) Does not respond to epinephrine

132. What is not true about human heart

(1) Myogenic

(2) Rhythmicity

(3) Heart beat initiated and controlled by SA node

(4) AV node modulate and dominate the activities of pace maker

133. AV node was discovered by

(1) Loewis (2) His

(3) Ringer (4) Harvey

134. Bundle of His is a network of

(1) Nerve fibres found throughout the heart

(2) Muscle fibres distributed throughout the heart walls

(3) Muscle fibres found only in the ventricle wall

(4) Nerve fibres distributed in ventricles

135. If the pace maker is absent

(1) Only auricles will contract

(2) Only ventricles will contract

(3) Cardiac muscles will contract in a coordinated manner

(4) Cardiac muscles will not contract in a coordinated manner

136. A pace maker is meant for

(1) Transplanting liver

(2) Transplanting heart

(3) Initiation of heart beats

(4) Regulation of blood flow

137. Identify the incorrectly matched pair

(1) Diastole - Phase of contraction of cardiac muscle

(2) Systole-Dilation phase of cardiac muscle

(3) Duration of cardiac cycle in humans 0.8 sec.

(4) Haemoglobin - Respiratory pigment

138. QRST is related with
(1) Ventricular contraction or depolarization
(2) Auricular contraction
(3) Auricular relaxation
(4) Cardiac cycle

139. In an ECG, QRS wave represent
(1) Activity of pace setter
(2) Auricular relaxation
(3) Ventricular contraction
(4) Ventricular relaxation

140. In an old man's ECG, T-waves shall be
(1) Flat (2) Inverted
(3) Very prominent (4) Same as in adults

141. Although much CO_2 is carried in the blood, yet blood does not becomes acidic. This is because
(1) In CO_2 transport, blood buffers play an important role
(2) CO_2 combines with water to form H_2CO_3 which is neutralised by
(3) CO_2 is continuously diffused through the tissues and is not allowed to accumulate
(4) CO_2 is absorbed by leucocytes

142. What is the end diastolic volume of blood in a normal adult heart
(1) 50 ml (2) 70 ml
(3) 90 ml (4) 110 ml

143. Which of the following cardiac effects can be observed if the potassium concentration is increased two to three times the normal value
(1) Weakness of heart (2) Abnormal rhythm
(3) Death (4) All the above

144. In all the leads of ECG, all following are positive waves except
(1) P (2) Q
(3) R (4) T

145. Which of the following is a repolarization wave
(1) P (2) T
(3) QRS (4) None of these

146. ECG records
(1) Electric current of the body
(2) Potential differences
(3) Pulse rate
(4) Quantity of blood pumped per minute

147. Sinu-atrial node is innervated by branches of
(1) V cranial nerve (2) X cranial nerve
(3) IX cranial nerve (4) VI cranial nerve

148. A man will be unconscious if the blood supply to the brain is stopped for more than
(1) 2 second (2) 5 second
(3) 10 second (4) 30 second

149. The blood pressure is high in
(1) Arteries (2) Veins
(3) Capillaries
(4) Veins of portal system

150. Fall in blood pressure due to loss of blood is soon restored because the
(1) Blood vessels dilate
(2) Blood cells decrease in number
(3) Heart beat is increased
(4) Heart beat is decreased

151. Serotonin in the blood
(1) Relaxes blood vessels
(2) Prevents clotting of blood
(3) Helps in clotting of blood
(4) Constricts blood vessels

152. Systolic pressure is higher than diastolic pressure because
(1) Arteries are contracting during systole
(2) Blood is pumped with a pressure in the arteries by the heart during systole but not during diastole.
(3) Arteries resist during systole only
(4) Volume of blood is higher in systole than that of diastole in the heart

153. In several vertebrates the rate of heart beat and increase in blood pressure is caused by a hormone
(1) Thyroxin (2) Secretin
(3) Noradrenalin (4) Adrenalin

154. In man, blood passes from the post caval into the diastolic right atrium of the heart because of
(1) Pushing of venous valves
(2) Suction pull
(3) Beating of S.A. node
(4) Pressure between post caval and atrium

155. Sphygmomanometer measure
(1) Nerve conduction rate
(2) Heart beat rate
(3) Blood pressure (4) Pulse rate

156. Renin is released by the kidney when the arterial blood pressure
(1) Gets elevated (2) Becomes low
(3) Remains constant (4) Becomes high

157. Cardiac output signifies
(1) The amount of blood entering the heart per unit time
(2) The amount of blood entering the lung per unit time
(3) The amount of blood leaving the heart per unit time
(4) The amount of blood leaving the lung per unit time

158. Normal diastolic pressure in young man is about
(1) 20 mm Hg (2) 80 mm Hg
(3) 110 mm Hg (4) 130 mm Hg

159. How much arterial pressure rises during arterial contraction (mm Hg)
(1) 2 – 4 (2) 4 – 6
(3) 6 – 8 (4) Does not rise at all

160. If glucose is to be injected in human blood, the property to be matched with glucose is
(1) Density (2) Viscosity
(3) Osmotic potential (4) Sugar group

161. For the diffusion to take place effectively in capillaries the blood stays there for how long
(1) 1 - 3 second (2) 5 - 9 second
(3) 9 - 13 second (4) > 20 second

162. Heart rate is increased by all the following except
(1) Anoxia
(2) Moderate excess
(3) Elevated body temperature
(4) Increased intracranial pressure

ANSWER KEY

EXERCISE - 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	4	3	4	4	3	3	3	3	2	1	4	1	4	4	4	3	1	2	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	4	1	4	4	3	1	3	3	2	1	4	4	2	2	1	3	2	2	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	2	4	3	1	4	2	1	1	4	3	3	1	4	1	4	4	1	3	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	1	1	1	4	2	4	1	4	1	1	1	1	4	1	1	4	4	4	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	3	1	2	1	4	1	2	4	4	3	1	1	2	3	3	2	4	4	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	1	3	1	4	3	4	2	2	1	2	2	1	1	3	4	1	1	2	4
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	2	3	1	1	4	3	2	3	4	1	4	4	3	4	3	1	1	3	1
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	1	4	4	2	2	2	2	2	1	3	4	2	4	4	3	2	3	2	3	3
Ques.	161	162																		
Ans.	1	4																		

EXERCISE - 2

Q.1 All arteries carry oxygenated blood except
(1) Systemic (2) Hepatic
(3) Pulmonary (4) Cardiac

Q.2 Heart beat in vertebrates is –
(1) Neurogenic (2) Myogenic
(3) Both (4) None

Q.3 Rate of heart beat in frog is –
(1) 72 times per minutes
(2) 75 times per minutes
(3) 50 times per minutes
(4) 64 times per minutes

Q.4 Single heart circuit occurs in –
(1) Fishes (2) Frog
(3) Reptiles (4) Man

Q.5 Which of these has a closed type of circulatory system –
(1) Cockroach (2) Fish
(3) Mollusca (4) Scorpion

Q.6 Pain in heart muscle is–
(1) Angina
(2) Angina pericardius
(3) Angina pectoris
(4) None

Q.7 Heart of frog differs from that of rabbit by presence of –
(1) Sinus venosus (2) Four chambers
(3) Mitral valve (4) Two aortae

Q.8 Study of blood circulation system is called–
(1) Angiology (2) Cardiology
(3) Haematology (4) Osteology

Q.9 Father of Angiology is–
(1) William Harvey
(2) Batson
(3) Marsello Malpighi
(4) Landsteinar

Q.10 'Vasa Vasorum' refers to–
(1) Jugular anastomosis
(2) A netwatk of blood vessels in an organ
(3) 'Vessels of vessels' nutritive in function
(4) Carotid labyrinth regulating pressure of blood vessels

Q.11 Coronary artery supplies blood to–
(1) Mammary glands (2) Ribmuscles
(3) Skin (4) Heart

Q.12 When there is a sudden loss of blood from the body the organ which supplies blood is–
(1) Spleen (2) Heart
(3) Liver (4) Lungs

Q.13 The blood vascular system of rabbit is–
(1) Open type (2) Closed type
(3) Semi closed type (4) Semi open type

Q.14 Carotico-systemic arch aries from–
(1) Right auricle (2) Right ventricle
(3) Left auricle (4) Left ventricle

Q.15 The colour of lymph is–
(1)White (2) Pale yellow
(3) Colourless (4) Milky

Q.16 Lymph node in man are found abundantly in–
(1) Fingers (2) Neck
(3) Arms (4) Legs

Q.17 Coagulation of lymph is–
(1) Faster than blood
(2) Not possible
(3) Slower than blood
(4) A passive process

Q.18 An artery can be distinguised from a vein in having
(1) Thicker wall (2) Lesser lumen
(3) No valves (4) All of the above

Q.19 The most important center of lymph formation is–

(1) Liver (2) Spleen

(3) Bone marrow (4) Mucosa of ieum

Q.20 The renal portal system of vertebrates is significant for–

(1) Elimination of excess fats by kidneys

(2) Removing nitrogenous wastes in kidneys

(3) Sypplying food to the kidneys

(4) Draining blood from the kidney

Q.21 The spleen of rabbit serves to–

(1) Generate all blood cells in early foetal life

(2) Produce lymphocytes, monocytes and antibodies in adult stage

(3) Acts as blood bank for the peiod of emergency and control blood volume in adults

(4) All of the above

Q.22 The wall fo Rabbit's heart is thick due to presence of –

(1) Inner layer endocardin

(2) Middle layer mycardium

(3) Outer most layer paricardium

(4) Outer layer epicardium

Q.23 Removal of which organ will have least effect in an adult Rabbit–

(1) Spleen (2) Liver

(3) Pancreas (4) Pituitary

Q.24 The pulmonary aorta aries from–

(1) Left ventricle (2) Right ventricle

(3) Left auricle (4) Right auricle

Q.25 Contraction of heart is called–

(1) Peristalsis

(2) Systole

(3) Diastole

(4) Voluntary contraction

Q.26 Mitral valve is the other name of–

(1) Valve found in venacava

(2) Valve found at the base of dorsal aorta

(3) Tricuspid valve

(4) Bicuspid valve

Q.27 Thebesian valve guards–

(1) Coronary sinuns

(2) Bases of pulmonary veins

(3) Opening between right auricle & right ventricle

(4) Opening between left auricle and left ventricle

Q.28 The rate of heart beat in a Rabbit is nearly–

(1) 92 per minute (2) 100 per minute

(3) 72 per minute (4) 200 per minute

Q.29 Bundle of His originates from–

(1) Sinu-auricular node

(2) Auriculo-ventricular node

(3) Pulmonary aorta

(4) Systemic aorta

Q.30 The small oval depression found on inter auricular septum in adult Rabbit is termed–

(1) Foramen ovale

(2) Fossa ovalis

(3) Foramen of monro

(4) Foramen of magnum

Q.31 Purkinje fibres mainly help in contraction of–

(1) Right auricle (2) Left ventricle

(3) Ventricles (4) Aorta

Q.32 One of the following nerves inhibit the rate of heart beat–

(1) Vagus

(2) Sympathetic

(3) Ocullomotor

(4) None of the above

Q.33 Sinus venosus in mammals is believed to have merged with the wall of–

(1) Right auricle (2) Left auricle

(3) Right ventricle (4) Left ventricle

Q.34 Which one of the following is the main graveyard of RBC–
(1) Bone marrow (2) Spleen
(3) Liver (4) Kidney

Q.35 Brachial arteries suply blood to–
(1) Neck (2) Fore lims
(3) Chest (4) Abdomen

Q.36 A portal system is that in which–
(1) A vein begins from an organ and ends in heart
(2) An artery breaks up in an orgain & restarts by the union of its capillaries
(3) The blood from gut is brought in to kidneys before it is poured in to heart
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ

Q.37 Right sub clavian artery in Rabbit arises from–
(1) Right common carotic artery
(2) Carotico sytemic aorta
(3) Dorsal aorta
(4) Innominate artery

Q.38 Adult mammals have–
(1) Only left aortic arch
(2) Only right aortic arch
(3) Both of the above
(4) Completely developed left arch but right arch is poorly developed

Q.39 The papillary muscles are helpful in–
(1) Movement of eye balls
(2) Movement of eye lids
(3) Closing & opening thevalves of heart
(4) Movement of pinnae

Q.40 After the death of Rabbit–
(1) Both veins & arteries are empty
(2) Both veins & arteries are empty
(3) Arteries are full of blood while veins are empty
(4) Veins are full of blood while arteries are empty

Q.41 Indicate correct statement for Rabit–
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood
(2) Venous blood is retured to left aurilce
(3) Arteries are provided with valves while veins are devoid to valves
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart

Q.42 A vein differ from an artery in having–
(1) Strong muscular walls
(2) Narrow lumen
(3) Valves to control direction of blood flow opposite to heart
(4) Valves to control direction of blood flow towards heart

Q.43 The correct sequence of layers found in the walls of arteries from inside outward is–
(1) Tunica adventitia, tunica interna & tunica media
(B) Tunica interna, tunica externa & tunica media
(3) Tunica interna, tunica media & tunica externa
(4) Tunica media , tunica externa & tunica interna

Q.44 If spleen of Rabbit is removed from body then–
(1) Animal will die
(2) Number of blood plateles will increase
(3) Number of blood plateles will decrease
(4) There will be no effect on the number of blood plateles

Q.45 Heart of Rabbit does not have–
(1) Right auricle (2) Sinus venosus
(3) Conus arterious (4) Both B & C

Q.46 The 'Lubb' and "Dupp" heart sound are due to–
(1) Opening of heart valves
(2) Action of papillary muscles
(3) Closing of heart valves
(4) Activity of pace maker

Q.47 The valves of the heart are attached to papillary muscles by–
(1) Columnae corrinae
(2) Chordae tendinae
(3) Tendinae
(4) Pectinati muscles

Q.48 In cyanosis colouration of body parts appears–
(1) Bluish (2) Yellowish
(3) Reddish (4) Brownish

Q.49 Filter apparatus for dead R.B.C is–
(1) Spleen + Kidney
(2) Liver + Kidney
(3) Spleen + Liver + Kidney
(4) Liver + Spleen

Q.50 Heart of fishes–
(1) Two chambered
(2) Venous heart
(3) Both
(4) None of the above

Q.51 Cells foming the wall blood capillaries are called–
(1) Oxyntic cells (2)Endothelium cells
(3) Parietal cells (4) Haemocytes

Q.52 Blood pressure and heart beat is regulated by–
(1) Insulin (2) Adrenalin
(3) Optic nerve (4)Growth hormone

Q.53 The pace maker in frog heart is–
(1) SA Node (2) AV Node
(3) Conus arterious (4) Heart muscles

Q.54 Heart beat is controlled by which cranial nerve–
(1) X^{th} (2) IX^{th}
(C) III^{rd} (D) V^{th}

Q.55 Blood capillaries are made of–
(1) Endothelium and thin coat of connective tissue
(B)Endothelium and thin coat of muscle fibres
(3) Endothelium and thin coat of connective tissue and muscle fibres
(4) Only endothelium

Q.56 If the vagus branch of frog is stimulate the heart will show–
(1) Stoppage of heart beat
(2) Decreased heart beat
(3) Increased heart beat
(4) No change

Q.57 The heart sound "DUP" is Produced when
(1) Mitral valve opens
(2) Mitral valve closes
(3) Semilunar valve at the base of aorta closes
(4) Tricuspid valve opens

Q.58 Red pulp and whit pulp are histological structure found in–
(1) Tooth (2) Spleen
(3) Bone (4) Liver

Q.59 Where is the pace makes situated–
(1) In left auricle near opening of pulmonary vein
(2) In right auricle near eustachan valve
(3) On inter–auricular septum
(4) On inter–ventricular septum

Q.60 Papillary muscles are found in –
(1) Haemocoel of cockroach
(2) Auricles of heart
(3) Ventricles of heart
(4) Arm

Q.61 In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving–
(1) Fossa-ovalis
(2) Carotico pulmonary aperture
(3) Ligamentum arteriosus
(4) None of these

Q.62 Right atrium or auricle in mammalian heart receives blood From–
(1) Precavals
(2) Precavals and post cavals
(3) Pulmonary veins
(4) Sinus venosus

Q.63 Blood circulation take following course in heart of mammals –
(1) Left auticle–left ventricle–body–right auricle–right ventricle
(2) Right auricle–left
(3) Left auricle–left ventricle–lungs–right auricle–right ventricle
(4) None of them

Q.64 Pulmonary veins are those which–
(1) Carry impure blood from lungs to heart
(2) Carrying pure blood from lungs to heart
(3) Carry impure blood from heart to lung
(4) Carry pure blood from heart to lungs

Q.65 To reach the left side of heart the blood must pass through–
(1) Sinus venosus (2) Kidneys
(3) Liver (4) Lungs

Q.66 How many contraction nodes are found in heart of Rabbit–
(1) One (2) Two
(3) many (4) None

Q.67 Characteristics of cardiac muscles are that they–
(1) Contract quicly and get fatigued
(2) Contract quicly and do not get fatigued
(3) Contract slowly and get fatigued
(4) Contract slowly and do not get fatigued

Q.68 Larget amount of urea in blood is found in–
(1) Hepatic portal vein
(2) Hepatic artery
(3) Coeliac artery
(4) Renal artery

Q.69 Oxygenated blood is carried by–
(1) Pulmonary artery
(2) Pulmonary vein
(3) Renal vein
(4) Hepatic portal vein

Q.70 Lymph can be defined as–
(1) Blood minus corpuscles
(2) Blood minus plasma
(3) Blood minus WBC
(4) Blood minus RBC & Platlates

Q.71 Sphygmomanometer measures
(1) Blood pressure
(2) Pulse rate
(3) Rate of heart beat
(4) All

Q.72 Chordae tendinae are found in–
(1) Ventricles of brain
(2) Ventricles of heart
(3) Auricles of heart
(4) Connection between bone

Q.73 William Harvey is credited with discovery of–
(1) Blood clotting
(2) Blood circulation
(3) Process of digestion
(4) Mechanism of respiration

Q.74 A Pace maker of S.A. Node is found in–
(1) Lungs (2) Brain
(3) Spleen (4) Heart

Q.75 The blood during diastole–
(1) Leaves the heart (2) Enters the heart
(3) Enters lungs (4) Heart

Q.76 The blood vein have :
(1) More CO_2
(2) More O_2
(3) Both
(4) None

Q.77 Eustachian valve occurs in–
(1) Connection between middle ear and pharynx
(2) Middle ear
(3) Left ventricles of heart
(4) Right auricle of heart

Q.78 Heart of Man is–
(1) Myogenic (2) Neurogenic
(3) Cardiogenic (4) Digenic

Q.79 In heart of Rabbit bicuspid valve is situated in–
(1) Right auricle and pulmonary aorta
(2) Post caval and auricle
(3) Left auricle and left ventricle
(4) Right auricle and right ventricle

Q.80 Which has no muscular walls–
(1) Capillary (2) Arteriole
(3) Veins (4) Artery

Q.81 Pulse beat is measured in–
(1) Veins (2) Artery (Radial)
(3) Nerve (4) Capilary

Q.82 pH of blood in arteries and vein is–
(1) More in veins and less in arteries
(2) More in arteries and less in veins
(3) same (4) Not definite

Q.83 In a normal man blood pressure is–
(1) 120/80 mm of Hg
(2) 80/120 mm of Hg
(3) 80/120 mm of Hg
(4) 100/80 mm of Hg

Q.84 Post caval opening in right auricle is guarded by–
(1) Arterio-ventricular valve
(2) Tricuspid valve
(3) Bicuspid valve
(4) Eustachain valve

Q.85 When the right ventricle contracts the blood is pump in to–
(1) Superior vena cava
(2) Dorsal aorta
(3) Pulmonary aorta
(4) Pulmonary veins

Q.86 The blood leaving the lungs is richer than the blood entering the lung in–
(1) Oxygen (2) CO_2
(3) Hydrogen (4) Moisture

Q.87 Caroid artery carries the blood which is–
(1) Impure blood to kidneys
(2) Oxygenated blood to brain
(3) Oxygenated blood to heart
(4) Inpur blood from brain

Q.88 Role of spleen in mammals is–
(1) To control blood pressure
(2) To assist liver
(3) To assist kidneys
(4) To act as haemopoitic tissues in embryo

Q.89 Pace maker influences–
(1) Contraction of heart muscles
(2) Flow of blood in heat
(3) Rate of heart beat
(4) Formation of nerve impulse

Q.90 In which of the following charactor a vein differs from an artery–
(1) Having valves to control flow of blood
(2) Having narrow lumen
(3) Having muscular wall
(4) Having pigmented wall to give dark look

Q.91 Systolic pressure is higher than diastolic pressure due to–
(1) Volume of blood in the heart is greater during systole
(2) Arteries contract during systole
(3) Blood vessels offer ressistance to flowing blood during systole
(4) Blood is forced into arteries during systole

Q.92 The venous system of from differs form that of a mammals in the presence of–
(1) Ranal portal system
(2) Hapatic portal system
(3) Three superior venacava
(4) Hepatic vein

Q.93 First heart transplant was perfomed by–
(1) William harvey (2) Watson
(3) Christian Bernard (4) Khorana

Q.94 When heart beat is decreased than normal is called–
(1) Bradicardia (2) Tachycardia
(3) Hypocardia (4) Nicacardia

Q.95 First heat sound is–
(1) Lubb sound at the end of systole
(2) Lubb sound at the gegining of ventricular systole
(3) 'Dup' sound at the end of systole
(4) Dup sound at the begining of ventricular systole

Q.96 Which artery supplies blood to the diaphragm–

(1) Phrenic (2) Splenic

(3) Renal (4) Caudal

Q.97 Which one of the following organ can be called a sort of 'blood bank'

(1) Heart (2) Liver

(3) Spleen (4) Lungs

Q.98 A renal portal system is found in–

(1) Rabbit (2) Mouse

(3) Horse (4) Frog

Q.99 Purkinje fibres are found in–

(1) Brain (2) liver

(3) eyes (4) Heart

Q.100 Blood of which vessel in mammals carries least percentage of urea –

(1) Dorsal aorta

(2) Renal vein

(3) Renal artery

(4) Posterior vena cava

ANSWER KEY

EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	2	4	1	2	3	1	1	1	3	4	1	2	4	3	2	3	4	4	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	2	1	2	2	4	1	4	2	2	3	1	1	2	2	4	1	1	3	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	3	3	4	4	3	2	1	3	3	2	2	1	1	4	2	3	2	2	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	2	1	2	4	2	2	4	2	4	1	2	2	4	2	1	4	3	1	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	2	1	4	3	1	2	4	1	1	4	1	3	1	2	1	3	4	4	2

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Which organ receives only oxygenated blood? **[AFMC 2001]**

(1) Gill (2) Spleen

(3) Lung (4) Liver

Q.2 Largest heart is of **[KCET 2003]**

(1) Giraffe (2) Elephant

(3) Crocodile (4) Lion

Q.3 Cardia output is blood **[Karnataka 1996]**

(1) Received by heart per minute

(2) Pumped by ventricles per sec

(3) Pumped by left ventricle per minute

(4) Pumped by left ventricle per hour

Q.4 Pericardial fluid is secreted by **[HP PMT 1995]**

(1) Myocardium

(2) Perietal peritoneum

(3) Visceral peritoneoum

(4) Pericardium

Q.5 Which one generates heart beat? **[Punjab PMT 1997]**

(1) Pukinje fibres

(2) Cardiac branch of vagus nerve

(3) SA nnode (4) AV node

Q.6 Heart wall is made of **[Punjab PMT 1997]**

(1) Myocardium (2) Epicardium

(3) Endocardium (4) All the above

Q.7 In order to study blood circulation in rat, capillaries are observed in

(1) Mesentery (2) Kidney

(3) Liver (4) Lung

Q.8 Glucose is carried from digestive tract to liver by **[CBSE 1999]**

(1) Hepatic artery

(2) Hepatic portal vein

(3) Pulmonary vein

(4) None of the above

Q.9 Match the columns **[Karnataka 1999]**

	Column I		Column II
(a)	Superior Vena Cava	(p)	Carries deoxysgenated
(b)	Inferior Vena Cava	(q)	Carries oxygenated blood from lungs
(c)	Pulmonary Artery	(r)	Brings deoxygenated blood from lower parts of body to right atrium
(d)	Pumonary Vein	(s)	Brings deoxygentaed blood from upper parts of body into right atrium

(1) a–q, b–t, c–r, d–p

(2) a–t, b–p, c–q, d–r

(3) a–t, b–r, c–p, d–q

(4) a–t, b–p, c–r, d–q

Q.10 During high blood pressure, regulations of heart beat and circulation are controlled by **[AIIMS 1999]**

(1) Vasodilator and vasconstrictor centres

(2) Cardio-stimulatory and vasoconstrictor centres

(3) Cardio-inhibitory and vasocintrictor centres

(4) Cardio-inhibitory and vasodilator centers

Q.11 Pulmonary artery differs from pulmonary vein in having **[CBSE 2000]**

(1) Thick wall (2) Thin wall

(3) Valves (4) Both (2) and (3)

Q.12 Blood vessel which brings oxygenated blood to left auricle is **[AFMC 2000]**

(1) Precaval vein (2) Post caval vein

(3) Pulmonary vein (4) Pulmonary artery

Q.13 Blood pressure is measured by **[AIIMS 2000]**

(1) Sphygmonanometer

(2) Phonocardiogram

(3) Electrocardiogram

(4) Stethoscope

Q.14 Heart beat is inititated by **[CET Chd. 2000]**

(1) AV node (2) SA node

(3) Bundle of His (4) Purkinje fibres

Q.15 Match the columns **[Karnataka 2000]**

	Column I		Column II
(a)	Bicuspid valve	(p)	Brain
(b)	Nephron	(q)	Liver
(c)	Alveoli	(r)	Heart
(d)	cerebrum	(s)	Kidney
		(t)	Lungs

(1) a–s, b–r, c–p, d–t

(2) a–r, b–t, c–s, d–p

(3) a–r, b–s, c–t, d–p

(4) a–s, b–q, c–p, d–t

Q.16 All veins have deoxygenated blood except **[AIIMS 2001]**

(1) Renal vein (2) Hepatic vein

(3) Hepatic portal vein

(4) Pulmonary veins

Q.17 'Dup' sound is produced during closure of

(1) Semilunar valves (2) Bicuspid valve

(3) Tricuspid value (4) Both (2)and (3)

Q.18 The value of diastolic blood pressur is **[Karnataka 2001]**

(1) 120 mm Hg (2) 80 mm Hg

(3) 120/80 mg Hg (4) 40 mg Hg

Q.19 Normal pulse pressure is **[Manipal 2001]**

(1) 80 mm Hg (2) 120 mm Hg

(3) 40 mg Hg (4) 40 mg Hg

Q.20 Arterial blood pressure in human beings

(1) 120 and 80 mm Hg

(2) 150 and 100 mm Hg

(3) 50 and 100 mm Hg

(4) None

Q.21 Ventricular contraction in command of– **[CBSE 1999]**

(1) S.A. Node (2) A.V. Node

(3) Pukinje fibers (4) Papillary muscles

Q.22 Fully digested food reaches to liver by– **[CBSE 1999]**

(1) Hepatic portal vein

(2) Hepatic artery

(3) Hepatic vein (4) All the above

Q.23 Impulse of heart beat originates from **[CBSE 2002]**

(1) S.A. Node (2) A.V. Node

(3) Vagus Nerve (4) Cardiac Nerve

Q.24 Which of the following statement is true for Lymph **[CBSE 2002]**

(1) WBC adn serum

(2) All components of blood except RBCs, Platelets and some proteins

(3) RBCs, WBCs and Plasma

(4) RBCs, Proteins and Platelets

Q.25 Bundle of His is a network of - **[CBSE 2003]**

(1) Muscle fibres distributed throughout the heart walls

(2) Muscle fibres found only in the ventricle wall

(3) Nerve fibres distributed in ventricles

(4) Nerve fibres found throughout the heart

Q.26 Systemic heart refers to - **[CBSE 2003]**

(1) The heart that contracts under stimulation from nervous systm

(2) Left auricle and left ventricle in higher vertebrates

(3) Entire heart in lower vertebrates

(4) The two ventricle together in humans

Q.27 The cardiac pacemaker in a patient fails to function normally. The doctors find that an artifical pacemaker is to be grafted in him. It is likely that it will be drafted at the site of- **[CBSE 2004]**

(1) Purkinje system (2) Sinuatrial node

(3) Atrioventricular node

(4) Atrioventricular bundle

Q.28 If parasympathetic nerve of the Rabbit is cut then heart beat - **[RPMT 2001]**

(1) Unaffected (2) Decreases

(3) Increases (4) Stop

Q.29 In Rabbit oxygenated blood flows from - **[RPMT 2001]**

(1) Left auricle to left ventricle durin gauricular systole

(2) Righ tauricle to right ventricle during ventricular

(3) Right ventricle to aorta during ventricular systole

(4) Pulmonary vein to left auricle during auricular systole

Q.30 Which of the folllowing vessel in rabbit starts with capillaries and ends in capillaries- **[RPMT 2002]**

(1) Pulmonary artery (2) Renal vein

(3) Hepatic portal vein

(4) Renal artery

Q.31 In cardiac circulation, "Dup" sound is heard when **[RPMT 2003]**

(1) Mittral valves close

(2) Mittral valves open

(3) Semilunar valves

(4) Tricuspid valve close

Q.32 Lymph vessels pour trheir materials in **[RPMT 2003]**

(1) Vena cava which enters in right auricle

(2) Pulmonary artery

(3) Artery which enters in legs

(4) Rgiht ventricle

Q.33 Which of the following have thickest wall **[RPMT 2003]**

(1) Right auricle (2) Left auricle

(3) Right ventricle (4) Left ventricle

Q.34 Which vein in rabbit is unpaired **[RPMT 2004]**

(1) Azygous (2) Hemiazygous

(3) Caudal (4) All of the above

Q.35 Which of the following blood vessel in the circulatory system of frog has more deoxygenated **[Uttaranchal PMT 2004]**

(1) Pulmonary artery

(2) Precaval veins

(3) Pulmocutaneous artery

(4) Pulmocutaneous vein

Q.36 Tachycardia is **[Uttaranchal PMT 2004]**

(1) Fast heart rate (2) Slow heart rate

(3) Stop heart rate (4) Normal heart rate

Q.37 The cardiac impules that results into the heart beat is delayer at - **[West Bengal JEE 2007]**

(1) Intenodal tract (2) AV node

(3) Bundle of His (4) Purkinje fibres

Q.38 Among the following which one is not true about chordae tendinae - **[West Bengal JEE 2007]**

(1) They are strips of muscle fibre

(2) They are attached to the valves

(3) They regulated opening of valves

(4) They prevent backflow of blood

Q.39 The heart keeps on beating throughout the life without fatigue because - **[West Bengal JEE 2007]**

(1) In contracts slowly

(2) It has a resting or recovery period

(3) It can use lactic acid as an extra source of energy

(4) None of the above

Q.40 In the animal body blood bank is - **[Jharkhand 2004]**

(1) Heart (2) Spleen

(3) Lungs (4) Liver

Q.41 Which of the following vessel in Rabbit starts with capillaries and ends in capillaries **[Jharkhand 2003]**

(1) Pulmonary artery

(2) Renal vein

(3) Hepatic ortal vein

(4) Renal artery

Q.42 Pace-maker in heart is situated - **[Jharkhand 2004]**

(1) In the wall of left atrium

(2) In the wall of righ atrium

(3) On inter-ventricular septum

(4) On inter-auricular septum

Q.43 72 beat per minute heart beat rate of man is controlled by **[Bihar 2004]**

(1) SA-node (2) Ventricles

(3) PUrkinje fibers (4) AV-node

Q.44 Cardiac muscles contract **[Bihar 2002]**

(1) quickly and they fatigue

(2) quicklyu and unfatigued

(3) Slowly and are not fatigued

(4) slowly and they fatigue

Q.45 ECG is a measure of - **[Bihar 2002]**

(1) Rate of heart beat

(2) Difference in electric potential

(3) Volume of blood pumped

(4) Ventricular contraction

Q.46 Heart of elephant is **[UP CPMT 2002]**

(1) Neurogenic (2) Myogenic

(3) Loop of Henle

(4) Bownman's capsule

Q.47 Blood leaving liver and moving to heart will have more concentration of - **[UP CPMT 2005]**

(1) Bile (2) Urea

(3) Glycogen (4) Amino acid

Q.48 The blood circulatio which starts and ends into capillaries is **[UP CPMT 2006]**

(1) Renal circulation (2) Portal circulation

(3) Hepatic circulation

(4) Lymphatic circulation

Q.49 Maximum surface area of Circulatory gsystem is seen in - **[UP CPMT 2007]**

(1) Heart (2) Capillaries

(3) Arterioles (4) Veins

Q.50 "Bundle of His" are - **[MP CPMT 2007]**

(1) Nervous tissue supplied to ventricles

(2) Nervou tissue supplied to heart

(3) Muscular tissue supplied to ventricle

(4) Musclular tissue supplied to heart

Q.51 "Bundle of His" is group of - **[MP PMT 2004]**

(1) Nerve fibres (2) Ganglia

(3) Connective tissue (4) Muscle fibres

Q.52 Blood pressure is controlled by - **[MP PMT 2004]**

(1) Pituitary gland (2) Thymus gland

(3) adrenal gland

(4) Parathyroid gland

Q.53 Haemoglobin shows maximum affinity with - **[MP PMT 2005]**

(1) Carbon monoxide (2) Carbon dioxide

(3) Oxygen (4) Ammonia

Q.54 Pace maker of heart is - **[MP PMT 2005]**

(1) B (2) U

(3) G (4) A

Q.55 Bicuspid valve (mitral) guards the opening in mammals between **[MP PMT 2006]**

(1) Left atrium and let ventricle

(2) Pulmonary vein and left auricle

(3) Stomach and intestine

(4) Right atrium and right ventricle

Q.56 Cardiac muscle fibres are differ from skeletal muscles because these are **[MP PMT 2006]**

(1) Striated, involuntary

(2) Non-striated-volvntary

(3) Non striated involuntary

(4) Antagonistic

Q.57 Atherosclerosis refers to the ailment of **[MP PMT 2005]**

(1) Lungs (2) Heart

(3) Kidney (4) Liver

Q.58 All arteries carry oxygenated blood except **[MP PMT 2001]**

(1) Hepatic artery (2) Renal artery

(3) Pulmonary artery (4) Cardiac artery

Q.59 Diameter of capillaries for RBC to pass should be **[BHU / JIPMER 1986]**

(1) 4 μ (2) Less than 5 μ

(3) More than 5 μ (4) More than 10 μ

Q.60 Femoral artery supplies blood to **[EAMCET 1976]**

(1) Hind limb (2) Rectum

(3) Dorsal region of thigh

(4) Ventral region thigh

Q.61 Iliac artery carries blood to the **[EAMCET 1977]**

(1) Lungs (2) Ileum

(3) Hind limbs (4) Brain

Q.62 The wall of blood capillaries is made up of

(1) Mesenchymal cells **[CPMT 1999]**

(2) Connective tissues

(3) Endothelial cells (4) Fibrocytes

Q.63 Which of the following has no muscular wall **[DPMT 1985, 86]**

(1) Artery (2) Vein

(3) Arteriol (4) Capillary

Q.64 Smallest lumen blood vessel in the body is **[BHU 1985]**

(1) Capillary (2) Artery

(3) Vein (4) Venacava

Q.65 In which region the lymphatic system and blood circulatory system meet **[Bih. 2000]**

(1) Liver (2) Precaval

(3) Pulmonary artery (4) Systematic arch

Q.66 The process of blood clot formation within the circulatory system is **[CBSE PMT 1993]**

(1) Thrombosis (2) Thrombocytes

(3) Thrombin

(4) Thrombocytopenia

Q.67 Thrombin occurs in the vertebrates in **[CMC Vellore 1993]**

(1) The liver and is important for bile secretion

(2) The stomach and digests proteins

(3) The blood and is important for clotting

(4) The blood and gives it red colour

Q.68 Blood leaving lungs is rich in **[AFMC 1983, 87]**

(1) Oxygen (2) Haemoglobin

(3) Carbon dioxide

(4) More number of RBC

Q.69 The artery can be distinguished from the vein in having **[CPMT 1970]**

(1) Thicker walls (2) More blood cells

(3) More plasma (4) Larger cavity

Q.70 A vein differs from the artery in having **[Pb. PMT 2000]**

(1) Narrow lumen

(2) Strong cuticular and muscular wall

(3) Valves to control direction of flow

(4) Dark pigmented wall

Q.71 Oxygenated blood is carried by **[AFMC 1984, 95]**

(1) Pulmonary vein (2) Pulmonary artery

(3) Renal vein

(4) Hepatic portal vein

Q.72 The blood coming out of lungs is richer than that entering into lungs in **[MP PMT 1994]**

(1) Oxygen (2) Carbon dioxide

(3) (1) and (2) both (4) None of these

Q.73 Pulmonary veins **[MP PMT 1994]**

(1) Carry pure blood from heart to lungs

(2) Carry impure blood from lungs to heart

(3) Carry pure blood from lungs to heart

(4) Carry impure blood to lungs

Q.74 The posterior venacava **[CPMT 1988]**

(1) Divides into the hepatic portal veins

(2) Opens into the left auricle

(3) Commences at the kidney

(4) Begins at the hind end of abdomen

Q.75 Oxygenated blood is found in **[MP PMT 1998]**

(1) Pulmonary veins

(2) Pulmonary arteries

(3) Right atrium (4) Right ventricle

Q.76 The blood vessel which brings oxygenated blood from lungs towards the heart of frog is **[AFMC 2000]**

(1) Pre caval (2) Post caval

(3) Pulmonary vein (4) Pulmonary artery

Q.77 When the right ventricle contracts the blood goes into **[AFMC 1989; CBSE PMT 1992]**

(1) Aorta (2) Brain

(3) Pulmonary artery (4) None

Q.78 Arteries are **[CPMT 1980, 84]**

(1) Thin-walled and blood flows under diminished pressure

(2) Thick-walled and blood flows under high pressure

(3) Thin-walled and blood flows under high pressure

(4) Thick-walled and blood flows under diminished pressure

Q.79 All arteries carry oxygenated blood except **[MP PMT 2001; AFMC 2003]**

(1) Systemic (2) Hepatic

(3) Pulmonary (4) Cardiac

Q.80 The pre-caval veins collect blood from **[Pune CET 1998]**

(1) Trunk and hind limbs

(2) Fore limbs and hind limbs

(3) Head and fore limbs

(4) Head and hind limbs

Q.81 The post-caval vein collects blood from **[Pune CET 1998]**

(1) Hind limbs

(2) Hind limbs and organs of the body cavity

(3) Body cavity organs

(4) Renal organs

Q.82 Which of the following is different from others in absence of muscular coat **[CPMT 1999; JIPMER (Med.) 2001]**

(1) Veins (2) Arteries

(3) Capillaries (4) Arterioles

Q.83 Right systemic arch is absent in **[AMU 1997]**

(1) Reptiles (2) Birds

(3) Mammals

(4) None of the above

Q.84 Iliac artery carries blood to **[APMEE 1977]**

(1) Hind limb (2) Fore limb

(3) Lung (4) Brain

Q.85 The blood vessel of frog which opens in its right ventricles bringing oxygenated blood is **[AFMC 2000]**

(1) Pulmocutaneum artery

(2) Inferior vena cava

(3) Pulmocutaneum vein

(4) Superior vena cava

Q.86 Splenic artery arises from **[CBSE PMT 1990]**

(1) Anterior mesenteric artery

(2) Coeliac artery

(3) Posterior mesenteric artery

(4) Intestinal artery

Q.87 The carotid labyrinth of frog is concerned with the control of **[EAMCET 1996]**

(1) Number of RBCs

(2) Number of WBCs

(3) Blood pressure

(4) Blood glucose level

Q.88 Common thrombosis leading to myocardial infarction is of **[AIIMS 1988]**

(1) Right circumflex coronary artery

(2) Left circumflex coronary artery

(3) Left anterior descending artery

(4) Right coronary artery

Q.89 Pulmonary aorta in mammalian embryo communicates with carotico - systemic aorta by a thin vessel called ductus arteriosus which later closes and remains in adult as **[CPMT 1971]**

(1) Fossa ovalis
(2) Ligamentum arteriosus
(3) Carotico-pulmonary aperture
(4) None of these

Q.90 The internal carotid artery **[Orissa JEE 1995]**

(1) Supplies impure blood to kidney
(2) Supplies oxygenated blood to brain
(3) Brings impure blood from the brain
(4) Supplies oxygenated blood to heart

Q.91 The two branches of the iliac artery are **[Pune CET 1998]**

(1) Femoral and renal
(2) Femoral and sciatic
(3) Vesiculo - epigastric and femoral
(4) Renal and sciatic

Q.92 The pre-caval vein is formed of **[Pune CET 1998]**

(1) External jugular and innominate
(2) Innominate and subclavian
(3) External jugular, innominate and subclavian
(4) External jugular and subclavian

Q.93 The post-caval is constituted by **[Pune CET 1998]**

(1) Renal, gonadial and hepatic
(2) Renal and gonadial
(3) Gonadial and hepatic
(4) Hepatic and renal

Q.94 Which of the following carries glucose from digestive tract to liver **[CBSE PMT 1999; BHU 2001]**

(1) Hepatic artery
(2) Hepatic portal vein
(3) Pulmonary vein
(4) None of these

Q.95 Which of the following blood vessels in mammals normally carry largest amount of urea **[MP PMT 1997]**

(1) Hepatic portal vein
(2) Hepatic vein
(3) Renal artery
(4) Hepatic artery

Q.96 Which one of the following is found both in frog and in rabbit **[CPMT 1992]**

(1) Spinal accessory nerve
(2) Diaphragm
(3) Hepatic portal system
(4) Eustachian tube

Q.97 Thrombosis in which coronary artery is met most frequency in MI **[AIIMS 1988]**

(1) Right coronary artery
(2) Left anterior descending artery
(3) Left circumflex coronary artery
(4) Right circumflex coronary artery

Q.98 Systemic heart refers to **[CBSE PMT 2003]**

(1) The two ventricles together in humans
(2) The heart that contracts under stimulation from nervous system
(3) Left auricle and left ventricle in higher vertebrates
(4) Entire heart in lower vertebrates

Q.99 Which substance is more in blood flowing through hepatic vein than blood flowing through portal vein **[CPMT 1979]**

(1) Water (2) Urea
(3) Fatty acid
(4) Amino acid + oxygen

Q.100 Carotid artery carries **[NCERT 1975, 76; MP PMT 1995]**

(1) Impure blood from brain
(2) Oxygenated blood to anterior region of body or to brain
(3) Impure blood to kidney
(4) Oxygenated blood to heart

Q.101 Innominate is **[CPMT 1984]**

(1) A nerve and artery
(2) A muscle and artery
(3) Skeleton part and artery
(4) A nerve and vein

Q.102 Valves are found in veins to check the backflow of blood flowing under **[CPMT 1977]**

(1) Low pressure (2) High pressure
(3) No pressure (4) Very high pressure

Q.103 Hepatic portal system starts from **[CMC Vellore 1982]**

(1) Digestive system to liver
(2) Kidney to liver
(3) Liver to heart (4) Liver to kidney

Q.104 Digested food materials entering the blood reach the heart by **[EAMCET 1978]**

(1) Hepatic portal vein, hepatic vein and post caval
(2) Hepatic vein and post caval
(3) Hepatic portal vein and post caval
(4) Hepatic portal vein and hepatic vein

Q.105 Blood circulation that starts in capillaries and ends in capillaries is called **[NCERT 1984]**

(1) Portal circulation
(2) Hepatic circulation
(3) Cardiac circulation
(4) None

Q.106 A portal system is a system in which **[NCERT 1978]**

(1) A vein starts from an organ and ends up in heart
(2) An artery breaks up in an organ and restarts by the union of its capillaries
(3) The blood from the gut is brought into the kidney before it is poured into posterior venacava
(4) A vein breaks up in an organ into capillaries and restarts by their union as a new vein in the same organ

Q.107 Hypophysial portal system is found in **[AMU 1997]**

(1) Kidney (2) Liver
(3) Brain (4) Heart

Q.108 The principle function of the lymph node in the man is **[CPMT 1983, 84]**

(1) Destruction of old RBC
(2) Destruction of old WBC
(3) Collection and destruction of pathogens blood
(4) Production of WBC

Q.109 What will happen to an adult human being if spleen is removed **[MP PMT 2000]**

(1) RBC production will be lowered
(2) Antibody production will be lowered
(3) Filteration of dead RBC will not be there
(4) WBC production will be lowered

Q.110 Lymph is colourless because **[MP PMT 1999]**

(1) WBC are absent
(2) WBC are present
(3) Heamoglobin is absent
(4) RBC are absent

Q.111 Spleen is **[CBSE PMT 2001]**

(1) Haemopoeitic (2) Lymphoid
(3) Reproductive (4) Celluloid

Q.112 Lymphoid tissue is found in **[CPMT 2000]**

(1) Thymus (2) Tonsils
(3) Lymph nodes (4) All of these

Q.113 In our body, the blood bank is **[MP PMT 1999, 2001]**

(1) Red bone marrow (2) Spleen
(3) Liver (4) Heart

Q.114 The lymph differs from the blood in having **[CPMT 1973, 74, 84]**

(1) Blood with more RBC and less WBC
(2) Blood without plasma
(3) Plasma without proteins
(4) No RBC but more WBC

Q.115 In connection with circulatory system, valves are present **[CBSE PMT 1995]**

(1) Not only in heart and blood vessels or vertebrates and invertebrates, but in vertebrate lymphatics as well
(2) Vertebrate heart only
(3) Vertebrate heart and invertebrate hearts only
(4) Vertebrate hearts, invertebrate hearts and their blood vessels

Q.116 A yellow substance oozing out from wound has **[AFMC 1986]**

(1) Lymph + RBC + WBC
(2) Lymph + RBC + dead bacteria
(3) Lymph + WBC + dead bacteria
(4) Lymph + dead leucocytes

Q.117 Function of human spleen is to **[DPMT 1984]**

(1) Control the pulse rate
(2) Secrete hormone
(3) Stimulate heart
(4) Control blood volume

Q.118 Which organ is considered as "Graveyard of RBC" where most of them are destroyed by macrophages **[AFMC 2001]**

(1) Red bone marrow (2) Spleen
(3) Kidney (4) Intestine

Q.119 Lymph vessels are united to form **[BHU 2001]**

(1) Lymph heart (2) Cisterna chyle
(3) Thoracic duct (4) Jugular vein

Q.120 The most active phagocytic white blood cells are : **[AIPMT 2008]**

(1) Neutrophils and eosinophils
(2) Lymphocytes and macrophages
(3) Eosinophils and lymphocytes
(4) Neutrophiles and monocytes

Q.121 'Bundle of His' is a part of which one of the following organs in humans? **[AIPMT 2011]**

(1) Brain (2) Heart
(3) Kidney (4) Pancreas

Q.122 Arteries are best defined as the vessels which : **[AIPMT 2011]**

(1) Supply oxygenated blood to the different organs
(2) Break up into capillaries which reunite to from a vein
(3) Break up into capillaries which renite to from a vein
(4) Carry blood from one visceral organs to another visceral organ

Q.123 Given below is the ECG of a normal human. Which one of its components in human is correctly interpreted below **[AIPMT Mains 2008]**

(1) Complex QRS – One complete Pulse
(2) Peak T – Initiation of total cardiac contraction
(3) Peak P and Peak R together – Systolic and diastolic bool pressures
(4) Peak P – Initiation of left atrial contraction only

Q.124 Bulk of carbon dioxide (CO_2) released from body tissuse into the blood present as

(1) Bicarbonate in blood plasma and RBCs
(2) Free CO_2 in blood plasma
(3) 70 % carbamino – haemoglobin and 30 % as bicarbonate
(4) Carbamino – haemoglobin in RBCs

Q.125 Cardiac output is determind by : **[Manipal / BHU 2008]**

(1) Heat rate (2) Stroke volume
(3) Blood flow (4) Both (1) and (2)

Q.126 In frog heart, there are cardiac muscles which consist of fibres called : **[BHU 2006, CPMT 2008]**

(1) Myonemes (2) Telodendria
(3) Purkinje fibres (4) Columnae carnae

Q.127 In a standard ECG which one of the following alphabets is the correct representation of the respective activity of the human heart? **[CBSE 2009]**

(1) P–depolarisation of the atria
(2) R–repolarisation of ventricles
(3) S-start of systole
(4) T–end of diastole

Q.128 If the heart sound recording and ECG recordings are superimposed then the heart sound would occur : **[Pune CET 2002]**

(1) At the P wave
(2) Just after the P wave
(3) Just before the QRS complex
(4) Just after the QRS complex

Q.129 An oval depression called fossa ovalis is seen on : **[Kerala PMT 2009]**

(1) Interatrial septum
(2) Papillary muscles
(3) Inter ventricular septum
(4) Right auriculo – ventricular septum
(5) left auriculo – ventricular septum

Q.130 The deposition of lipids on the wall lining the lumen of large and medium sized ateries is referred to as : **[Kerala PMT 2009]**

(1) Osteoporosis (2) Osteoarthritis

(3) Atherosclerosis

(4) Deep vein thrombosis

(5) Stokes – Adams syndrome

Q.131 If due to some injury the chordae tendinae of the tricuspid valve of the human heart is partially non-functional, what will be the immediate effect? **[CBSE 2010]**

(1) The 'pacemaker' will stop working

(2) The blood will tend to flow back into the left atrium

(3) The flow of boond into the aorta will be slowed down

(4) The flow of blood into the pulmonary artery will be reduced

Q.132 Fastest distribution of some injectable material/ medicine and with no risk of any kind can be achieved by injecting it into the : **[CBSE 2010]**

(1) Muscles (2) Arteries

(3) Veins (4) Lymph vessels

Q.133 Which statement is true about the venous blood vessels of frog? **[AMU 2010]**

(1) Lingual and Submandibular unite to from internal jugular

(2) musculocutaneous and Brachial unite to form the subclavian

(3) The ventral abdominal vein drains into the posterior vena cava

(4) The pelvic veins unite to from the renal portal vein

Q.134 Which of following is not a major organ of lymphatic system? **[MPPMT 2010]**

(1) Spleen (2) Kidney

(3) Thymus (4) Lymph nodes

ANSWER KEY

EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	2	3	4	3	4	1	2	3	2	1	3	1	2	3	4	1	2	3	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	1	2	2	2	2	3	1	3	3	1	4	4	3	1	2	3	2	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	2	1	2	2	2	2	2	2	3	4	3	1	1	1	1	2	3	1	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	3	4	1	2	1	3	1	1	3	1	1	3	4	1	3	3	2	3	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	3	2	1	1	2	3	4	2	2	3	3	1	2	2	3	1	3	2	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	1	1	1	1	4	3	3	3	4	2	4	3	4	1	3	4	2	3	4
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134						
Ans.	2	2	3	1	4	3	1	4	1	3	4	3	2	2						

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** A chronic vasoconstriction of arterioles may cause hypertension.
R : In vasoconstriction abnormal rise in the arterial blood pressure occurs.

Q.2 **A :** Fainting is a homeostatic mechanism.
R : Prolonged standing leads to fainting.

Q.3 **A :** The increased permeability of the lymph capillaries is easily altered.
R : Do not increased permeability of the lymph capillaries is easily altered.

Q.4 **A :** Arterioles possess smooth muscles on their walls.
R : These smooth muscles help in regulating blood volume flowing through a tissue or organ.

Q.5 **A :** Blood flows at a very slow velocity in the lacunae and sinuses of prawn.
R : This happens because of the absence of heart in the prawn.

Q.6 **A :** The open circulatory system is more efficient than the closed circulatory system.
R : The blood flows far more rapidly in open circulatory system than in the closed one.

Q.7 **A :** Larger animals have higher heart rates than smaller animals.
R : Metabolic rate of a larger animal is higher than a smaller animal.

Q.8 **A :** Heart of fish contains only deoxygenated blood.
R : Oxygenated blood do not return back to the heart in fishes.

Q.9 **A :** The cardiac impulse is said to be myogenic.
R : Rate of formation and conduction of cardiac impulse can be changed by the action of nerves

Q.10 **A :** Walls of ventricles are thicker than the auricles.
R : This helps in preventing the back flow of the blood.

Q.11 **A :** Ventricular systole precedes the atrial systole.
R : The cardiac impulse passes relatively fast across the AV node.

Q.12 **A :** Left ventricle of heart has a thinner wall than that of the right ventricle.
R : Left ventricle needs to pump blood to nearby lungs only.

Q.13 **A :** AV bundle is essential for the conduction of cardiac impulse.
R : There is no continuity between the cardiac muscle fibres of the auricles and those of the ventricles.

Q.14 **A :** Mixing of oxygenated blood occurs in reptilian and amphibian hearts.
R : This happens because of the incomplete partitioning of the auricle.

Q.15 **A :** AV node is also called as the pacemaker of the heart.
R : It is because of the fact that AV node determines the rate of heart beat.

Q.16 **A :** Pulse rate per minute can be counted to know the heart rate.
R : Each heart beats send one pulse along the arteries.

Q.17 **A :** There is no mixing of oxygenated and deoxygenated blood in the human heart.
R : Valves are present in the heart which allows the movement of blood in one direction only.

Q.18 **A :** Hypotension is observed in arteriosclerotic patients.

R : In the condition of arteriosclerosis, the arteries gain their elasticity and get stiffened.

Q.19 **A :** EEG is of immense diagnostic value in the cardiac diseases.

R : Defects in cardiac functions can be reflected in changes in the pattern of electrical potential recorded in the EEG.

Q.20 **A :** An artificial pacemaker can replace the sinoatrial node of heart.

R : This is because, an artificial pacemaker is capable of stimulating the heart electrically to maintain its beats.

Q.21 **A :** Extracellular fluids transport nutrients.

R : Extracellular fluids flow throughout the body.

Q.22 **A :** More advanced animals require a greater and speedier supply of nutrients and oxygen.

R : More advanced group of animals possesses higher metabolic rates.

Q.23 **A :** Blood is the circulatory fluid.

R : Blood has some advantage over water.

Q.24 **A :** Many advanced invertebrates have open circulatory system.

R : The open circulatory system is open to the environment.

Q.25 **A :** The vertebrates have closed circulatory system.

R : Circulation is confined in certain regions of the body.

Q.26 **A :** Heart valves resemble swing doors in action.

R : Valves are present in the heart chamber, at the opening of the heart into large arteries and veins.

Q.27 **A :** Closed circulatory system is more effective than open type.

R : The closed circulatory system considerably enhances the speed, precision and efficiency of circulation.

Q.28 **A :** The normal heart rate is 75/min and cardiac cycle is 0.8 sec.

R : Cardiac cycle is inversely proportional to the heart rate.

Q.29 **A :** Mammalian heart can prevent the mixing of deoxygenated and oxygenated blood.

R : Sinus venosus has totally fused with the right auricle.

Q.30 **A :** Sinus venosus is present as the remnant in mammalian heart.

R : Sinus venosus is not necessary in human blood circulation.

ANSWER KEY

EXERCISE - 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	2	1	3	4	4	1	2	3	4	4	1	3	4	1	2	4	4	1
Ques.	21	22	23	24	25	26	27	28	29	30										
Ans.	2	1	2	3	3	2	1	1	2	1										

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

RESPIRATORY SYSTEM

DEFINITION

Respiration is the physiological catabolic process in which gaseous exchange occurs to oxidise food. The energy generated is utilized and by products, CO_2 and H_2O are given out.

So, respiration is a physio-chemical process. The surface at which exchange of gases occurs is called respiratory surface, and the compounds oxidised in respiration are called respiratory substrate.

TYPES OF RESPIRATION

Following are the types of respiration :

(1) Direct and Indirect respiration

(2) Aerobic and Anaerobic respiration

1. DIRECT AND INDIRECT RESPIRATION

Direct respiration

(a) In this type of respiration, there is direct exchange of gases in between body cells and respiratory medium.

(b) Exchange of gases occurs on the principle of diffusion, through moist body surface.

(c) Direct respiration is found in unicellular organisms like, aerobic bacteria, amoeba, ssponges, hydra, flatworm, roundworm etc.

Indirect respiration

(a) In this type of respiration, their is no direct contact in between the body cells and respiratory medium.

(b) Indirect respiration is found in complex and higher form of organism.

(c) Higher organism have some specialized, structure for gaseous exchange which are called **respiratory organs**.

e.g. (a) Skin - Skin is respiratory organ in annelida and amphibians.

(i) Gills - Most of crustaceans, mollusca, all fishes and some amphibians the exchange of gases in gills is called branchial respiration.

(ii) Lungs - Lungs is respiratory organ in snails, some amphibians, all reptiles, birds and mammals.

(iii) Trachea - Trachea is respiratory organ in insects.

2. AEROBIC AND ANAEROBIC RESPIRATION

AEROBIC RESPIRATION

(i) Respiration which occurs in presence of oxygen is called aerobic respiration.

(ii) The oxygen completely oxidises the food to CO_2 and H_2O releasing large amount of energy. This process can be shown by following way.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 2880$ KJ Energy

(iii) Such type of respiration (aerobic respiration) found in most animals and plants.

Phases of aerobic respiration

There are two phases of aerobic respiration.

(A) External respiration (B) Internal respiration

A. External respiration

(i) External respiration is also called **breathing** or **ventillation**.

(ii) It is gaseous exchange in between respiratory organ and outer environment.

e.g. Exchange of gases in between lungs and air.

B-Internal respiration

(i) Internal respiration is also called **tissue respiration**.

(ii) It is the exchange of oxygen of blood and carbon dioxide of body cells through tissue fluid at the cellular level

(iii) It involves cellular respiration in which glucose is oxidised inside the mitochondria of cell to produce H_2O, CO_2 and energy.

ANAEROBIC RESPIRATION

(i) Respiration which occurs in absence of oxygen is called anerobic respiration, anaerobic respiration is also called **fermentation.**

(ii) It is found in bacteria, yeast, parasitic worms

(iii) In this type of respiration food is partially oxidised. It can be shown by following way.

$$C_6H_{12}O_6 \xrightarrow{\text{In intestinal worms}} 2CH_3CHOHCOOH + \text{Energy}$$

(Lactic acid)

Note :

Anaerobic respiration even takes place in certain particular body tissues of aerobes.

e.g. In skeletal muscles fibres, In mammalian RBC.

(iv) In skeletal muscle fibres during vigrous exercise **glucose is metabolised into lactic acid**. The rapid formation and accumulation of lactic acid are responsible for muscle fatigue.

(v) In mammalian RBC anaerobic respiration is found, because no mitochondria is found in mammalian RBC.

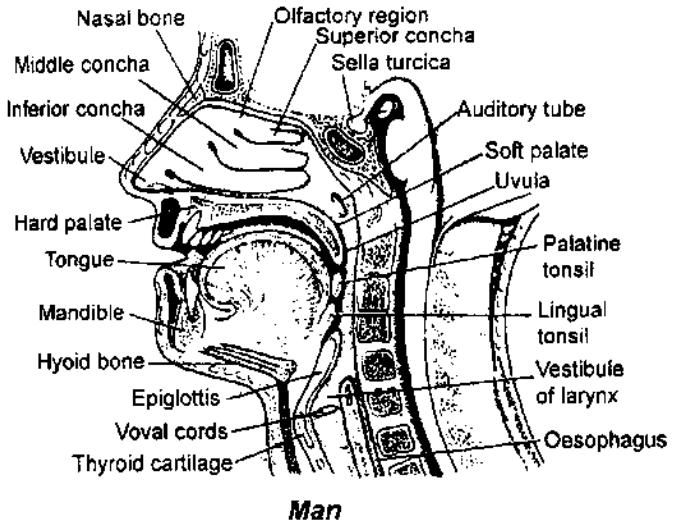
MAMMALIAN (HUMAN) RESPIRATORY SYSTEM

Mammalian respiratory system is formed of following parts-

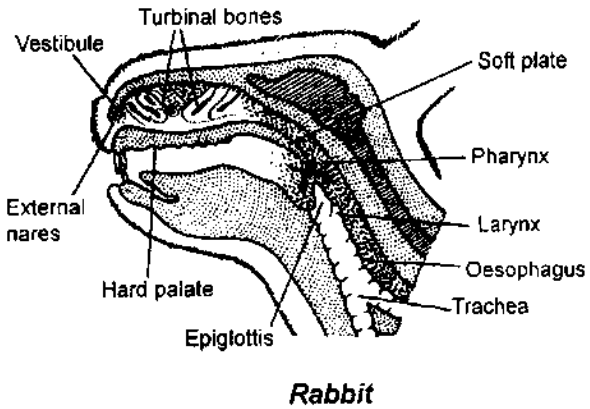
(1) Nostril (2) Nasal chamber (3) Internal nare (4) Pharynx

(5) Laryngopharynx (6) Larynx (7) Vocal cord (8) Trachea

(9) Primary bronchi (10) Lungs



Man



Rabbit

Nostril

(i) It is also called external nare.

(ii) It is oval aperture of nose present at the lower end.

Note : Presence of two nares is called dirhynous stage.

- **Nasal chamber**

  Nasal septum (made of Hyaline cartilage) divides nasal cavity into two nasal chamber by the nasal septum. Each nasal chamber can be divided into three regions. These three parts are as follows -

  (i) Vestibular part

  It is smaller and anterior part, and is lined by hairy skin which acts as filter and prevents entry of dust particles.

  (ii) Respiratory part

  It is middle part and is lined by pseudo-stratified epithelium which acts as air conditioner and brings the inspired air at the body temperature.

  (iii)Olfactory part

  It is upper part of nasal chamber and is lined by olfactory epithelium called **schneiderian membrane**. It looks yellowish brown, This region acts as an organ of smell. Three bony ridges the superior, middle and inferior nasal conchae arises from the wall of each nasal chamber. The nasal conchae increases the surface area of nasal chamber for better air conditioning

- **Internal nares**

  There are posterior opening of nasal chambers that leads into nasopharynx.

- **Pharynx**

  Pharynx comprises nasopharynx, oropharynx and laryngopharynx. The pharynx provides passage to both air and food.

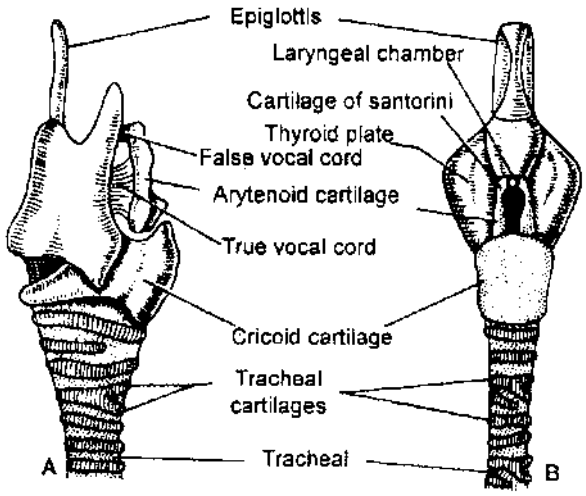
- **Laryngopharynx**

  It is the lower part of pharynx and has a slit like aperature called **glottis**, which can be closed by a leaf like bilobed cartilage **epiglottis**, during swallowing of food bolus.

- **Larynx**

  (i) It is also called **voice box** or **adam's apple** or **pomas adami**.

  (ii) After puberty it get more developed in males in comparison to female, because of this very reason, males have deeper voice.



  (iii) It is supported by four cartilage which prevent its collapsing these cartilage are as follows.

  – Cricoid-1 – Thyroid-1 – Arytenoid-2 – Cartilage of santorini-2

  (i) **Thyroid cartilage**

  - It is single in number (Hyaline Cartilage).
  - It is largest size and c shaped cartilage which supports anterior and lateral sides of upper part of the larynx.

(ii) **Cricoid cartilage**

- It is single in number. (Hyaline Cartilage)
- It is some what smaller, thicker and a complete ring or collar like cartilage around the larynx behind the thyroid cartilage.
- It is broad **dorsally** and narrow ventrally.

(iii) **Arytenoid cartilage**

- These are two pyramid shaped cartilage.(Hyaline carhilage)
- It is smallest cartilage which support posterior wall of upper part of larynx.

(iv) **Cartilage of Santorini**

Each arytenoid terminates in front in a Swollen knob called the cartilage of santorini.(Elastin Cartilage)

- **Vocal cords**
  - In larynx, 2 pairs of vocal cord is found outer pair is **false vocal cord** whereas, inner pair is **true vocal cord** when air is forced through the larynx it cause vibration of true vocal cards and sound is produced.
  - The pitch of the sound is determined by the tension of vocal cards, the greater the tension the higher the pitch.
  - Vocal cards are modified mucous folds of larynx.

Note :

(i) Sound get converted into speech by Tongue. Movement of Tounge is controlled by Speech centre of the brain.

(ii) Speech centre is not well developed in dumb persons.

(iii) Voice of rabbit is called **Quacking**.

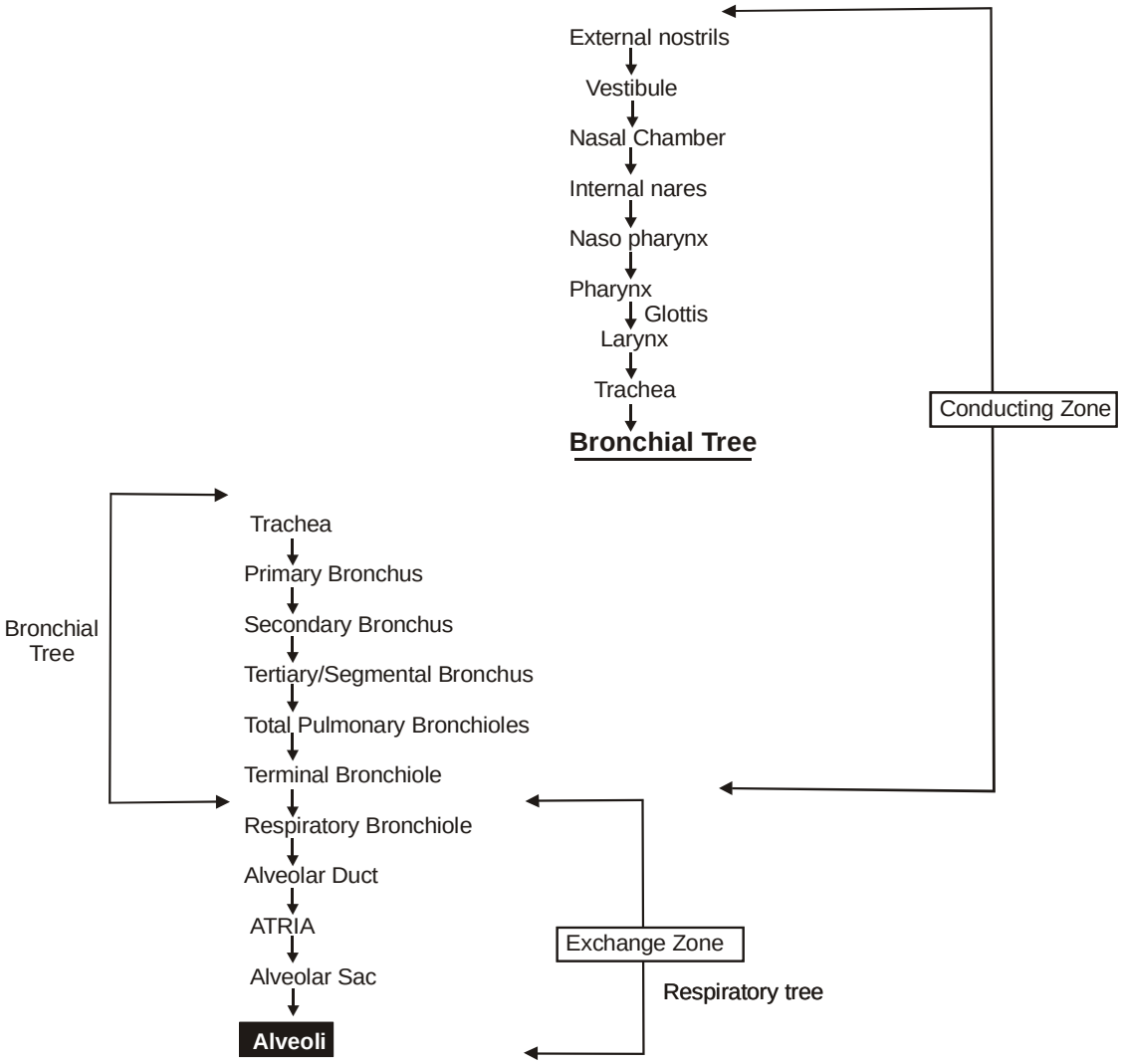
(iv) False vocal cord remain absent in **Elephant**.

(v) True vocal cord remain absent in **Hippopotamus**.

(vi) Voice apparatus of birds is called **syrinx**.

- **Trachea (Wind pipe)**
  - It is long, tubular structure which runs downward through the neck in front of oesophagus.
  - It is supported by 16-20 dorsally incomplete C-shaped cartilagenous tracheal ring, which prevents its collapsing.
  - It is lined by pseudostartified ciliated epithelium with mucous secreting goblet cells.
- **Primary bronchi**
  - These are one pair of small thin walled tubular structure formed by the division of trachea at the level of 5th thoracic vertebrae near the heart.
  - The right bronchus (2.5 cm) is wider shorter and more vertically placed then the left bronchus.
  - Like trachea primary bronchi is supported by cartilaginous rings.
  - Each primary bronchus enters the lungs of its own side.
- **Bronchial tree (B.T.) & Respiratory Tree (R.T.)**
  - When trachea enter into thoracic cavity, it divides in two branches called as primary bronchus. Branches of Primary bonchus upto terminal bronchioles makes **bronchial tree**
  - Terminal bronchioles divide to form respiratory bronchioles & branches of respiratory broncholes makes **respiratory tree**
  - In branchile tree, cartilage rings are present, while these are absent in respiratory tree.
  - Gaseous exchange occurs in respiratory tree while it is absent in bronchial tree.
  - Volume of air which is filled in B.T. is a part of **dead space volume.** which doesn't take a part in gaseous exhange. (150 ml)

There are two zones.



- **Lungs**
  - **Position**

    Lungs are present in thoracic cavity on either side of heart.
- **Pleural membranes**
  - Each lung is enclosed with double membrane pleural membrane.
  - The outer membrane is called **parietal pleura**. Whereas inner membrane is known as visceral pleura.
  - In between two pleural membranes, hollow space is found which is called pleural cavity.
  - Pleural cavity is filled with watery fluid called **pleural fluid.** Pleural fuild is secreted by pleural membrane.

    Pleural fluid perform three function which are as follows-

(a) It allows free frictionless movement of lungs.

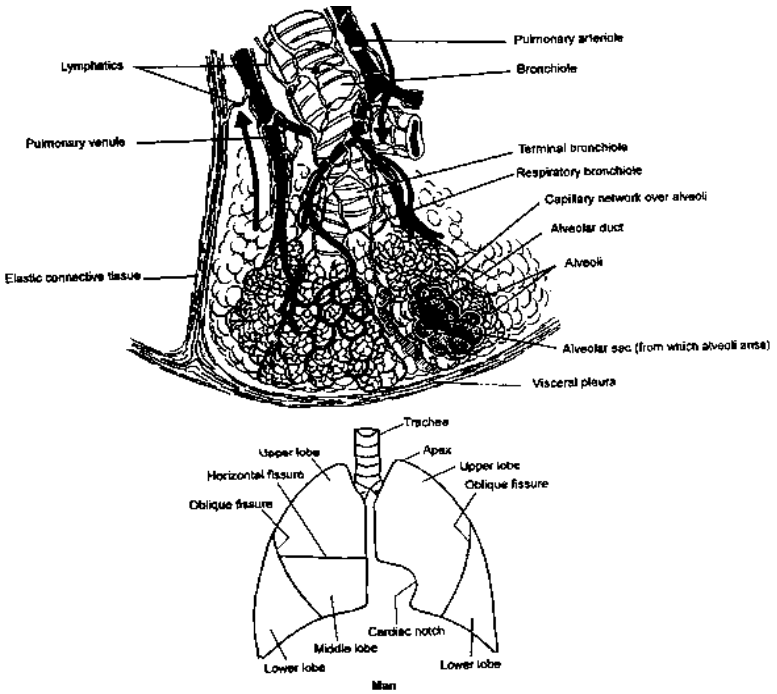
(b) It protects the lungs from mechanical shock.

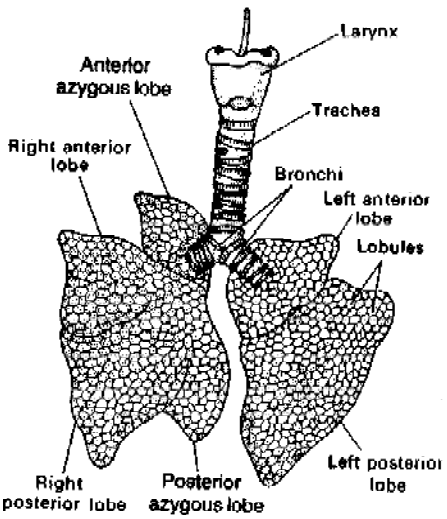
(c) It prevents pleural membrane from sticking together.

Note :

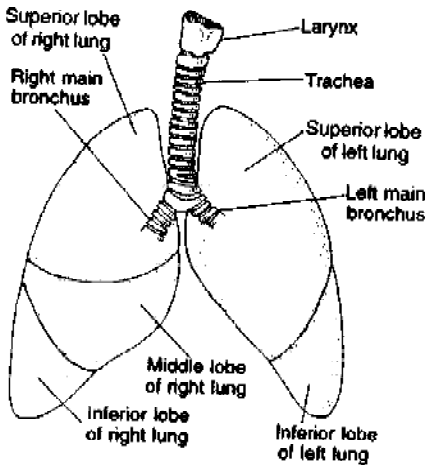
Accumulation of fluid between the pleura is called pleural effusion or pleuricy. It happens because of bacterial infection and the person feel difficulty in breathing. due to the increased intrapleural pressure

- **External structure of lungs**
  - The lungs are spongy, soft, pinkish elastic organs.
  - The most upper portion of each lungs is called the **apex** and the most lower portion is called the **base**.
  - **Right lung** is slightly larger and broader in size.
  - Each lung is a lobulated structure and is divided externally into the lobes by transverse and oblique grooves called **fissures**.





Lung of Rabbit



Lung of Man

- **Lobes of lungs**

  (A) Lobes of lungs in man

  (i) Left lung is 2 lobed, upper superior lobe, and lower inferior lobe. (575 gm)

  (ii) Right lung is 3 lobed; upper superior lobe, middle lobe and lower inferior lobe. It is demarcated by transverse and oblique fissures. (625 gm)

(B) Lobes of lungs in rabbit

(i) Right lung is 4 lobed, the right lobes are anterior and posterior azygous medianwards and right anterior and right posterior lobes outwards.

(ii) Left lung is 2 lobed upper anterior and lower posterior lobe.

- **Alveoli :**

Each lobe is further divided into several lobules by septas of connective tissue. Each lobule is further divided into several airsacs ; and in the end, each air-sac is lastly divided into 3 or 4 alveolis ; which are also termed as the units of lungs.

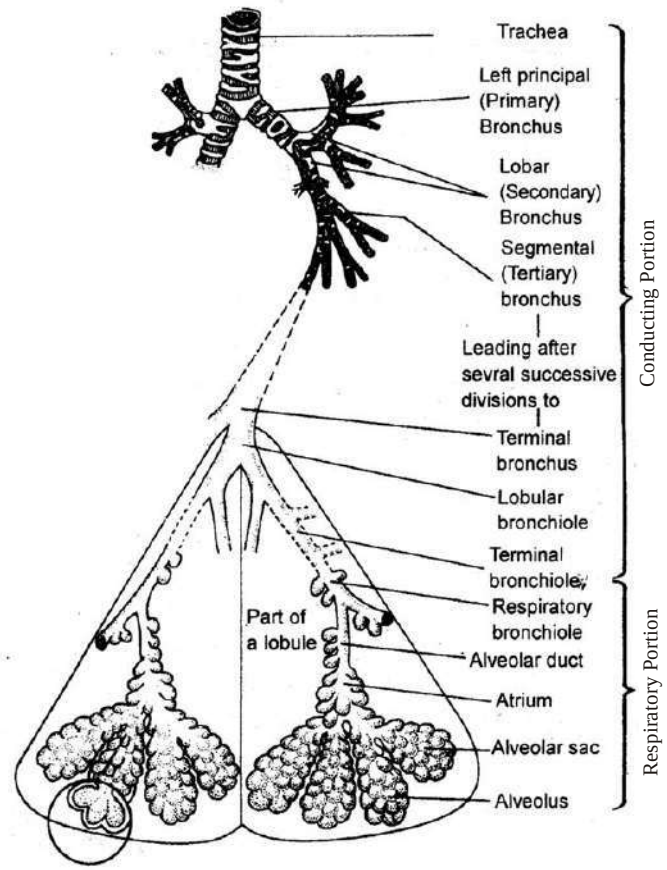
Sturctural & functional unit of lungs is called **alveoli**

Approximately 300 million alveoli are present in Both lungs. Inner (Alveolar) surface area of both lungs is approximately 100 m^2. Wall of alveoli consists of two layers, outer layer is composed of yellow fibrous C.T. Inner layer is composed of Simple Squamous Epithelium

– squamous cells are called as **pneumocytes.**

– most of these Pneumocytes help in gasesous exhanges while few pneumocytes which are larger in size (type II pneumocyte) secrete LECITHIN (Phospholipid) this acts as surfactant which prevents alveoli from remaining collapse by reducing its surface tension.

Alveolis internal surface is termed as the Respiratory surface. It is derived from the endoderm of the embryo. Rest whole lung is mesodernal. The middle part of alveoli wall is made up of connective tissue.It is richly supplied with blood capillaries, a dense network of blood capillaries is found in alveoli.



These blood capillaries come from pulmonary artery. Pulmonary artery divides into blood capillaries after reaching in lungs. These capillaries from a dense network in the walls of alveoli. All these capillaries combine to form pulmonary vein at the another end.

These veins carries pure blood to the left auricle of the heart. There are small pores present in the walls of alveoli. These pores make difusion of gases easy. These pores are called **pores of Kuhn**. It is the characterstic feature of mammalian lungs, that there is no central cavity, Mammalian lungs are **solid and spongy.**

Muscles are absent in the lungs of mammals. So the power of self-contraction and self-expansion is absent in these lungs. (Sucken lungs).

- **Internal structure of lungs**
- **Thoracic cavity**
  - Thoracic cavity is like a cage, so also called thoracic cage.
  - Thoracic cavity is combination of following structure.

(a) Vertebral column - Found on dorsal part of thoracic cavity.
(b) Sternum - Found on ventral part of thoracic cavity.
(c) Ribs - Found on lateral part of thoracic cavity.
(d) Diaphragm - Found on posterior part of the throacic cavity.

- **Diaphragm**

A muscular septum which is found only in mammals (and crocodile). Normal shappe of it is dome like which divides body cavity in two parts upper thoracic cavity & lower adbominal cavity.
In it radial muscles are present. They originate from periphery and inserted in central region of diaphragm. By the contraction in these mucles, diaphragm become flattened in shape. So, volume of thoracic cavity increases. Therefore, diaphragm helps in inspiration.

- **Intercostal muscles (ICM)**

Space between two ribs is called intercostal space in which 2 types of muscles are present
– External ICM. (EICM) – Internal ICM. (IICM)

(a) EICM

They originate from dorsal part of upper rib & insert on ventral part of lower rib. By the contraction in this muscles, rib. and sternum shifts upward and outward. So they helps in inspiration.

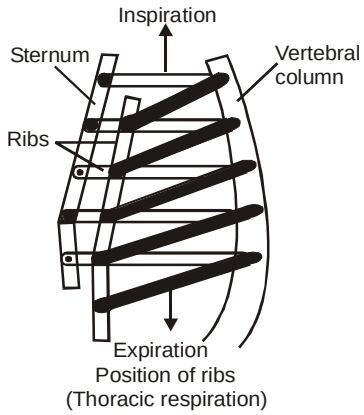
(b) IICM

They originate from dorsal part of lower rib and insert in ventral part of upper rib. By the contraction in these muscles, ribs and sternum shifts downward and inward respectively, so it helps ih forceful expiration which is a voluntary acitivity. So contraction of IICM is under the control of cerebrum.

MECHANISM OF RESPIRATION OR BREATHING

Mechanism of Breathing involves two phases

(1) Inspiration (2) Expiration



Position of ribs
(Thoracic respiration)

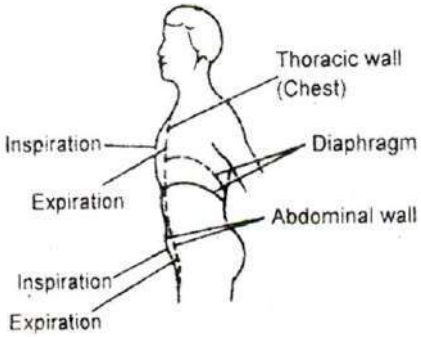
- **INSPIRATION**

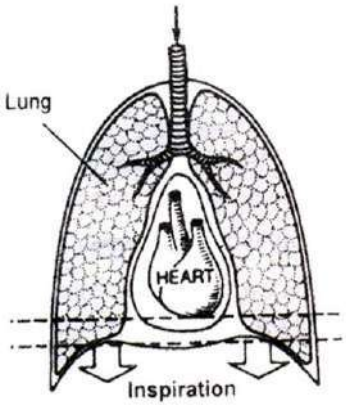
(i) It is a process by which fresh air enters the lungs, the intercostal muscles, diaphragm, and abdominal muscles play an important role.

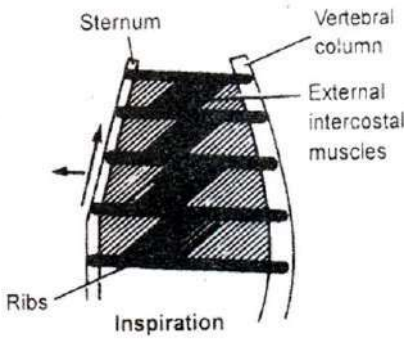
(ii) During inspiration, diaphragm becomes flat and gets lowered by the contraction of its radial muscle fibres, This increases vertical diameter of Thoracic cavity.

(iii) Due to contraction of external intercostal muscles, ribs and sterum are pulled upward and outward and it also result in increase of transverse diameter of thoracic cavity.

(iv) Due to increase in both diameters of thoracic cavity, intrapleural pressure falls causing decompression of lungs so lungs expand due to elastic recoil and air pressure within lungs decrease. The greater pressure outside the body now causes air to flow rapidly into lungs.





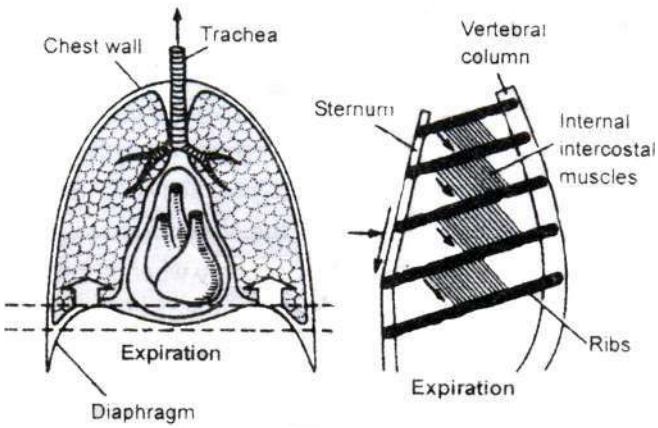


- **EXPIRATION**

(i) It is a process by which the foul air (carbon dioxide) is expelled out from the lungs.

(ii) It is passive process

(iii) During expiration muscles fibres of the diaphragm relax, so diaphragm becomes convex towards thoracic cavity, it results in decrease vertical diameter of thoracic cavity.



(iv) Due to relaxation of external intercostal muscles, ribs and sternum return back to their original position and this also results in decrease in transverse diameter of thoracic cavity.

(v) Due to decrease in both diameter of thoracic cage, intrapleural pressure increases, lungs are now compressed so pressure within lungs increase, the greater pressure within lungs force foul air from lungs to outside of body.

- **Forceful expiration**

During forceful expiration as during exercise coughing and sneezing, abdominal muscles and internal intercostal muscles come into action which rapidly reduces volume of thoracic cavity. So, abdominal musclesand internal intercostal muscles are called expiratory muscles.

REGULATION OF BREATHING

Breathing is an **involuntary process** and is **controlled by medulla oblongata**, but it can be made voluntary for a short while, during this period it is **controlled by cerebrum**, those involuntary process which can be made voluntary are called **Reflex action**.

- Breathing is regulated by two controls

  (1) Nervous control (2) Chemical control

1. NERVOUS CONTROL

The respiratory rhythm is controlled by the nervous system. The rate of respiration can be enhanced asper demand of the body during strainous physical exercises. A number of groups of neurons are located bilaterally in the medulla oblongata control the respiration, these are called **respiratory centres.** Three groups of respiratory centres have been indentified, namely : dorsal respiratory groups, ventral respiratory group and pneumotaxic centre.

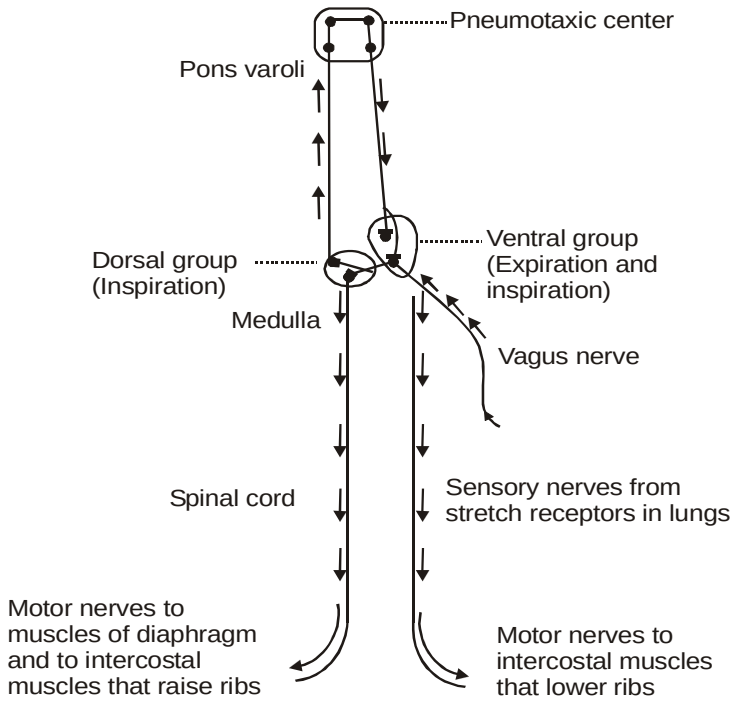


Diagram showing nervous control of breathing

The **dorsal respiratory group** is present in the dorsal portion of medulla oblongata. The signals from these neurons generate the basic respiratory rhythm. The nervous signal released from this group is transmited to the diaphragm, which is the primary inspiratory muscles & EICM. The **ventral respiratory group** of neurons are located anterolateral to the dorsal respiratory group During normal respiration, this remains inactive and even does not play any role.

In this enhanced respiratory drive, the respiratory signal of this group contributes to fulfil the demand by regulating both inspiration and expiration. Few of the neurons of this group control inspiration, while few other control expiration, thus regulating both. The **pneumotaxic centre** is located dorsally in the upper pons. It transmits signals to the inspiratory area. Primarily, it controls the switch off point of inspiration. When this signal is strong (high frequency), the inspiration lasts for a shorter duration and lungs are filled partially. During weak pneumotaxic signal, inspiration lasts for a longer duration resulting into complete filling of lungs. The strong signal (high frequency) causes increased rate of breathing, because duration inspiration as well as expiration, is shortened. The concentration of CO_2 and H^+ cause increased strength of inspiratory, as well as expiratory signal. However, oxygen has no such direct effect.

- **Heiring breuer reflex arch :**

  In the walls of terminal bronchioles and atria stretch receptors are present, Which are normally inactive but they become active when the lungs are excessively inflated due to failure of switch off of inspiration. The heiring breuer reflex arch now becomes activated and sends inhibitory signals to the inspiratory centre to switch off inspiration. This prevents the alveoli from over stretching and bursting. Thus Heiring Breuer reflex arch is a protective reflex which works only when normal mechanism of switch off of inspiration does not work timely due to any reason.

2. CHEMICAL CONTROL

- **Effect of CO_2**
  - Chemoreceptors are found in the **carotid bodies** (located in the wall of carotid arteries) and in the **aortic bodies** (located in the wall of aorta).
  - These chemoreceptors are stimulated by an increase in carbon dioxide concentration and by an increase in hydrogen ion concentration (pH) in the arterial blood.
  - Increased CO_2 concentration lowers the pH resulting in **acidosis**. These chemoreceptors sends signals to inspiratory and expiratory centres, thus rate of breathing is increased.

Note :

Activity and function of respiratory centre also get affected by body temperature and blood pressure. In case of increased blood pressure or increased body temperature the breathing rate also increases.

EXCHANGE OF GASES

(i) Ledwig at first described exchange of gases in blood.

(ii) Exchange of gases occurs in lungs and body tissue.

- **Exchange of gases in lungs**
  - Exchange of gases in lungs is also called pulmonary gas exchange.
  - In the lungs exchange of gases takes place between the air in the alveoli and the blood in the capillaries around the alveoli.
  - In this exchange of gases blood takes up oxygen from the alveolar air and release CO_2 to the alveolar air.
- **Uptake of oxygen (O_2) by pulmonary blood**

  The pO_2 (partial pressure of oxygen) of the alveolar air is 104 mm Hg and PO_2 of blood in alveolar capillaries is 40 mm Hg. Due to pO_2 differences of 64 mm Hg between air and blood. Oxygen diffuses rapidly from the alveolar air into the blood of alveolar capillaries raising PO_2 of blood to about 95 to 104 mm Hg.
- **Uptake of CO_2 by the air**

  The pCO_2 of the venous blood entering the pulmonary capillaries is 46 mm Hg while that of the alveolar air is 40 mm Hg. Therefore CO_2 diffuses from the blood of alveolar capillaries into the alveolar air till the pCO_2 of blood falls to 40 mm Hg.
- **Exchange of gases in tissue**

(i) The oxygenated blood is send from the pulmonary blood capillaries to the heart. The heart distributes this oxygenated blood to various body parts and tissues through arteries. The arteries divide to form arterioles which further divide to form capillaries.

(ii) In tissues exchange of gases occurs between the blood and the tissue cells. The exchange occurs through tissue fluid that surrounds the tissue cells.

(iii) The blood reaching the tissue capillaries has PO_2 of 95 to 104 mmHg and PCO_2 of 40 mmHg. The tissue cell have lower pO_2 and higher pCO_2. Due to pO_2 and pCO_2 difference between blood and tissue cell, oxygen separates from oxyhaemoglobin and diffuses from the blood into the tissue fluid and finally into the tissue cells. CO_2 diffuses from tissue cell into the tissue fluid and finally into the blood present in the tissue **capillaries**, as a result of this, the blood becomes deoxygenated. The deoxygenated blood returns to right side of the heart that sends it to lungs for reoxygenation.

(iv) In inspired air oxygen is 19.6% whereas in expired air oxygen is 15.7%, hence, **nearly 4% oxygen comes in from air to blood, similarly in inspired air CO_2 is 0.04%**. Whereas in expired air CO_2 is 3.6% hence nearly **3.56% CO_2 comes out from blood into air**.

Table of partial pressures and percentage concentrations (in brackets) of gases in various airs

Gas	Atmospheric air	Inspired (= humidified air)	Functional residual alveolar air	Expired air
N_2	597.0(78.62%)	563.4(74.09%)	569.0(74.9)	566.0(74.5%)
O_2	159.0(20.84%)	149.3(19.67%)	104.0(13.6%)	120.0(15.7%)
CO_2	0.3(0.04%)	0.3(0.04%)	40.0(5.3%)	27.0(3.6%)
H_2O	3.7(0.5%)	47.0(6.2%)	47.0(6.2%)	47.0(6.2%)
	760.0(100%)	760.0(100%)	760.0(100%)	760.0(100%)

Partial Pressure	Alveolar air	Pulmonary Arterial Blood	Pulmonary Venous Blood
PO_2	104 mm Hg	40 mm Hg	95 - 104 mm Hg
PCO_2	40 mm Hg	45 - 46 mm Hg	40 mm Hg

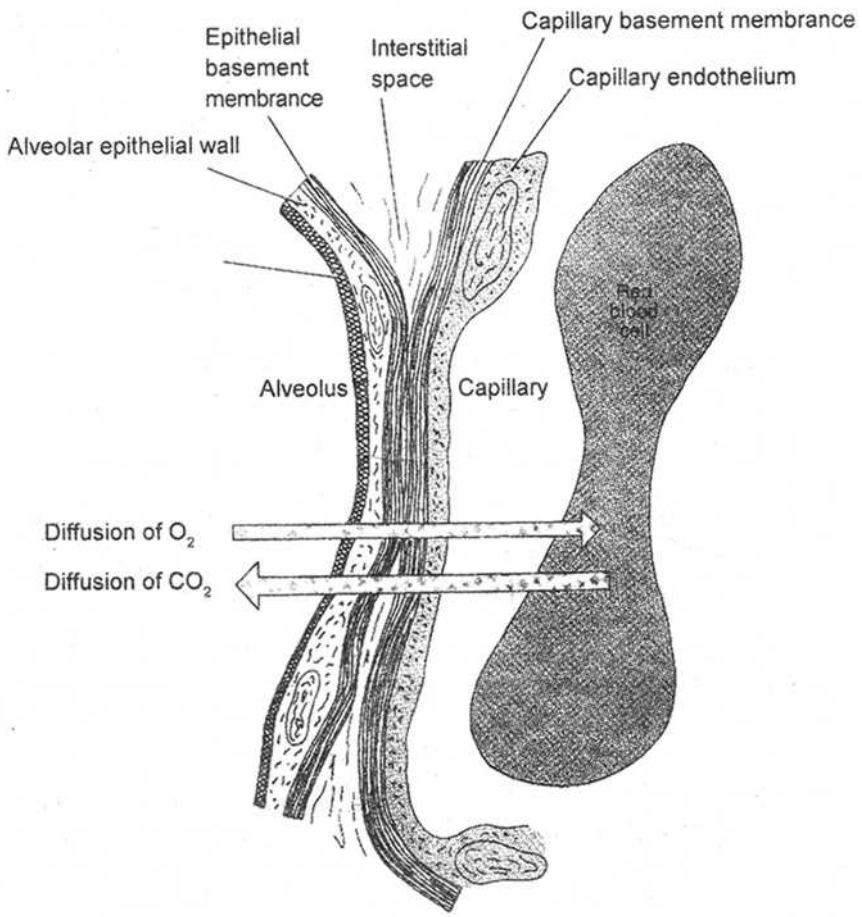
TRANSPORT OF GASES IN BLOOD

Blood carries oxygen from lungs to the heart and from the heart to various cells and tissue.

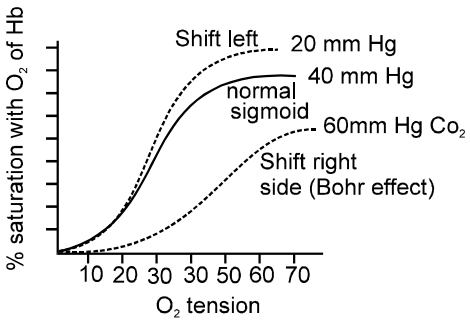
The blood also brings CO_2 from cells and tissue to the heart, from heart to lungs, for expiration.

- **TRANSPORT OF OXYGEN**

As much oxygen comes in the blood from air, approximately 3% of it dissolves in the blood plasma. Remaining 97% oxygen combines with haemoglobin to form oxygaemoglobin. One molecule of haemoglobin combines with 4 molecules of oxygen Haemoglobin is made up of 4 units. Every unit of it, reacts with one molecule of oxygen. 1 gm haemoglobin can combine with a maximum of 1.34 ml of oxygen and 100 ml blood carries about 15 gm haemoglobin so 100 ml blood transports approximately 20 ml of oxygen. Oxygen does not oxidise haemoglobin. Formation of oxyhaemoglobin is a process of oxygenation. The valency of iron is 2 in oxyhaemoglobin. Some gases (eg. Ozone SO_3, NO, NO_2 etc.) oxidise haemoglobin. This oxidised haemoglobin is alled Methamoglobin. This is a colourless compound. This type of gases are enviromental pollutant. At the time, oxyhaemoglobin reaches upto the tissues it dissociates. O_2 freed it goes into the tissue fluid from blood. In place of it, CO_2 from tissue fluid comes into blood. Gaseous exhange between blood and tissue is called internal respiration. It is also done by simple diffusion. In a conduction cycle blood gives its 25%O_2 to tissues . The rate of saturation of haemoglobin with O_2 is directly proportional to concentration of oxygen as with a rise in pO_2 the affinity between O_2 and Hb also increases.



- **Oxygen dissociation curve**
  (i) The relationship between the saturation of haemoglobin and oxygen tension is studied by examination of dissociation curve of oxyhaemoglobin.
  (ii) Oxygen dissociation curve is **sigmoid**. It is also called oxygen equilibrium curve.
  (iii) At normal condition it is sigmoid & normal.
  (iv) With increase in concentration of CO_2 in tissues curve shifts towards right side and % of O_2 in Hb decreases due to more dissociation of oxyhaemoglobin.
  (v) By decrease in conc. of CO_2 in tissues curve shifts towards left side and % of O_2 in Hb becomes more due to low dissociation of oxyhaemoglobin.
  (iv) p50 is the partial pressure of O_2 at which Hb is 50% saturated with O_2. Its normal value is 30 mmHg.



Factors affecting oxygen dissociation curve

(a) Temperature - Oxygen dissociation curve turns to right side with increase in temperature.

(b) pCO_2 - Oxygen dissociation curve turns to right side and oxygen binding capacity of haemoglobin is lowered with increase in pCO_2.

(c) pH - Oxygen dissociation curve turns to right side with decrease in pH. Moreover dissociation of oxyhaemoglobin will increase when pH of blood falls or H^+ concentration of blood rises.

(d) Fetal Haemoglobin - Pressure of Fetal Hb shifts the curve fowards left. Because fetal Hb has a higher degree of affinity with oxygen than normal haemoglobin.

- **Bohr effect**

(i) Bohr effect is the effect of CO_2 on **oxyhaemoglobin**.

(ii) Dissociation of oxyhaemoglobin is directly proportional to blood pCO_2. Because with a rise in pCO_2 the affinity between oxygen & haemoglobin decreases.

- **Haldane effect**

According to haldane effect the **oxyhaemoglobin** behave like strong acid and cause dissociation of CO_2 from its carrier compounds.

TRANSPORT OF CARBON DIOXIDE

During oxidation of food CO_2, water and energy are produced. From the cells carbon dioxide in gaseous state diffuses out of the cells into the capillaries. From capillaries it is transported by 3-ways.

1. As a dissolved gas

A very small amount of CO_2 about 5% to 7% dissolves in the plasma and is carried as a physical solutions to the lungs.

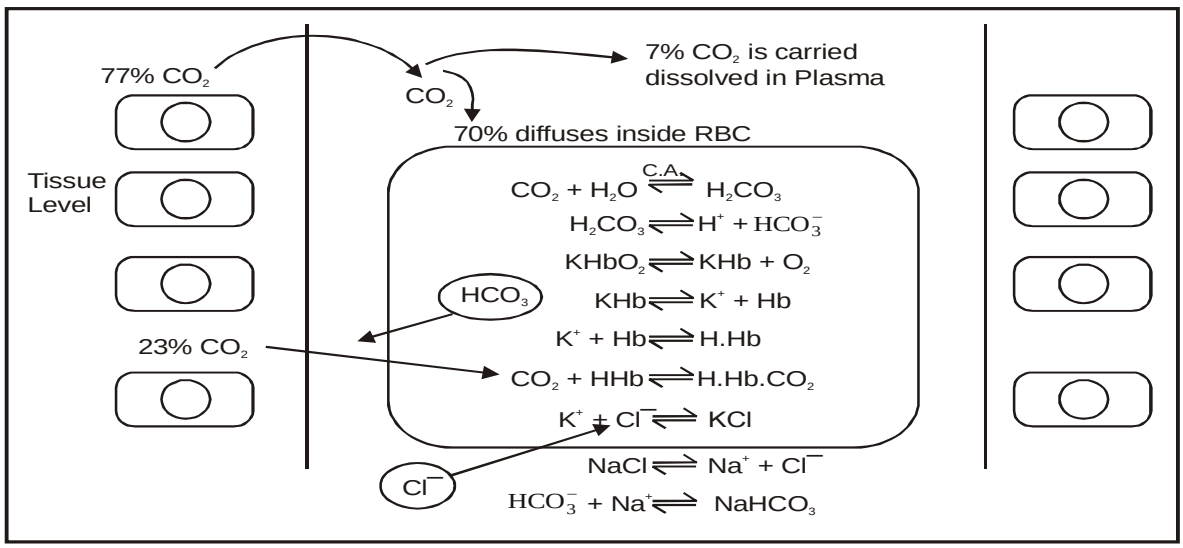
2. As bicarbonates

(i) About 70% of CO_2 enters the erythrocytes where it react with water to form **carbonic acid** in the presence of an enzyme called the **carbonic anhydrase**.

(ii) In erythrocytes most of the **carbonic** acid rapidly dissociates to form bicarbonate and hydrogen ion.

(iii) Bicarbonate ion passes out from the erythrocytes into the plasma. This causes significant difference in ionic balance between ions in the, plasma and those inside the erythrocytes. To restore the ionic balance the chloride ion diffuse from the plasma into the erythrocytes. This movement of chloride ions is called **chloride shift or Hamburger's phenomenon** reported by **Hamburger in 1918**. The chloride shift maintains an acid base equilibrium of pH 7.4 for the blood and electrical balance between erythrocytes and plasma.

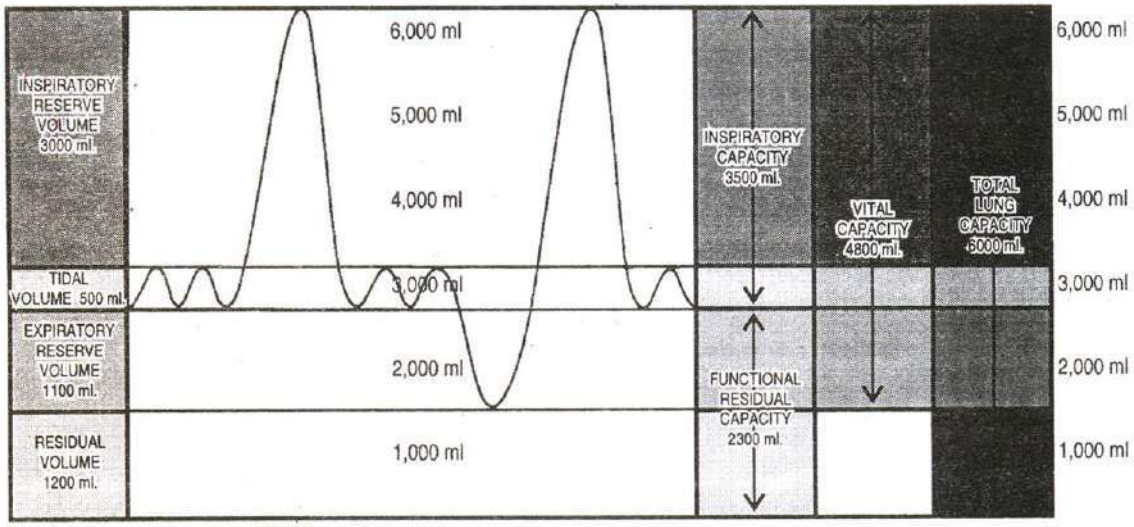
(iv) Some of the bicarbonate is carried in erythrocytes while most of bicarbonate is released into plasma and carried or transported by it



3. As carbaminohaemoglobin

About 23% of CO_2 it transported as carbamino haemoglobin which is formed by the **reversible combination** of CO_2 with amino group of globin part of the haemoglobin.

- **PULMONARY CAPACITY (SPIROMETRY)**



1. Tidal volume

- Volume of air inspired or expired with each normal breath (in voluntarily) is called tidal volume.
- In normal person tidal volume is **500 ml**.

2. Inspiratory reserve volume (IRV) or complimental air volume

- It is the extra volume of air which can be inspired by deepest forced inhalation beyond tidal volume.
- It is about 3000 ml

3. Inspiratory capacity

- It is total volume of air that can be inhaled forcefully after a normal exhalation.

  IC = TV + IRV

  = 500 + 3000 = 3500 mL.

4. Expiratory reserve volume (ERV)

- It is extra amount of air that can be expired forcibly after a normal expiration. It is about 1100 ml.

5. Residual volume (RV)

- It is volume of air which remains still in the lungs even after the most forceful expiration.It is about 1200 ml.

6. Functional residual volume (FRV)

- It is the amount of air that normally remains inside lungs after a normal expiration.
- It is equal to the sum of expiratory reserve volume and the residual volume.

  E.R.V. + R.V. = FRC

- It is about 2300 ml

7. Vital capacity of lung (V.C)

- It is the maximum amount of air that can be expelled from the lungs by forced exhalation after a deepest forced inhalation. It is equal to sum of tidal volume, inspiratory reserve volume and expiratory reserve volume.

  V. C. = TV + IRV + ERV = 500 + 3000 + 1100 = 4600 ml

  Vital capacity is higher in mountain dwellers, atheletes, young person and men.

8. Total lung capacity (TLC)

- It is the total amount of air that can be present in the lungs after a maximum inhalation effort.

TLC = VC + RV OR TV + IRV + ERV + RV

= 5-6 liter (Average 5800 ml)

- **Respiratory pigment**

Name of pigment	Colour (oxidised)	Metal	Place	Example
Haemoglobin	Red	*Fe*	RBC	Chordata (Vertebrate)
Haemocyanin	Blue	*Cu*	Plasma	Mollusca and arthropoda
Chlorocruorin	Green	*Fe*	Plasma	Annelida, sabella, serpulids
Haemoerythrin	Red	*Fe*	Corpuscle	Annelida, Sipunculoidea, lingula
Venadium	Green	*Va*	Vanadocytes in Plasma	Urochordata
Echinochrome	Red	*Fe*	Coelomic fluid	Echinodermata
Pinnoglobin	Brown	*Mn*	Coelomic fluid	Pinna
Molpedin	Brown	*Mo*	Coelomic fluid	Holothuria
Heamoglobin	Red	*Fe*	Plasma	Earthworm, nereis, arenicola, chironomas insect, planorbis.
Erythrocruonin	Red	*Fe*	Plasma	Leech

RESPIRATORY QUOTIENT

Respiratory quotient is the ratio of the volume of carbon dioxide produced to the volume of oxygen consumed over a period of time in respiration.

$$\textbf{RQ} = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ absorbed}}$$

- Respiratory quotient varies with different foods utilized in respiration.
- For **glucose**, RQ is 1 (RQ = 6 $CO_2/6O_2$ = 1), for **fats** it is about 0.7, for **proteins** it is about 0.9 and for organic acids it is about 1.3 or 1.4.
- In anerobic respiration, there is no consumption of oxygen. Carbon dioxide is produced in most of the cases. Therefore **R.Q. is infinity.**
- The respiratory quotient indicates the type of food oxidized in the body of the animal during respiration.
- R.Q. is determined by **Ganong's respirometer**.

COMMON RESPIRATORY DISEASES

1. **Pharyngitis -** It is an inflammation of the pharynx, often called sore throat. It may accompany the common cold and it usually involves inflammation of the tonsils.
2. **Laryngitis -** It is an inflammation of the larynx that often accompanies pharyngitis. In laryngitis, inflammation of the larynx disturbs the vibration of vocal cords and speaking is difficult or impossible.
3. **Bronchitis-** It is an inflammation of the bronchi. Bronchitis is caused by an infection or some other forms of irritation.

4. **Asthma -** It is caused by an allergic reaction to foreign substances that affects the respiratory tract. Allergens stimulate. the release of histamine from the mast cells. Histamine cause bronchial smooth muscle to contract. Exhaling is more difficult than inhaling.
5. **Emphysema -** In this respiratory disorder, many septa between the alveoli are destroyed and much of the elastic tissue of the lungs is replaced by connective tissue. Major causes are cigarette smoking and inhalation of other smoke or toxic substances over a period of time.
6. **Hypoxia -** It is an insufficiency of oxygen reaching the tissues of the body.
7. **Yawning -** A deep inspiration through widely opened mouth producing an exaggerated depression of the lower jaw. May be stimulated by drowsiness or fatigue.
8. **Pleurisy -** In this disease pleural membranes surrounding the lungs get inflammed and scrape against each other during breathing.
9. **Coughing -** Coughing is a protective reflex to getrid of the irritation in the throat and respiratory passage. The irritation may be caused by illhaled dust, food, smoke, mucus from lungs or nasal passages.
10. **Sneezing -** It is a protective relex to get rid of the irritation in the nasal passage.
11. **Whooping cough -** Whooping cough is caused by Haemophilus pertussis. It spreads by discharge from the throat of infected persons.
12. **Tuberculosis -** It is caused by bacteria-Mycobacterium tuberculosis. It spreads through sputum of infected persons. Sputum is mucus expelled from trachea via mouth. It contains the mucus trapped dust particles and bacteria. The bacteria of T .B. release tuberculin, a toxin which causes fever, loss of weight and general weakness. The bacteria damage the lung alveoli and cause coughing. Tuberculosis can be cured by BCG vaccine.
13. **Influenza or flu -** It is a viral disease. The common symptoms are fever, pain in the body arid discharge through nose.
14. **Mountain sickness -** Persons living in plains, when ascend mountains above 8000 ft.. from sea level, develop symptoms of mountain sickness within 8-24 hours. The symptoms are breathlessness, headache, dizziness, nausea, vomiting, mental fatigue and even bluish tinge on skin, nails and lips. This is because partial pressure of oxygen Po_2 falls with the fall of atmospheric pressure and rise of altitude. This lowers Po_2 in alveolar air and consequently reduces diffusion of oxygen into the blood. The fall in oxygenation of blood produces mountain sickness.
15. **Hiccough -** (Hiccup). Inspiratory spasm caused by sudden contraction of diaphragm accompanied by loud closure of glottis.
16. **Cyanide poisoning (Histotoxic anaemia)**

    Causing inactivation of cytochrome oxidase enzyme of mitochondria leading to asphyxia & death
17. **CO poisoning**

    Carbon monoxide affinity for haemoglobin is about 300 times more than O_2. It forms a stable carboxy haemoglobin (chery red in colour) hence decreasing oxygen carrying capacity of Hb.

IMPORTANT TIPS

- Protoplasmic respiration refers to the respiration of proteins.
- Polarography is employed to measure the concentration of oxygen in fluid.
- Accumulation of blood in pleural cavity is called haemothorax.
- All pulmonary volume and capacities are about 20-25% less in females than males.
- Accumulation of water is called hydrothorax.
- Accumulation of pus is called pyothorax.

- Accumulation of air is called pneumothorax.
- If chest wall is punctured, then pressure inside the pleural cavity become equal to atmospheric pressure so breathing stops.
- Besides lungs, the term alveolus is associated with bony socket for tooth, and in mammary glands also.
- In general, a man respires about 16 - 18 time in a minute.
- A new born child respires 32/min.
- A five year old child respires 26/min.
- A fifty year old man respires 18/min.
- Respiratory rate is lowest while sleeping (10 minute in human), respiratory rate during sitting (12 minute in human).
- Orthinolarynology - The branch of medicine deals with the diagnosis and treatment of diseases of the ears, nose and throat.
- Rhinoplasty - or 'Nose job' surgically change in shape of external nose.
- Smaller the animal higher the respiratory rate.
- Rate of respiration is directly proportional to concentration of CO_2 in blood.
- Inspired air has 20.48 ml. O_2 in its 100 ml.
- Expired air has 15.70 ml. O_2 in its 100 ml.
- In pregnant woman diaphragm does not take part in breathing.
- After 6 months, formation of alveoli of lungs.
- In embroys of mammals, respiration takes place by chorion.
- In snakes, only right lung in functional, left lung is reduced.
- Rate of breathing of a normal man during heavy exercise is 40-50 times/minute.
- Diaphragm plays 75% part in breathing (abdominal breathing).
- Ribs and sternum plays 25% part in breathing (thoracic breathing).
- In pregnant females most part during breathing is played by intercostal muscles.
- In monkeys, kangaroo and other jumping animals, intercostal muscles play important role in breathing.

SARS - Severe Acute Respiratory Syndrome -

- SARS is a highly infectious disease caused by corona virus.
- Corona virus in RNA virus, its genome was sequenced with in 15 days.
- The origin of SARC is from South China, from South China this disease spread to Hongkong.
- Bird sellers and presous in contact with birds to suffer from SARS.
- Symptoms of infections are flue like symptoms. Fever occurs with dry cough. There is difficult in breathing. Fluid filled in lungs and death occurs with in one week of infection from respiratory failure.
- Rate of death was initially 4% but now death rate has increased to 10%.
- Line of treatment is quarnatine and ribovinin durgs.
- The causative agent of SARS was identified by Dr. Malik Peiris of Microbiology Department of Honkong University.

EXERCISE - 1

Q.1 Oxygenated blood from lungs is carried to the heart by-
(1) Pulmonary artery (2) Pulmonary vein
(3) Coronary vein (4) Pre-cavals

Q.2 A person met with an accident and died instantly without any injury to heart, brain, stomach and kidney. One of the following is a reason for his death-
(1) Intestine got twisted
(2) RBC became coagulated
(3) Stomach stopped digestion
(4) Diaphragm got punctured

Q.3 The function of nasal cavity & nasopharynx is to-
(1) Warm the inspired air
(2) Moisten the inspired air
(3) Filter out the dust particles from the inspired air
(4) All of the above

Q.4 The breathing controlling centre of medulla oblongata is mainly under
(1) Chemical control (2) Physical control
(3) Neural control (4) All of the above

Q.5 Schneiderian epithelium is found in
(1) Trachea (2) Nasal passage
(3) Palate (4) Buccal cavity

Q.6 Much developed larynx of human male is called
(1) Aristole's lanttern (2) Syrinx
(3) Adam's apple (4) Muller's organ

Q.7 What is the cause for the movement of oxygen through the alveolar blood capillaries of lungs
(1) Difference in the O_2 tension and partial pressure of these chambers
(2) Partial pressure of CO_2
(3) Union of O_2 with haemoglobin
(4) All of the above

Q.8 One of the following is a difference between pulmonary respiration of frog and human-
(1) Diaphragm and ribs play role in respiration in frog
(2) Lungs are respiratory organs
(3) Respiration occurs due to pressure gradient in human
(4) None of the above

Q.9 Asphyxia occurs due to-
(1) Rise in level of CO_2
(2) Fall in level of CO_2
(3) Rise of O_2 level (4) Fall in O_2 level

Q.10 The tissue respiration refers to-
(1) Inspiration (2) Expiration
(3) External respiration (4) Internal respiration

Q.11 Cellular respiration depends upon the
(1) Availability of carbohydrates in cells
(2) Concentration of O_2 in atmosphere
(3) Presence of nitrogen with O_2 in air
(4) Transport of O_2 to the cells

Q.12 Respiratory quotient (R.Q.) is equal to one when
(1) Proteins are metabolised
(2) Carbohydrates are metabolised
(3) Fats are metabolised
(4) Mixture of all the three is metabolised

Q.13 Lungs in addition to the respiratory function also help in-
(1) Excretion
(2) Temperature regulation
(3) pH regulation
(4) Maintaining balance of body

Q.14 Impulses for voluntary muscles forced breathing start in
(1) Vagus nerve (2) Spiral cord
(3) Cerebrum (4) Medulla oblongata

Q.15 When the oxygen supply to the tissues is inadequate the condition is-
(1) Hypoxia (2) Asphyxia
(3) Pleurisy (4) Anoxia

Q.16 If the thoracis wall but not lungs is punctured-
(1) The lungs get inflated
(2) The man dies as the lungs get collapsed
(3) The breathing rate decreases
(4) The breathing rate increases

Q.17 During transportation of CO_2 when bicarbonate ions diffuses from RBC into plasma, the increased hydrogen ion concentration RBC is balanced by the entry of which substance from plasma into
(1) Water (2) Oxygen
(3) Hydroxyl ions (4) Chloride ions

Q.18 During respiration in Rabbit atmospheric oxygen is first accepted by
(1) Lungs (2) Alveoli
(3) RBC (4) Trachea

Q.19 The surface of lungs is covered by
(1) Mesentery (2) Serous membrane
(3) RBC (4) Trachea

Q.20 The lungs of Rabbit expand due to
(1) Contraction of muscles in lung walls
(2) Contraction of diaphragm muscles
(3) Relaxation of ribs
(4) Relaxation of abdominal muscles

Q.21 The cartilaginous incomplete rings supporting the trachea are made up of
(1) Elastic cartilage (2) Hyaline cartilage
(3) Fibrous cartilage (4) Calcified cartilage

Q.22 Number of alveoli in the human lungs is-
(1) 300-400 million (2) 100-150 million
(3) 1-2 million (4) 100,000-150,000

Q.23 In human beings, rib case and sternum move upwardly and out wardly during-
(1) Exercise (2) Sudden back injury
(3) Expiration (4) Inspiration

Q.24 Expiration involves-
(1) Relaxation of diaphragm and intercostal muscles
(2) Contraction of diaphragm and intercostal muscles
(3) Contraction of diaphragm muscles
(4) Contraction of intercostal muscles

Q.25 Residual volume refers to the volume of
(1) Air inspired in one breath
(2) Air expired in one breath
(3) Air left in lungs after expiration
(4) Oxygen take in one breath by blood

Q.26 The cavity of the nose is divided into two lateral halves known as
(1) Vibrissae (2) Conchae
(3) Vestibules (4) Fossae

Q.27 The quick energy we get is stored in the
(1) Glucose (2) A.T.P.
(3) ADP (4) Mitochondria

Q.28 Intercostal muscles in Rabbit extend between its
(1) Thoracic ribs (2) Vertebrae
(3) Neck and shoulder (4) Diaphragm

Q.29 If the concentration of CO_2 in blood increases, the process of breathing will
(1) Have no effect (2) Increase
(3) Decrease (4) Irregular

Q.30 During inspiration, air passes into lungs due to-
(1) Increase in volume of thoracic cavity and fall in pressure
(2) Fall in pressure inside the lungs
(3) Increased volume of thoracic cavity
(4) Muscular expation of lungs

Q.31 Expiratory muscles contract at the time of-
(1) Deep inspiration
(2) Normal inspiration and expiration
(3) Forceful expiration
(4) Normal expiration

Q.32 Reduction in respiratory surface of the lungs due to break of partition in the alveoli is known as-
(1) Asphyxia (2) Bronchitis
(3) Asthma (4) Emphysema

Q.33 The rate and depth of breathing will in crease when in blood concentration of
(1) O_2 increases (2) HCO_3 increases
(3) CO_2 increases (4) HCO_3 decreases

Q.34 The function of tracheal hair (cilia) is to pass
(1) Air (2) Air out
(3) Mucous in (4) Mucous out

Q.35 In lungs of Rabbit the alveoli are the sub divisions of
(1) Trachea (2) Bronchioles
(3) Alveolar ducts (4) Infundibulum

Q.36 In the lungs of man the total respiratory surface is about, how many square meters
(1) 10 (2) 100
(3) 1000 (4) 10000

Q.37 Respiration is a
(1) Chemical process
(2) Physical process
(3) Destructive process
(4) Physiochemical process

Q.38 Tidal volume in human beings is-
(1) 1000ml (2) 1500ml
(3) 500ml (4) 4.5 litres

Q.39 Residual volume in the lungs of an average human is-
(1) 500 ml (2) 3–4.5 litres
(3) 1000 ml (4) 1500 ml

Q.40 Vital capacity of lungs of an average human is-
(1) 3000–4500 ml (2) 1500–1800ml
(3) 2000–2500ml (4) 500–1000ml

Q.41 The chemical formula of oxyhemoglobin is
(1) Hb_4O_8 (2) Hb_4O_6
(3) $H_2b_2O_4$ (4) $H_3b_2O_8$

Q.42 Which of the following equations represents respiratory quotient ratio correctly
(1) $\frac{CO_2}{O_2}$ (2) $\frac{O_2}{CO_2}$
(3) $\frac{CO_2 - O_2}{O_2}$ (4) $\frac{O_2}{CO_2 - O_2}$

Q.43 If a Rabbit utilizes fats and proteins as respiratory materials then its respiratory quotient respectively is likely to be
(1) One & one (2) 0.71 & 0.82
(3) 0.12 & 0.72 (4) 0.62 & 0.53

Q.44 We can compare the metabolic rates of mammals directly without any reference of environmental temperature because they
(1) Have mammary glands
(2) Have very much developed brain
(3) Are poikilothermic animals
(4) Are homiothermic animals

Q.45 Haemocyanin is
(1) Always found in blood corpuscles
(2) Always found dissolved in blood plasma
(3) Found dissolved in some kinds of water
(4) Some times found in blood corpuscles & some time dissolved in plasma

Q.46 Partial pressure of oxygen in the inspired and expired air is respectively-
(1) 158 and 116 mm Hg
(2) 158 and 40 mm Hg
(3) 100 and 95 mm Hg (4) 40 and 95 mm Hg

Q.47 In human beings, CO_2 concentration in the inspired and expired air is respectively-
(1) 0.03% and 5.3% (2) 0.4% and 5.0%
(3) 0.04% and 3.0% (4) 0.03% and 4.0%

Q.48 Haemoglobin is-
(1) Always found in RBC
(2) Always found dissolved in plasma
(3) Found in RBC or dissolved in plasma
(4) Always found as respiratory pigment

Q.49 Oxygen dissociates from the oxymyoglobin at-
(1) Very high atmospheric pressure
(2) Very high oxygen pressure
(3) Moderately high oxygen pressure
(4) Low oxygen pressure

Q.50 Oxygen dissociation curve expresses-
(1) Proportion between the haemoglobin & oxyhaemoglobin
(2) Concentration of O_2 & haemoglobin
(3) Proportion between with oxygen concentration
(4) Ratio of O_2 and CO_2 at the tissue level

Q.51 The oxyhaemoglobin dissociation curve -
(1) Is not the same for all animals
(2) Will be shifted to left by an increase in CO_2 concentration
(3) Will be shifted to right if concentration of O_2 increases
(4) Is the same for all animals

Q.52 Oxygen dissociation j-curve of myoglobin is-
(1) Hypobolic (2) Hyperbolic
(3) Linear (4) Sigmoid

Q.53 Mammalian lungs have numerous alveoli for-
(1) Increasing volume of inspired air
(2) Keeping the lungs in proper shape
(3) Higher number of muscles to provide greater elasticity
(4) Increasing surface area for gaseous diffusion

Q.54 The shifting of oxyhaemoglobin dissociation curve to right due to increased CO_2 concentration in blood is also called-
(1) Haburger phenomenon
(2) Bohr's effect
(3) Donanum equilibrium
(4) Chloride shift

Q.55 Beside breathing the diaphragm of mammals also helps in-
(1) Defaecation (2) Micturition
(3) Parturition (4) All of the above

Q.56 The respiratory centre in the brain is stimulated by all except-
(1) High level of CO_2 in blood
(2) Excess of lactic acid in blood
(3) High blood pressure
(4) Excess of oxyhaemoglobin in blood

Q.57 Anaerobic respiration is likely to occur in -
(1) Cockroach (2) Earthworm
(3) Tapeworm (4) Rabbit

Q.58 Which of the following contain inner lining of ciliated epithelium-
(1) Trachea (2) Ureter
(3) Uterus (4) Vasdaferens

Q.59 During the period of emergency the breathing quickens to-
(1) Prevent the collapsing of lungs
(2) Supply more oxygen to the tissues
(3) Control the heart beat
(4) Prevent collapsing of heart

Q.60 Major part of CO_2 is transported to respiratory surface as-
(1) HCO3 ions (2) H_2CO_3
(3) Hb-CO_2 (4) Free CO_2

Q.61 Forced deep breathing during rest for some time is followed by temporary stoppage of breating because of-
(1) Little CO_2 in blood
(2) High CO_2 content in blood
(3) High oxygen content in blood
(4) Little O_2 content in blood

Q.62 Hamburger's phenomenon is also known as-
(1) HCO_3 shift (2) Na^+ shift
(3) H^+shift (4) Chloride sift

Q.63 Most of CO_2 from cell respiration is transported to lungs in the form of-
(1) Carbonic acid
(2) Dissolved CO_2
(3) Bicarbonates of K & Na
(4) Sodium bicarbonate

Q.64 The lungs of Rabbit are-
(1) Non elastic and contractile
(2) Sac like structure, having no power of contraction and relaxation of their own
(3) Bulbular structures and non contractile
(4) Soft, Bulbus and Contractile

Q.65 The trachea is prevented from collapsing by-
(1) Complete cartilaginous rings
(2) Incomplete cartilaginous rings at intervals
(3) Bony rings
(4) Chitinous rings

Q.66 One of the following structures closes the respiratory passage during ingestion of food-
(1) Larynx (2) Glottis
(3) Epiglottis (4) Palate

Q.67 The inspired air ultimately reaches in lungs in-
(1) Alveolar sacs (2) Bronchioles
(3) Bronchi
(4) Respiratory bronchioles

Q.68 Respiratory movements are controlled by-
(1) Cerebellum (2) Cerebrum
(3) Medulla oblongata (4) Crura cerebri

Q.69 At higher CO_2 concentration, oxygen dissociation curve of haemoglobin will-
(1) Move to left (2) Move to right
(3) Become irregular (4) Move upwardly

Q.70 Lungs are enclosed by a double layered membrane known as-
(1) Pericardium (2) Meninges
(3) Pleura (4) Mesorchium

Q.71 The muscles which help in breathing are known as-
(1) Intercostal muscles (2) Thoracic muscles
(3) Transverse muscles
(4) Inter mammary muscles

Q.72 In a person living at high altitude, where the atmosphere is deficient of oxygen, which inference is more likely to occurs in his body-
(1) Liver produces more oxygenating compounds
(2) Spleen get enlarged
(3) Liver destroys RBC more quickly
(4) Bone marrow produces RBC more quickly

Q.73 The mode of respiration in Rabbit is-
(1) Cutaneous (2) Tracheal
(3) Branchial (4) Pulmonary

Q.74 Which one of the following events takes place during inspiration in rabbit-
(1) The internal intercostal muscles relax
(2) The stomach muscles contract
(3) Due to contraction of external intercostal muscles & flattening of diaphragms the volume of thoracic cavity increases
(4) Due to contraction of external intercostal muscles, and flattening of diaphragm the volume of thoracic cavity decreases

Q.75 The alveolar epithelium in the lung in humans-
(1) Nonciliated columnar
(2) Nonciliated squamous
(3) Ciliated columnar (4) Ciliated squamous

Q.76 Which is correct?
(1) Respiratory centres are not affected by CO_2
(2) In humans vital capacity is just double the expiratory volume
(3) A human lung has 10^3 alveoli
(4) During inspiration the lungs act at suction pump.

Q.77 Presence of large number of alveoli around alveolar ducts opening into bronchioles in mammalian lungs is-
(1) Inefficient system of ventilation with little of residual air
(2) Inefficient system of ventilation with high percentage of residual air
(3) An efficient system of ventilation with no residual air
(4) An efficient system of ventilation with little residual air

Q.78 The transverse muscular wall present in between thoracic cavity and abdominal cavity in mammals is called-
(1) Visceral epithelium (2) Parietal epithelium
(3) Diaphragm (4) Mesentary

Q.79 The ribs of rabbit are attached to-
(1) Cervical vertebrae (2) Caudal vertebrae
(3) Sacral vertebrae (4) Thoracic vertebrae

Q.80 Glottis is the opening which leads to-
(1) Oesophagus (2) Trachea
(3) Stomach (4) Duodenum

Q.81 Chemical energy is-
(1) The energy released when the chemicals react
(2) Energy contained in certain molecules which can be converted into other form of energy
(3) Heat energy (4) Light energy

Q.82 Very small animals donot have specially developed respiratory organs because-
(1) They are too small to posses these organs
(2) Small animals do not need much O_2
(3) They are inactive, so do not need special organs for respiration
(4) Their oxygen absorbing external surface area is large as compared with their internal volume

Q.83 Maximum amount / 70–75% of CO_2 transport occurs as-
(1) Dissolved in plasma
(2) Carbamino haemoglobin complex
(3) Bicarbonate
(4) None of above

Q.84 Haldane believes oxyhaemoglobin to act as-
(1) Acid (2) Alkali
(3) Buffer (4) None of the above

Q.85 Inner/alveolar surface area of human lungs is-
(1) $1m^2$ (2) $10m^2$
(3) $100m^2$ (4) 1000m2

Q.86 The rate of breathing means-
(1) The amount of respiration, that has taken place in a given time
(2) The speed of ventilation movements
(3) The comparison between respiration rates of two animals
(4) The way in which the animals respiration is typed

Q.87 Which of the following will take more part in breathing of pregnant women-
(1) Ribs (2) Diaphragm
(3) Intercostal muscles (4) Neck muscles

Q.88 Metal contained in haemoglobin is-
(1) Copper (2) Iron
(3) Zinc (4) Magnesium

Q.89 When a fish is taken out of water it dies because-
(1) It gets too much oxygen of air
(2) It is unable to drink water and die of thrust
(3) It is unable to utilize oxygen found in air
(4) Its body temperature rises to high

Q.90 The structures which mainly participate during breathing are -
(1) Ribs & abdominal muscles
(2) Larynx and ribs
(3) Diaphragm & intercostal muscles
(4) Belly & abdomen

Q.91 A child was killed through asphyxiation. Post mortem confirmed it because a piece of lung put in water-
(1) Settled down (2) Kept floating
(3) Had blood spots (4) None of the above

Q.92 In lungs, air is separated from venous blood by-
(1) Squamous epithelium + tunica externa of blood vessel
(2) Squamous epithelium + endothelium of blood vessel
(3) Transitional epithelium + tunica media of blood vessel
(4) Columnar epithelium + 3 layered wall of blood vessel

Q.93 'Hiccough (hiccup) is due to activity of-
(1) Intercostal muscles
(2) Food in air tract
(3) Diaphragm
(4) Inadequate oxygen in environment

Q.94 A singer breaths as much air as possible with his-
(1) Larynx (2) Ribs
(3) Intercostal muscles (4) Diaphragm

Q.95 Which of the following is not a strong stimulus comparatively for the respiratory centre of brain-
(1) Shortage of oxygen in blood
(2) Excess of CO_2 in blood
(3) Excess of lactic acid in blood
(4) Lowering of pH

Q.96 Condition during which the respiratory centre is inhibited is called-
(1) Suffocation (2) Anoxia
(3) Asphyxia (4) None of the above

Q.97 The narrowest and most numerous tubes of the lungs are-
(1) Bronchi (2) Bronchioles
(3) Respiratory bronchioles
(4) Alveolar ducts

Q.98 If diaphragm of rabbit is punctured then breathing is-
(1) Increased (2) Decreased
(3) Stopped (4) Not effected

Q.99 Apnoea is-
(1) Decreased ventilation
(2) Absence of breating
(3) Laboured breathing
(4) Increased ventilation

Q.100 Book lungs are respiratory structures of-
(1) Arachnida (2) Mollusca
(3) Mammals (4) Earthworm

Q.101 Cartilage of Santorini is found at the end of which of the following cartilage of larynx -
(1) Cricoid (2) Arytenoid
(3) Thyroid (4) Hyoid

Q.102 Exchange of gases takes place through the walls of-
(1) Bronchioles
(2) Respiratory bronchioles
(3) Alveolar ducts (4) Alveoli

Q.103 Scroll like turbinals are found in-
(1) Nasal chambers (2) Buccal cavity
(3) Pharynx (4) Palate

Q.104 The trachea & chief bronchi of Rabbit's lung are lined by-
(1) Stratified ciliated epithelium
(2) Pseudo stratified columnar ciliated epithelium
(3) Columnar epithelium
(4) Stratified epithelium

Q.105 How many pairs of ribs are found in rabbit-
(1) 13 (2) 10
(3) 12 (4) 11

Q.106 Bicarbonic formed inside erythrocytes passes out into plasma while chloride of plasma pass into erythrocytes. The phenomenon is called-
(1) Bicarbonate shift
(2) Carbonation
(3) Hamburger phenomenon
(4) None of the above.

Q.107 Vital capacity of lung is equal to-
(1) IRV + ERV + TV
(2) IRV+ERV+TV+RV
(3) IRV+ERV+TV+RV
(4) IRV+ERV

Q.108 Carbon monoxide contained in Tobacco smoke-
(1) Is carcinogenic
(2) Causes gastric
(3) Reduces oxygen carrying capacity of blood
(4) Raises blood pressure

Q.109 Upper part of trachea bears a cylindrical cartilagenous box like structure called-
(1) Pharynx (2) Larynx
(3) Palate (4) Syrinx

Q.110 Respiratory pigment of Rabbit is-
(1) Haemoglobin (2) Haemocyanin
(3) Erythrocrurin (4) Chlorocuroin

Q.111 CO_2 is released from bicarbonates in lungs with the help of enzyme called-

(1) Cytochrome oxidase

(2) Decarboxylase

(3) Carbonic anhydrase

(4) Dehydrogenase

Q.112 Trachea after entering into lungs divides into two branches called-

(1) Bronchi

(2) Bronchioles

(3) Respiratory bronchioles

(4) Alveolar ducts

Q.113 How many lobes are found in right lung of rabbit-

(1) Two (2) Three

(3) Four (4) Only one

Q.114 The exchange between CO_2 & O_2 between atmospheric air & the blood of lung alveoli is called-

(1) Internal respiration (2) External respiration

(3) Tissue respiration (4) Respiration

Q.115 The process of breathing is-

(1) Completely involuntary

(2) Completely voluntary

(3) Essential involuntary but is influenced voluntary with in certain limits

(4) None of the above

Q.116 Which of the following structures of Rabbit represent segmentation-

(1) Two pairs of limbs

(2) Paired eye & nostrils

(3) Vertebral column & ribs

(4) None of the above

Q.117 Which of the following perform the function of respiration in a mammal-

(1) Livers cells (2) Blood cells

(3) All body cells (4) Cells of lung alveoli

Q.118 Mammalian lungs have enormous alveoli which help in-

(1) Providing more space for air

(2) Providing more surface area for exchange of gases

(3) Keeping lungs more spongy

(4) Increasing area for more nerve supply

ANSWER KEY

Exercise - 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	4	1	2	3	1	3	1	4	4	2	3	3	1	2	4	4	2	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	4	1	3	2	2	1	2	1	3	4	3	4	3	2	2	3	3	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	1	2	4	2	1	4	3	4	1	1	2	4	2	4	4	3	1	2	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	4	3	2	2	3	1	2	2	3	1	1	4	3	2	4	4	3	4	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	4	3	1	3	1	3	2	3	3	2	2	3	3	1	4	2	3	2	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118		
Ans.	2	4	1	2	1	3	2	3	2	1	3	1	3	3	3	3	3	2		

EXERCISE - 2

Q.1 In expiration, diaphragm becomes
(1) Flattened (2) Relaxed
(3) Straightened (4) Arched.

Q.2 Rate of respiration is directly affected by:
(1) Concentration of carbon dioxide
(2) Oxygen in trachea
(3) Concentration of oxygen
(4) Diaphragm expansion

Q.3 Carbon dioxide is transported from tissue to respiratory surface by only
(1) Plasma and erythrocytes
(2) Plasma
(3) Erythrocytes
(4) Erythrocytes and leucocytes

Q.4 Respiratory system is derived from :
(1) Endoderm (2) Mesoderm
(3) Ectoderm (4) None of these

Q.5 Which is correct ?
(1) Respiratory centres are not affected by CO_2
(2) In humans vital capacity is just double the expiratory volume
(3) A human lung has 10^3 alveoli
(4) During inspiration the lungs act as suction pump

Q.6 Common feature of human and insect trachea is
(1) Noncollapsible wall (2) Supporting rings
(3) Ectodermal origin (4) Endodermal origin

Q.7 Which is false :
(1) Blood from Right side of heart is carried to lungs by pulmonary artery
(2) Pleura is double covering of kidney
(3) Pancreas is both exocrine and endocrine gland
(4) Scurvy is due to vitamin C deficiency

Q.8 Pericardial fluid is secreted by :
(1) Myocardium (2) Parietal peritoneum
(3) Visceral peritoneum (4) None of these

Q.9 Vocal cords occur in -
(1) Larynx (2) Pharynx
(3) Glottis (4) Bronchial tube

Q.10 Body tissues obtain oxygen from haemoglobin because of its dissociation in tissues caused by-
(1) Low oxygen concentration and high carbon dioxide concentration
(2) Low oxygen concentration
(3) Low carbon dioxide concentration
(4) High carbon dioxide concentration

Q.11 Lungs have a large number of alveoli for :
(1) Having spongy texture and proper shape
(2) More surface area for diffusion of gases
(3) More space for increasing volume of inspired air
(4) More nerve supply

Q.12 Respiratory organs in scorpion are :
(1) Gills (2) Booklungs
(3) Skin (4) Bookgills

Q.13 Which energy is consumed in breathing ?
(1) Mechanical (2) Chemical
(3) Bioelectrical (4) Physical energy

Q.14 During inspiration, the diaphragm:
(1) relaxes (2) contract
(3) expands (4) shows no change

Q.15 In which form CO_2 is carried in blood?
(1) Sodium bicarbonate
(2) Sodium carbonate
(3) Potassium carbonate
(4) Magnesium carbonate

Q.16 How the transport of O_2 and CO_2 by blood happens ?
(1) with the help of RBCs and blood plasma
(2) with the help of RBCs and WBCs
(3) with the help of WBCs and blood serum
(4) with the help of platelets and corpuscles

Q.17 When 1200 mL air is left in the lungs, it is called
(1) Vital capacity (2) Tidal volume
(3) Residual Volume
(4) Inspiratory reserve volume

Q.18 Mitochondria are yellow in colour due to the presence of :
(1) Xanthophyll (2) Riboflavin
(3) Carotene (4) Anthocyanin

Q.19 The vital capacity of human lung is equal to :
(1) 3500 ml (2) 4800 ml
(3) 500 ml (4) 1200 ml

Q.20 The type of respiration in mammals is called:
(1) Pulmonary respiration
(2) Gill respiration
(3) Cutaneous respiration
(4) Tracheal respiration

Q.21 Complete oxidation of one gram of glucose yields energy in calories :
(1) 6860000 (2) 68600
(2) 686000 (4) 686

Q.22 Normal breathing is called
(1) Apnoea (2) Dyspnoea
(3) Eupnoea (4) Hyperpnoea

Q.23 Trachea is lined with incomplete rings of
(1) Fibrous cartilage (2) Calcified cartilage
(3) Elastic cartilage (4) Hyaline cartilage

Q.24 Which one protects the lungs :
(1) Ribs (2) Vertebral column
(3) Sternum (4) All the above.

Q.25 Glycolysis is represented by :
(1) $C_6H_{12}O_6+6O_2 \rightarrow 6CO_2 +6H_2O$
(2) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
(3) $C_6H_{12}O_6 \rightarrow 2C_3H_4O_3+4H$
(4) $6CO_2+6H_2O \rightarrow C_6H_{12}O_6+6O_2$

Q.26 Compound soluble in water which does not impede oxygen transportation is :
(1) SO_2 (2) SO_3
(3) CO (4) NO

Q.27 In lungs, the air is separated from the venous blood through :
(1) squamous epithelium + endothelium of blood vessel
(2) squamous epithelium + tunica media of blood vessel
(3) transitional epithelium + tunica externa of blood vessel
(4) none of these.

Q.28 Hb most strongly combines with :
(1) CO (2) O_2
(3) CO_2 (4) O_3

Q.29 Tissue respiration is process by which :
(1) Carbohydrates are synthesized
(2) Proteins are broken down
(3) Fat molecules are metabolised
(4) Energy is liberated

Q.30 Biological oxidation of Krebs cycle involves:
(1) N_2 (2) CO_2
(3) O_2 (4) SO_2

Q.31 Anaerobic process after glycolysis is called:
(1) TCA (2) Calvin cycle
(3) Krebs cycle (4) Fermentation

Q.32 How does carbon monoxide, a poisonous gas emitted by automobiles, prevent transport of oxygen to body tissues ?
(1) by obstructing the reaction of oxygen with haemoglobin
(2) by destroying the haemoglobin
(3) by changing oxygen into carbon dioxide
(4) by forming a stable compound with haemoglobin

Q.33 Inspiratory air in lungs ultimately reaches
(1) trachea (2) alveoli
(3) bronchi (4) bronchioles

Q.34 If carbohydrate is subjected to anaerobic respiration, RQ will be :
(1) infinity (2) 1.7
(3) 1.2 (4) zero

Q.35 In which animal, diaphragm has no role in respiration ?
(1) Rat (2) Frog
(3) Rabbit (4) Camel

Q.36 Exchange of gases in lung alveoli occurs through
(1) Active transport (2) Osmosis
(3) Simple diffusion (4) Passive transport

Q.37 CO_2 is mainly transported by-
(1) Respiratory pigment
(2) Dissolution of gases
(3) O_2 taken by tissues
(4) Bicarbonates

Q.38 In which form iron is present in haemoglobin -
(1) Ionic (2) Unionic
(3) Fe^{2+} (4) Fe^{+3}

Q.39 Ventilation/respiratory control is present in-
(1) Medulla oblongata (2) Cerebellum
(3) Cerebrum (4) Diencephalon

Q.40 Haemoglobin is :
(1) Vitamin (2) Skin pigment
(3) Blood carrier
(4) Respiratory pigment

Q.41 Match the columns :

Column I	Column II
a Larynx	p lid of larynx
b Trachea	q Air sacs
c Alveoli	r Voice box
d Epiglottis	s Wind pipe
	t Common passage

(1) a – r, b – s, c – q, d – p
(2) a – t, b – s, c – p, d – q
(3) a – r, b – s, c – q, d – t
(4) a – r, b – t, c – q, d – p

Q.42 The process of migration of chloride ions froms plasma to RBC and of carbonate ions from RBC to plasma is
(1) Atomic shift (2) Ionic shift
(3) Na^+ pump (4) Chloride shift

Q.43 The most relativity of CO than CO_2 in which compound -
(1) Carboxy haemoglobin
(2) Oxygen
(3) oxyhaemoglobin
(4) Haemoglobin

Q.44 Respiratory centre is present where-
(1) cerebrum (2) hypothalamus
(3) cerebellum (4) medulla oblongata

Q.45 Which of the following is shift in chloride-shift?
(1) O_2 and CO_2 (2) Bicarbonate ions
(3) CO_2 (4) O_2

Q.46 Voice in mammal is produced :
(1) by syrinx (2) during inhalation
(3) by bronchus (4) during exhalation

Q.47 Which one of the following is capable of carrying oxygen ?
(1) Plasma (2) Blood
(3) Serum (4) Lymph

Q.48 Bicarbonate ions can be generated in :
(1) lymphocytes (2) neutrophil
(3) basophil (4) RBCs

Q.49 Ciliated cells are found in :
(1) liver (2) bronchus
(3) uterus (4) pancreas

Q.50 Adam's apple represents :
(1) Crioid cartilage (2) Thyroid cartilage
(3) Both (4) None

Q.51 Amount of oxygen which is present in one gm of Hb is :
(1) 1.34 ml (2) 13.4 ml
(3) 134 ml (4) 20 ml

Q.52 Alveoli increase the surface area by ..... m^2.
(1) 10 (2) 100
(3) 150 (4) 200

Q.53 Volume of air inspired or expired in relaxed position is
(1) 500 ml (2) 300 ml
(3) 150 ml (4) 115 ltr

Q.54 In which of the following animal respiration occurs without any respiratory organ ?
(1) Cockroach (2) Fish
(3) Frog (4) Earthworm

Q.55 Automobile exhaust causes respiratory problem because of the presence of
(1) CO (2) CH_4
(3) Chlorine (4) NO_2

Q.56 Book lungs are respiratory organs of
(1) mollusca (2) mammals
(3) archnida (4) earthworm

Q.57 The respiratory centre in the brain is stimulated by-
(1) CO_2 concentration in venous blood
(2) O_2 concentration in artery blood
(3) CO_2 concentration in artery blood
(4) O_2 concentration in venous

Q.58 The energy currency of a cell is
(1) 10 AMP (2) ATP
(3) Carbohydrates (4) NAD

Q.59 The net energy yield from aerobic respiration in eukaryotic cells is
(1) 10 ATP (2) 30 ATP
(3) 36 ATP (4) 38 ATP

Q.60 The volume of air breathed in end out during effortless respiration is referred to as
(1) vital volume (2) residual volume
(3) ideal volume (4) tidal volume

Q.61 What can determine the percentage of oxygen carried by Hb?
(1) pH of blood
(2) Percentage of CO_2
(3) Partial pressure of oxygen
(4) All of above

Q.62 Hamburgers effect is also known as
(1) Sodium shift (2) Chloride shift
(3) Lead shift (4) None of these

Q.63 Fully mature larva of frog respire by :
(1) Skin (2) Gills
(3) Lungs (4) Buccal cavity

Q.64 The correct order of structures through which the air passes in the body is :
(1) nasla cavity, larynx, trachea, bronchi air sacs
(2) bronchi, nasal cavity, larynx, trachea air sacs
(3) larynx bronchi, nasal cavity, trachea air sacs
(4) nasal cavity, trachea, larynx, bronchi air sacs

Q.65 The trachea is prevented form collapsing by the presence by rings of :
(1) striated muscles (2) cartilage
(3) adenoids (4) sinuses

Q.66 The process of breathing is controlled by respiratory centre located in the :
(1) spinal cord (2) cerebellum
(3) medulla oblongata (4) hypothalamus

Q.67 When the carbon dioxide concentration in blood increases, the rate of breathing will-
(1) remain unaffected (2) decrease
(3) stop (4) increase

Q.68 During inspiration :
(1) The diaphragm gets raised and ribs get lowered
(2) Both diaphragm and ribs get lowered
(3) Both diaphragm and ribs get lowered
(4) The diapghragm get flattered and ribs get raised

Q.69 Which one of the following can respire in the absence of oxygen ?
(1) *Amoeba* (2) Tapeworm
(3) House fly (4) *Hydra*

Q.70 The breathing rate gets increased by the increase in the content of :
(1) nitrogen (2) oxygen
(3) carbon dioxide (4) carbon monoxide

Q.71 The normal rate of respiration in man per minute is about :
(1) 10 to 15 times (2) 16 to 20 times
(3) 19 to 21 times (4) 23 to 25 times

Q.72 A normal man at rest inspires and expires about 500 millilitres of air, this amount is known as-
(1) complimental volume of air
(2) tidal volume of air
(3) reserve volume of air
(4) residual volume of air

Q.73 One of the following is not respiratory pigment?
(1) Anthocyanin (2) Haemoglobin
(3) Haemoerythrin (4) Haemocyanin

Q.74 The disease that occurs when the haemoglobin content of the blood goes down is :
(1) plurisy (2) emphysema
(3) anaemia (4) pneumonia

Q.75 The percentage of carbon dioxide, oxygen and nitrogen in exhaled air of man are about :
(1) 0.04 : 16 : 79 (2) 0.4 : 20 : 70
(3) 4.0 : 20 : 79 (4) 4.0 : 16 : 79

Q.76 The transport of oxygen by the blood takes place by :
(1) leucocytes (2) thrombocytes
(3) plasma (4) erythrocytes

Q.77 Lungs are surrounded by
(1) Pleura (2) Pericardium
(3) Epineurium (4) Perineurium

Q.78 The toxic effect of CO is due to its greater affinity for haemoglobin as compared to O_2, approximately by -
(1) 2 times (2) 20 times
(3) 200 times (4) 1000 times

Q.79 One haemoglobin carry how many molecule of O_2
(1) 4 (2) 2
(3) 6 (4) 8

Q.80 Volume of air breathed in and out during normal breathing is called
(1) vital capacity (2) IRV
(3) ERV (4) tidal volume

Q.81 Respiratory quotient of which diet is less than unity ?

(1) Carbohydrate (2) Fats

(3) Organic acid (4) Sugar

Q.82 Aerobic respiration is related with-

(1) Mitochondria

(2) Plasma membrane

(3) Golgi bodies

(4) Endoplasmic reticulum

Q.83 During hibernation, frog's respiration is-

(1) Cutaneous (2) Pulmonary

(3) Buccopharyngeal (4) Pharyngeal

Q.84 Blood carries CO_2 mainly in which form-

(1) $Hb.CO_2$ (2) $NaHCO_3$

(3) Carbonic acid

(4) Hb. CO_2 and carbon monoxide

Q.85 Book lungs are the respiratory organs in-

(1) Protozoans (2) Cnidarians

(3) Arthropods (4) Amphibians

Q.86 When CO_2 concentration in blood increases, breathing becomes-

(1) Slow and deep (2) Faster and deeper

(3) Shallower and slow

(4) There is no effect on breathing

Q.87 After deep inspiration maximum expiration of lungs is called-

(1) Vital capacity (2) Total lung capacity

(3) Inspiratory capacity

(4) Functional residual capacity

Q.88 Ascent of high mountains may cause altitude sickness in men. Prime cause of this is-

(1) Excess of CO_2 in blood

(2) Decreased efficiency of haemoglobin

(3) Decreased partial pressure of oxygen

(4) Decreased proportional of oxygen in air

Q.89 In lungs, there is definite exchange of ions between RBC and plasma. Removal of CO_2 from blood involves-

(1) Efflux of Cl^- ions from RBC

(2) Influx of Cl^- ions into RBC

(3) Influx of HCO_3^- ions into RBC

(4) Efflux of HCO_3^- ions from RBC

Q.90 Lungs ventilation movement is due to-

(1) Intercostal muscles and diaphgram

(2) Wall of the lungs

(3) Costal muscles

(4) Diaphragm

Q.91 Part of brain which control respiration is-

(1) Cerebrum (2) Cerebellum

(3) Spinal cord (4) Medulla oblongata

Q.92 Which enzyme is most abundantly found in RBC-

(1) Carbonic anhydrase (2) Haemoglobin

(3) Albumin (4) Thrombinase

Q.93 Sum total of constructive activities in the body is called-

(1) Catabolism (2) Anabolism

(3) Metabolism (4) Active transport

Q.94 The oxygenated blood leaving the heart & reaching the tissues gives up its some oxygen to the tissues because-

(1) Oxyhaemoglobin undergoes reduction

(2) O_2 concentration in tissues is lower & CO_2 concentration is higher

(3) The tissues are capable of absorbing O_2 from the oxyhaemoglobin

(4) O_2 concentration in tissues is higher & CO_2 concentration

Q.95 Which one has the smallest diameter-

(1) Right bronchus

(2) Left bronchus

(3) Secondary bronchiole

(4) Respiratory bronchiole

Q.96 When man takes in air containing normal concentration of O_2 as well as CO_2 he suffers from suffocation because -

(1) CO affects the nerves of the lungs

(2) CO affect diaphgram and costal muscles

(3) CO reacts with O_2 & prevent the entry of O_2 in blood in lungs

(4) Haemoglobin combines with CO_2 instead of O_2 & the product so formed cannot dissociated easily

Q.97 The combination of O_2 with haemoglobin can be increased mostly by-
(1) Decreasing O_2 concentration in blood
(2) Increasing O_2 concentration in air
(3) Increasing CO_2 concentration in air
(4) Decreasing CO_2 concentration in air

Q.98 Breathing in rabbit is mainly controlled by-
(1) Enzymes
(2) Sympathetic nervous system
(3) Central nervous system
(4) Hormones

Q.99 The capacity of lungs to expire maximum volume of air after a deep inspiration is called-
(1) Vital capacity
(2) Total lungs capacity
(3) Tidal capacity (4) Residual capacity

Q.100 In mammalian lung tidal means-
(1) Total number air that can be drawn in
(2) The amount of air that can be expelled out forcibly by normal expiration
(3) The amount of air that normally enters the lungs and comes out by expiration
(4) The amount of air which is left lungs after normal expiration

Q.101 BMR (Basal metabolic rate) of rabbit is controlled by the secretion of-
(1) Pancreas (2) Thyroid
(3) Liver (4) Pituitary

Q.102 The capacity for doing work is called-
(1) Energy (2) Power
(3) Heat (4) Life

Q.103 The release of energy in the living cells is the process of-
(1) Oxidation (2) Respiration
(3) Digestion (4) Assimilation

Q.104 The ultimate of all kinds of respiration is-
(1) Formation of CO_2 (2) Oxidation of food
(3) Release of energy (4) Formation of water

Q.105 The elastic cartilage which acts as a lid for glottis is called-
(1) Cricoid (2) Epiglottis
(3) Arytenoid (4) Thyroid

Q.106 The contraction of internal intercostal muscles in rabbit cause-
(1) Inspiration (2) Expiration
(3) Aspiration (4) Assimilation

Q.107 The vocal cords of Rabbit are-
(1) Membranous (2) Thread like
(3) Cartilagenous (4) Bony

Q.108 When temperature of a mammals rises the rate of breathing-
(1) Increases (2) Decreases
(3) Remains unaffected
(4) Stops

Q.109 Carbodioxide rapidly dissolves in blood due to the presence of-
(1) Haemoglobin
(2) Carbonic anhydrase enzyme
(3) RBC (4) Blood plasma

Q.110 Converse of Bohr's effect is called-
(1) Root effect (2) Chloride shift
(3) Haldane effect
(4) Hamburger phenomenon

Q.111 SARS is caused by variant of-
(1) Pneumococcus pneumonia
(2) Common cold Corona virus
(3) Asthma (4) Bronchitis

Q.112 When the blood passes from lungs to tissues & back, in this one circuit the capacity of haemoglobin to give off O_2 is about -
(1) 25% (2) 50%
(3) 75% (4) 100%

Q.113 Pleurisy is the disease of-
(1) Liver (2) Heart
(3) Lungs (4) Kidneys

Q.114 The blood leaving the lungs is richer than the blood entering in lungs in the -
(1) Number of RBC per ml of blood
(2) Amount of haemoglobin per ml. of blood
(3) Amount of nutrients per ml of blood
(4) Amount of oxygen per ml of blood

Q.115 Direct respiration occurs in-
(1) Human beings (2) Prawn
(3) Insects (4) Fish

Q.116 At higher altitudes a man suffers much from-
(1) Cold (2) Oxygen deficiency
(3) Higher atmospheric pressure
(4) Ultraviolet radiations

Q.117 Tuberculosis in man is caused by-

(1) Tuberculosis virus (2) Streptococci

(3) Staphylococci

(4) Tuberculosis bacillus

Q.118 Asthma is a respiration disease caused due to-

(1) Infection of lungs (2) Tracheal infection

(3) Bleeding in the pleural cavity

(4) Cramps in the bronchial muscles obstructing the air passage

Q.119 When a mammal takes in atmospheric air, the diaphragms becomes-

(1) Domb shaped (2) Conical

(3) Flat (4) Unchanged

Q.120 Which has more affinity for haemoglobin?

(1) Cabon monoxide

(2) Carbon dioxide

(3) Oxygen

(4) Both 2 and 3.

Q.121 Person living at higher altitude have more haemoglobin than peoples of plains because at high altitude there is low-

(1) Temperature (2) Pressure of air

(3) O_2 concentration in air

(4) All of the above

Q.122 In fever a patient breaths at faster rate than to his normal healthy condition because-

(1) O_2 carrying capacity of blood is lowered in fever

(2) High temperature stimulates the respiratory centre of the brain

(3) Fever requires more O_2 to fight germs

(4) Increased temperature enhances the metabolic rate of body which requires more energy

Q.123 When some food particle enters the trachea inseted of esophagus we get rid of it by the process of-

(1) Sneezing (2) Coughing

(3) Yawning (4) Forced breathing

Q.124 The most characteristic feature of haemoglobin is-

(1) Its red colour

(2) Presence of iron

(3) Presence of basic protein globin

(4) Its reversible association with O_2

Q.125 Stretch receptors of bronchi send information to inspiratory area of respiratory centre through-

(1) Vagus (2) Glossopharyngeal

(3) Sympathetic nerve

(4) Parasympathetic nerve

ANSWER KEY

Exercise - 2

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	1	1	1	4	1	2	3	1	4	2	2	2	2	1	1	3	2	2	1
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	3	3	4	4	2	1	1	1	4	3	4	4	2	1	2	3	4	3	1	4
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	1	4	4	4	2	4	2	4	2	2	1	2	1	4	1	3	3	2	3	4
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	4	2	2	1	2	3	4	4	2	3	1	2	1	3	4	4	1	3	4	4
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	3	1,2	1	2	3	**2**	1	3	1	1	4	1	**2**	**2**	**4**	**4**	**2**	**3**	**1**	**3**
Ques.	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
Ans.	**2**	**1**	**2**	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**2**	**1**	**3**	**4**	**3**	**2**	**4**	**4**	**3**	**1**
Ques.	**121**	**122**	**123**	**124**	**125**															
Ans.	**3**	**4**	**2**	**4**	**4**															

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 The aveolar epithelium in the lung is – **[C.B.S.E. 1990, B.H.U. 1996]**

(1) Nonciliated colomnar
(2) Nonciliated squamous
(3) Ciliated columnar
(4) Ciliated squamous

Q.2 Respiratory centre is situated in– **[C.B.S.E. 1999]**

(1) Cerebellum (2) Medulla oblongate
(3) Hypothalamus (4) Cerebrum

Q.3 Air is breathed through– **[Pb. P.M.T. 1999 C.B.S.E. 1994]**

(1) Trachea → lungs → laryns → pharynx → alveoli
(2) Nose → larynx → pharynx → bronchus → alveoli → bronchioles
(3) Nostrils → Pharynx → larynx → trachea → bronchi → bronchioles → alveoli
(4) Nose → mouth → lungs

Q.4 Carbonic anhydrase is mostly active in – **[C.E.T. Chd. 2000, Manipal 2001]**

(1) RBC (2) WBC
(3) Blood Plasma (4) Blood Platelets

Q.5 At high altitude, RBC of human blood will – **[C.B.S.E. 1995, Pb. P.M.T. 1999]**

(1) Increase in number
(2) Decrease in number
(3) Decrease in size
(4) Increase in size

Q.6 About 1200 ml of air left in lungs is called– **[C.B.S.E. 1996]**

(1) Tidal volume
(2) Ispiratory reserve volume
(3) Residual volume
(4) Vital capacity

Q.7 Which one protects the lungs– **[B.H.U. 1996]**

(1) Rib (2) Vertebral colum
(3) Sternum (4) All above

Q.8 Which one has the lowest value – **[B.H.U. 1996]**

(1) Tidal volume (2) Vital capacity
(3) Inspiratory reserve volume
(4) Expiratory reserve volume

Q.9 Amount of oxygen present in one gram of haemoglobin is– **[A.I.I.M.S. 1997, Har, PMT 2000]**

(1) 20 ml (2) 1.34 ml
(3) 13.4 ml (4) None of these

Q.10 Compound soluble in water which does not impede oxygen trasportation is– **[A.I.I.M.S. 1997]**

(1) SO_2 (2) SO_3
(3) CO (4) NO

Q.11 In lungs air is separated from venous blood by– **[C.B.S.E. 1997]**

(1) Squamous epithelium + tunica externa of blood vessel
(2) Squamous epithelium + endothelium of blood vessel
(3) Transitional epithelium + tunica media of blood vessel
(4) Columnar epithelium + 3 layered wall of blood vessel

Q.12 In carbon monoxide poisoning there is– **[A.F.M.C. 1997]**

(1) Increase in carbon dioxide concentration
(2) Decrease in oxygen availability
(3) Decrease in free haemoglobin
(4) None of these

Q.13 Exchange of gases in lung alveoli occurs through– **[C.B.S.E. 1998]**

(1) Active transport (2) Osmosis
(3) Simple diffusion (4) Passive transport

Q.14 Vocal cords occur in – **[M.P. P.M.T. 1999]**

(1) Pharynx (2) Larynx
(3) Glottis (4) Brronchial tube

Q.15 Match the columns– **[karnataka 1999]**

	Column I		Column II
(a)	Laynx	(p)	Lid of larynx
(b)	Trachea	(q)	Air sacs
(c)	Alveoli	(r)	Voice box
(d)	Epiglottis	(s)	Wind pipe
		(t)	Common passage

(1) a–r, b–s, c–q, d–p (2) a–t, b–s, c–p, d–q
(3) a–r, b–s, c–q, d–t (4) a–r, b–t, c–q, d–p

Q.16 Adam's Apple represents– **[Pb. P.M.T. 2000]**

(1) Arytenoid cartilage of larynx
(2) Cricoid cartilage of larynx
(3) Thyroid cartilage of larynx
(4) All the above

Q.17 Hiccough (Hiccup) is due to activity of– **[Manipal 2001]**

(1) Intercostal muscle
(2) Food in air tract
(3) Diaphragm
(4) Inadequate oxygne in environment

Q.18 respiratory centre of brain is stimulated by– **[A.I.I.M.S 2000]**

(1) Carbon dioxide content in venous blood
(2) Carbon dioxide content in arterial blood
(3) Oxygen content in venous blood
(4) Oxygen content in arterial blood

Q.19 Carbon dioxide entering erythrocytes reacts with water to form carbonic acid. The enzyme is– **[H.P.P.M.T. 2001]**

(1) Carbonic anhydrase
(2) Carhboxypeptidase
(3) Hydrolase
(4) Oxidoreductase

Q.20 Arytenoid cartilage is found in– **[B.H.U. 2000]**

(1) Hyoid (2) Sternum
(3) Larynx (4) Nose

Q.21 Dissociation of xoyhaemoglobin occurs in tissues due to – **[J.I.P.M.E.R. 2002]**

(1) High P_{O_2} (2) Low P_{O_2}
(3) Equal P_{O_2} (4) Irrespective of P_{O_2}

Q.22 At the time of expiration, diaphragm becomes– **[Karnataka 2003]**

(1) Oblique (2) Normal
(3) Flattened (4) Dome-shaped

Q.23 Exchange of bicarbonates and chloride ions beteween RBC and plasma is called– **[CBSE 1999]**

(1) Chloride shift
(2) Bohr's effect
(3) Haldane's effect
(4) Intra cellular respiration

Q.24 When CO_2 concentration in blood increase breathing becomes– **[CBSE 2004]**

(1) There is no effect on breathing
(2) Slow and deep
(3) Faster
(4) Shallower and slow

Q.25 In which part of lungs gaseous exchange takes place in Rabbit– **[RPMT 2001]**

(1) Trachea & alveolar duct
(2) Trachea & bronchi
(3) Alveolar duct & alveoli
(4) Alveoli & Trachea

Q.26 If CO_2 concentration increase in blood then breathing will– **[RPMT 2003]**

(1) Increases (2) Decrease
(3) Stop (4) Remain unchanged

Q.27 Heiring breuer reflex related to– **[RPMT 2003]**

(1) Effect of pH on respiratory centre
(2) Effect of CO_2 on respiratory centre
(3) Effect of nerves on respiratory centre
(4) Effect of temp. on respiratory centre

Q.28 Toxic effect of carbon monoxide is due to its greater affinity for haemoglobin as compared to oxygen– **[RPMT 2003]**

(1) 2 times (2) 20 time
(3) 200 times (4) 300 times

Q.29 Tracheal rins in rabbit are– **[RPMT 2004]**

(1) Complete
(2) Incomplete
(3) Dorsally incomplete
(4) Lateral incomplete

Q.30 Lungs ventilation movements is due to– **[Uttaranchal PMT 2004]**

(1) Costal muscle and diaphragm
(2) Costal muscle
(3) Diaphragm
(4) Wall of the lungs

Q.31 During hibernation period, frog's respiration is – **[Uttaranchal PMT 2005]**

(1) cutaneous (2) pulmonary
(3) pharyngeal (4) buccopharyngeal

Q.32 In alveolar air, the partial pressure of CO_2 is– **[West Bengal JEE 2007]**

(1) 40 mm of Hg (2) 42 mm of Hg
(3) 44 mm of Hg (4) 46 mm of Hg

Q.33 In lung, maximu gaseous exchange is due to– **[Jharkhand 2006]**

(1) Simple diffusion
(2) Active transport
(3) Passive transport
(4) fascilitated diffusion

Q.34 Respiratory centre in brain occurs in– **[Jharkhand]**
(1) Medulla oblongata (2) Cerebellm
(3) Hypothalamus (4) Pericardium

Q.35 CO_2 is transported mainly by– **[Bihar 2005]**
(1) plasma (2) carbonic acid
(3) bicarbonate
(4) carboxyhaemoglobin

Q.36 By which mechanism, oxygen is transported from lungs to cells– **[Bihar 2005]**
(1) Diffusion (2) Fascilitated diffusion
(3) Transpiration (4) Osmosis

Q.37 Repiratory pigment or oxygen carrier in frog's blood is – **[Bihar 2002]**
(1) haemocyanin (2) haemoglobin
(3) haemazoin (4) lymphocytes

Q.38 Why is CO poisonous for man– **[Bihar 2006]**
(1) CO affects the nerves of the lungs
(2) CO affects the diaphragm and intercostal muscles
(3)CO reacts with oxygen reducing percentage of O_2 in air
(4) haemoglobin combines with CO instead O_2 and the product cannot dissociate

Q.39 One haemoglobin carries how many molecules of O_2– **[UP CPMT 2002]**
(1) 4 (2) 2
(3) 6 (4) 8

Q.40 Respiratory centre is present in– **[UP CPMT 2002]**
(1) Cerebellum (2) Cerebrum
(3) Medulla oblongata (4) hypothalamus

Q.41 After deep inspiration, capacity of maximum expiration of lung is called– **[UP CPMT 2004]**
(1) Total lung capacity
(2) Functional residual capicity
(3) Vital capacity (4) Inspiratory capacity

Q.42 Acsent of high mountains may cause altitude sickness in men. Prime cause of this is– **[UP CPMT 2005]**
(1) Excess of CO_2 in blood
(2) Decreased effeciency of haemoglobin
(3) Decreased partial pressure ssof oxygen
(4) Decreased proportion of oxygen in air

Q.43 Pneumotaxic centre is present in– **[UP CPMT 2007]**
(1) Cerebrum (2) Cerebellum
(3) Medulla oblongata (4) Pons varolii

Q.44 Hamburger shift is also known as– **[MP PMT 2007]**
(1) bicarbonate shift (2) chloride shift
(3) Potassium shift (4) All of these

Q.45 Haemoglobin shows maximum affinity with– **[MP PMT 2005]**
(1) Carbon monoxide (2) Carbon dioxide
(3) Oxygen (4) Ammonia

Q.46 Dissociation curve shifts to the right when– **[MP PMT 2002]**
(1) CO_2 concentration decreases
(2) CO_2 concentration increases
(3) O_2 cocentration decrease
(4) Cl^- concentration increases

Q.47 The epithelium of bronchioles is– **[MP PMT 2002]**
(1) Pseudostratified and columnar
(2) Squamous and sensory
(3) Pseudostratified and sensory
(4) Cuboidal and columnar

Q.48 If a man from sea coast goes to Everest peak then **[MP PMT 2002]**
(1) His breathing and heart beat will increase
(2) His breathing and heart beat will decrease
(3) His respiratory rate will decrease
(4) His heart beat will decrease

Q.49 The structure which prevents the entry of food into the windpipe is **[Kerala 2000]**
(1) Gullet (2) Glottis
(3) Tonsil (4) Epiglottis

Q.50 In which of the following animals respiration occurs without a respiratory organ ? **[CPMT 2000]**
(1) Fish (2) Cockroach
(3) Tadpole (4) Earthworm

Q.51 Carbonic anhydrase is found in high concentration in **[PCS 2000, 2001]**
(1) leucocytes (2) blood plasma
(3) erythrocytes (4) lymphocytes

Q.52 What would happen if human blood becomes acidic (low pH) **[BHU 1989]**

(1) Oxygen carying capacity of haemoglobin increases

(2) Oxygen carrying capacity of haemoglobin decreases

(3) RBCs count increases

(4) RBCs count decreases

Q.53 Dissociation of oxyhaemoglobin can be promoted by **[HPMT 1996]**

(1) Low P_{CO_2}

(2) High P_{CO_2}

(3) Low body temperature

(4) High blood pH

Q.54 Which of the following is correct regarding respiration ? **[Punjab 2003]**

(1) no organism can live without respiration

(2) it takes place at every time day and night

(3) it involves production of carbon dioxide and water

(4) all of these

Q.55 Respiratory coefficient is **[CET Chd. 1999]**

(1) The amount of CO_2 produced to O_2 absorbed

(2) The amount of O_2 obtained to the amount of O_2 consumed

(3) Always more than one

(4) Always less than one

Q.56 Dyspnea is the **[Haryana 1998]**

(1) Normal breathing

(2) Difficult breathing

(3) Rapid breathing

(4) Stage without breathing.

Q.57 With reference to human respiration, which is correct ? **[Orissa 2003]**

(1) Pulmonary ventilation is equal to alveolar ventilation

(2) Alveolar ventilation is more than pulmonary ventilation

(3) Alveolar ventilation is less than pulmonary ventilation

(4) Pulmonary ventilation is less than alveolar ventilation

Q.58 Oxyhaemoglobin dissociates into oxygen and deoxygaemoglobin at **[JIPMER 2002]**

(1) low O_2 pressure in tissue

(2) high O_2 pressure in tissue

(3) equal O_2 pressure inside and outside tissue

(4) all times irrespective of O_2 pressure

Q.59 Voice in mammal is produced **[MP 2000]**

(1) by syrinx (2) during inhalation

(3) by bronchus (4) during exalation

Q.60 Oxygen carrier or the respiratory pigment in the blood of frog and other vertebrates is **[AIIMS 1981, CBSE 1999]**

(1) Haemocyanin (2) Cytochrome

(3) Haemoglobin (4) None of these

Q.61 During transport of CO_2, blood does not become acidic due to **[CBSE 1995]**

(1) neutralization of H_2CO_3 by Na_2CO_3

(2) absorption by leucocytes

(3) blood buffers

(4) nonaccumulation

Q.62 The respiratory centre, which regulates respiration, is located in **[CBSE 1994]**

(1) Cerebral peduncle (2) Vagus nerve

(3) Pons (4) Medulla oblongata

Q.63 Respiratory mechanism is controlled by **[AFMC 1982, DPMT 1985]**

(1) Central nervous system

(2) Sympathetic nervous system

(3) Parasympathetic nervous system

(4) Autonomic nervous system

Q.64 During hibernation frog resires through **[CPMT 1991]**

(1) Skin only (2) lung only

(3) Both (4) None

Q.65 Low oxygen tension in the blood causes **[DPMT 1985]**

(1) Coughing (2) Yawning

(3) Hiccuping (4) Sneezing

Q.66 Which one of these statements is correct ? **[CPMT 1981]**

(1) all animals require a medium for cellular respiration

(2) in all animals oxygen is transported by blood

(3) all animals take oxygen from water of air through gills of lungs

(4) all animals need oxygen for respiration

Q.67 Oxy-Haemoglobin dissociation curve is **[BHU 1995]**

(1) Sigmoid (2) Hyperbolic
(3) Straight line (4) Parabolic

Q.68 The affinity of CO with Hb is more than oxygen by **[BHU 1995]**

(1) 2 times (2) 20 times
(3) 200 times (4) 2000 times

Q.69 Exchange of gases in lungs is by **[AFMC 2002]**

(1) Simple diffusion (2) Active transport
(3) Passive transport (4) Osmosis

Q.70 The covering of lungs is called **[AFMC 2002]**

(1) Pleura (2) Pericardia
(3) Peritoneum (4) Mediastenum

Q.71 Hamburger phenomenon is also known as **[AIIMS 1994, JIPMER 2002]**

(1) Calcium shift (2) Bohr effect
(3) Chloride shift (4) Na^+ - K^+ pump

Q.72 Even when there is no air in it, human trachea does not collapse due to presence **[AFMC 1983]**

(1) Bony rings (2) Turgid pressure
(3) Chitinous rings (4) Cartilaginous rings

Q.73 Speciality common in the alveoli of lungs and villi of intestine in mammals is that both **[CPMT 1981]**

(1) provide a large surface area
(2) have ciliated epithelium
(3) are suited for diffusion of gases
(4) have rich supply of blood vessels and lymph ducts

Q.74 The movement of true vocal cords in man is controlled by cartilages **[JIPMER 1999]**

(1) arytenoids (2) cricoid
(3) thyroid (4) both (1) and (2)

Q.75 Presence of large number of alveoli around alveolar ducts opening into bronchioles in mammalian lungs is **[CBSE 1995]**

(1) Inefficient system of ventilation with little of residual air
(2) Inefficient system of ventilation with high percentage of residual air
(3) An efficient system of ventilation with no residual air
(4) An efficient system of ventilation with little residual air

Q.76 Sites of gaseous exchange in lungs are **[CPMT 1991]**

(1) tracheoles (2) alveoli
(3) bronchiloles (4)pulmonary chambers

Q.77 Exposure to carbon monoxide (from coal gas) is extremely dangerous and can kill a patient because **[AFMC 1994]**

(1) The compound carboxy-haemoglobin is formed with haemoglobin which can gradually clot the blood resulting in circulatory failure
(2) Carboxy-haemoglobin reduces the ability of blood to transport oxygen by repturing a vast majority of erythrocytes
(3) Carboxy-haemoglobin greatly modifies the structure of haemoglobin, thus making it lose its affinity for oxygen.
(4) The compound formed, carboxy-haemoglobin does not allow RBCs to act for their respiratory function.

Q.78 During inspiration the diaphragm **[CPMT 1987]**

(1) relaxes to become dome-shaped
(2) contracts and flattens
(3) expands
(4) shows no change

Q.79 Which is correct ? **[MP 1993]**

(1) Respiratory centres are not affected by CO_2
(2) In human vital capacity is just double the expiratory volume
(3) A human lung has 1000 alveoli
(4) During inspiration the lungs act as suction pump

Q.80 In lungs, the air is separated from the venous blood through. **[CBSE 1997]**

(1) Squamous epithelium + endothelium of blood vessel
(2) Squamous epithelium + tunica externa, media & interna of blood
(3) Squamous epithelium + basement membrane + endothelium of blood vessels
(4) None of these

Q.81 Intercostal muscles are found attached with **[AFMC 2002]**

(1) Diaphragm (2) Ribs
(3) plcura (4) Lungs

Q.82 Match the disorders given in column I with symptoms under column II. Choose the answer which gives the correct combination of alphabets with numbers. **[Kerala 2005]**

Column I	**Column II**
A. Asthma	1. Inflammation of nasal tract
B. Bronchitis	2. Spasm of bronchial muscles
C. Rhinitis	3. Fully blown out alveoli
D.Amphysema	4. Omf;a,,atopm pf bronchi
	5. Cough with blood strained sputum

(1) A = 4, B = 2, C = 5, D = 1
(2) A = 5, B = 3, C = 2, D = 1
(3) A = 3, B = 1, C = 5, D = 4
(4) A = 2, B = 4, C = 1, D = 3

Q.83 In lungs, there is definite exchange of ions between RBC and plasma. Removal of CO_2 from blood involves. **[CPMT 2005]**
(1) influx of Cl^- ions into RBC
(2) influx of HCO_3^- ions into RBC
(3) efflux of Cl^- ions from RBC
(4) efflux of HCO_3^- ions from RBC

Q.84 Which one of the following statements is incorrect ? **[CBSE 2006]**
(1) The presence of non-respiratory air sacs, increases the efficiency of respiration in birds
(2) In insects, circulating body fluids serve to distribute oxygen to tissues
(3) The principle of countercurrent flow facilitates efficient respiration in gills of fishes
(4) The residual are in lungs slightly decreases the efficiency of respriration in mammals

Q.85 About 1000 ml of air is always known to remain inside the human lungs. It is described as **[KCET 2006]**
(1) inspiratory reserve volume
(2) expiratory reserve volume
(3) residual volume
(4) tidal volume

Q.86 In the following statements **[Kerala 2006]**
A. Carbonic anhydrase is present in the erythrocytes
B. In erythrocytes the carbon dioxide combine with water and is transported.
(1) statement A is correct and is responsible for statement B
(2) statement A is not correct but statement B is correct
(3) both statement A and B are wrong
(4) statement A is correct but not involved in statement B

Q.87 Carboxyhaemoglobin complex results due to this pollutant ? **[JK 2006]**
(1) CO_2 (2) CO
(3) H_2CO_3 (4) SO_2

Q.88 Besides RBC, blood plasma also carries O_2 in solution. The % is **[Orissa 2006]**
(1) 3 – 9% (2) 1 – 2%
(3) 3 – 6% (4) 2 – 3%

Q.89 Listed below are four respiratory capacities (a-d) and four jumbled respiratory volume of a normal human adult : **[CBSE 2010]**

Respiratory Capacities	***Respiratory volumes***
(a) Residual volume	2500 mL
(b) Vital capacity	3500 mL
(c) Inspiratory reserve volume	1200 mL
(d) Inspiratory capacity	4500 mL

Which one of the following is the correct matching of two capacities and volume ?
(1) (a) 4500 mL, (b) 3500 mL
(2) (b) 2500 mL, (c) 4500 mL
(3) (c) 1200 mL, (d) 2500 mL
(4) (d) 3500 mL, (a) 1200 mL

Q.90 What is true about RBCs in humans ? **[CBSE 2010]**
(1) They do not carry CO_2 at all
(2) They carry about 20-25 percent of CO_2
(3) They transport 99.5 percent of O_2
(4) They transport about 80 percent oxygen only and the rest 20 percent of it is transported in dissolved state in blood plasma

Q.91 Which one of the following is the correct statement for respiration in humans ?

[AIPMT Pre 2012]

(1) Neural signals from pneumotoxic centre in pons region of brain can increase the duration of inspiration

(2) Workers in greinding and stone-breaking industries may suffer, from lung fibrosis.

(3) About 90% of carbon dioxide (CO_2) is carried by haemoglobin as carbamino-haemoglobin.

(4) Cigarette smoking may lead to inflammation of bronchi.

ANSWER KEY

EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	2	3	1	1	3	4	1	2	1	2	3	3	2	1	3	3	2	1	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	4	1	3	3	1	3	4	3	1	1	1	1	1	3	1	2	4	1	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	3	4	2	1	2	2	1	4	4	3	2	2	4	1	2	2	1	4	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	4	1	1	2	1	1	3	1	1	3	4	1	1	4	2	4	2	4	3
Ques.	81	82	83	84	85	86	87	88	89	90	91									
Ans.	2	4	4	2	3	1	2	4	4	2	2									

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** Oxidation of nutrients releases bond energy.
R : Oxidation of nutrients is done by using molecular oxygen.

Q.2 **A :** Aerobic animals are not truly aerobic.
R : They produce lactic acid anaerobically.

Q.3 **A :** Aerobic respiration involves the exchange of respiratory gases twice.
R : Exchange occurs from lung to heart and then heart to lung.

Q.4 **A :** Respiratory gas exchange occurs through osmosis.
R : Respiratory gas goes from lower partial pressure region to the region of higher partial pressure.

Q.5 **A :** First step of gas exchange occurs through body surface in some animals.
R : Body surface or membrane of amphibia is thick in nature.

Q.6 **A :** Insects develop a complex system of air tubes called trachea for respiratory purpose.
R : Exchange through body surface is not possible in insects.

Q.7 **A :** Abdominal muscle is related with respiration in animals.
R : Relaxation of abdominal muscles draws in air.

Q.8 **A :** Aquatic animals require more energy for the respiratory process.
R : Aquatic animals use dissolved oxygen.

Q.9 **A :** Gill - lamellae in aquatic animals help in exchange of gases.
R : Each gill lamella carries many blood capillaries.

Q.10 **A :** In mammals, complex respiratory system has developed.
R : Mammalian skin is impermeable to gases.

Q.11 **A :** Lungs replace the skin very effectively in mammals as respiratory organs.
R : Respiration by lungs is termed pulmonary respiration.

Q.12 **A :** Forceful expiration occurs through expiratory muscles.
R : Expiratory muscles expires quickly.

Q.13 **A :** Vital capacity is higher in athletes than non-athletes.
R : Vital capacity is about 3.5 - 4.5 litres in a normal adult person.

Q.14 **A :** Oxyhaemoglobin carries 1 - 4 molecules of oxygen in the blood.
R : The capacity of oxyhaemoglobin depends on the degree of (Fe^{2+}) saturation with oxygen.

Q.15 **A :** A person has died because of carbon monoxide poisoning.
R : A person slept in a closed room with a lamp burning.

Q.16 **A :** During inspiration, the volume of thorax increases.
R : This happens due to the relaxation of diaphragm and inspiratory muscles.

Q.17 **A :** Gaseous exchanges continue in the lungs without interruption even during expiration.
R : Residual volume of air can never be driven out by respiration.

Q.18 **A :** Erythrocytes can carry out anaerobic metabolism only.
R : In erythrocytes, carbon-dioxide is converted into bicarbonates.

Q.19 **A :** During expiration, volume of thorax decreases and air is expelled out.
R : This happens due to the contraction of inspiratory muscles.

Q.20 **A :** During inspiration, pressure of air falls in the thorax.

R : There is a rise in volume of thorax during inspiration.

Q.21 **A :** It is beneficial to respire through mouth than through the nasal openings.

R : Air gets filtered when passed through the mouth.

Q.22 **A :** More of oxygen is released from oxyhaemoglobin in a more active tissue than in a less active one.

R : This is because partial pressure of carbon-dioxide is very low in an active tissue than in a less active one.

Q.23 **A :** Symptoms of emphysema develops when a person living on plains ascends and stays on a mountain.

R : Air pressure and partial pressure of oxygen falls with the decrease in altitude.

Q.24 **A :** Oxygenation of blood promotes the release of carbon-dioxide from the blood in the lungs.

R : Carbon-dioxide is carried as bicarbonates in erythrocytes of blood.

Q.25 **A :** One should not sleep in a closed room with a lamp burning inside.

R : This can cause the production of carbon monoxide which renders haemoglobin inactive by binding to it and forming carbamino haemoglobin.

Q.26 **A :** Voice of women and children is high pitched whereas that of men is low pitched.

R : Vocal cords of men are longer than of women and children.

Q.27 **A :** Coughing and sneezing are necessary.

R : Coughing and sneezing are reflex actions..

Q.28 **A :** Most fish when out of water, die of suffocation.

R : Atmospheric air contains far less oxygen content than the dissolved oxygen in water.

Q.29 **A :** Aerobic respiration is more efficient than anaerobic respiration.

R : Aerobic respiration involves complete oxidation of respiratory substance to release more energy, while anaerobic respiration involves only partial breakdown of the food.

Q.30 **A :** Both external and internal respiration are physico-chemical processes.

R : In both of these, diffusion and oxidative phosphorylation of glucose occur.

Q.31 **A :** In annelids and amphibians, cutaneous respiration is main mode of respiration.

R : In these animals, skin is thin, moist, vascular and permeable to O_2 and CO_2.

Q.32 **A :** In cockroach, inspiration is a passive process while expiration is an active process.

R : Tracheae of cockroach form an extensive network and extends upto the body cells.

Q.33 **A :** In cockroach, there is no blood.

R : So transportation materials is by well developed tracheal network.

Q.34 **A :** Alveoli of lung of man are lined by lecithin phospholipid.

R : Lecithin lowers the surface tension and prevents collapsing of alveolar walls.

Q.35 **A :** Phrenic muscles of diaphragm are called principal expiratory muscles.

R : Contraction of these muscles decrease thoracic activity to expel main part of foul air

Q.36 **A :** In prawn, all the 8 pairs of gills are phyllobranchs.

R : In the gills of prawn, gill lamellae are finger-like.

ANSWER KEY

Exercise - 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	1	3	4	3	1	1	1	1	2	2	3	2	1	1	3	1	2	4	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
Ans.	4	3	4	2	1	1	2	3	1	4	1	2	4	1	1	4				

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A Question I am unable to solve in first attempt	COLUMN : B Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

DIGESTIVE SYSTEM

ANIMAL NUTRITION

- **Nutrition** - The sum total of the processes starting from taking the food upto its utilisation is called nutrition. Depending upon the mode of nutrition, the organisms can be classified as autotrophs and heterotrophs.
- **Autotrophs** manufacture their own organic food from inorganic raw materials.
- **Heterotrophs** are unable to manufacture their own food. They obtain organic food from outside. Heterotrophs include animals, fungi, protists and monerans.
- Euglena is **mixotrophic** (both autotrophic and saprotrophic).

Based on the methods of procurement or collection of food, **heterotrophic nutrition is of four major types-**

1. **Holozoic** (holotrophic) nutrition is also called **ingestive nutrition**. Depending upon food, animals are

(a) Herbivores- Feeding on plants e.g., Rabbit, Goat, Cow .
(b) Carnivores- Feeding on other animals e.g., Tiger, Lion.
(c) Omnivores- Feeding on all types of food e.g., humans
(d) Detrivores. Feeding on detritius or organic remains e.g, Earthworm.
(e) Scavengers- Feeding on carrions (carrion eaters) e.g., Hawk vulture.
(f) Insectivores- Eating insects e.g., common bats.
(g) Cannibals- Eating other members of own species e.g., Many snakes.
(h) Frugivorous- Feeding on fruits e.g., Parrot.
(i) Sanguivores- Taking meal of blood e.g., Leech, Female mosquito.
(j) Coprophagous - Eats its faecal matter. e.g., Rabbit.

2. **Saprozoic nutrition -** A few animals do **not ingest solid food**. Instead they secrete digestive enzymes directly into their food out side the body their food is **dead or decaying matter**. The food is thus digested out side the body by the digestive enzymes and then the animals suck digested food. This is called saprozoic nutrition.e.g. **Spiders, Housefly**, etc.

3. **Parasitic Nutrition -** Parasites take **liquid food** material from the body of the host. This is called parasitic nutrition. e.g. **Plasmodium, Trypanosoma, Taenia, Ascaris** etc.

4. **Symbiotic Nutrition (= Mutalism)) :** When two organism or animals live in association and **derive food from each other**, they are called symbionts and their nutrition is known as symbiotic nutrition (= mutualism). For example, **Escherichia coli** live in the human intestine and synthesis vitamin B12, which is used by man and the **E.coli** receives, in return, simpler food from human.

DIGESTIVE SYSTEM

INTRODUCTION

The process by which complex food is converted into simplest food with the help of digestive enzymes (Hydrolytic enzymes), hence process of digestion is a hydrolytic process.

- **Types of digestion**

(1) Intracellular : When the process of digestion occurs within the cell in the food vacuole. Examples : Protozoa, Porifera, Coelenterata and free living platyhelminthes. With the help of lysosomal enzymes. Food particle is taken in through endocytosis (phagocytosis). It forms a phagosome which fuses with a lysosome. Digestion occurs and the digested materials are passed on to cytoplasm. The undigested materials is thrown out by exocytosis.

(2) Extracellular : When the process of digestion occurs outside the cell. Examples : Coelenterates and phylum platyhelminthes to phylum chordata. Therefore, coelenterata and free living platyhelminthes (flat worms) perform both intracellular and extracellular digestion.

DIGESTIVE SYSTEM OF HUMAN

Digestion in vertebrates occurs in the digestive tract or alimentary canal. The various parts involved in digestion can be broadly grouped in two groups –

(1) Digestive tract or alimentary canal

(2) Digestive glands

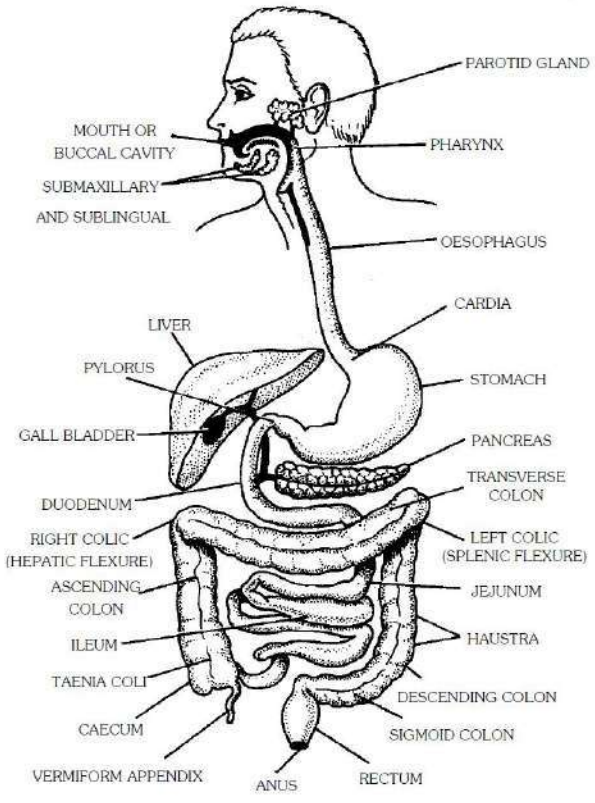
1. Digestive tract or alimentary canal

On the basis of the embryonic origin, the alimentary canal of vertebrates can be divided into three parts –

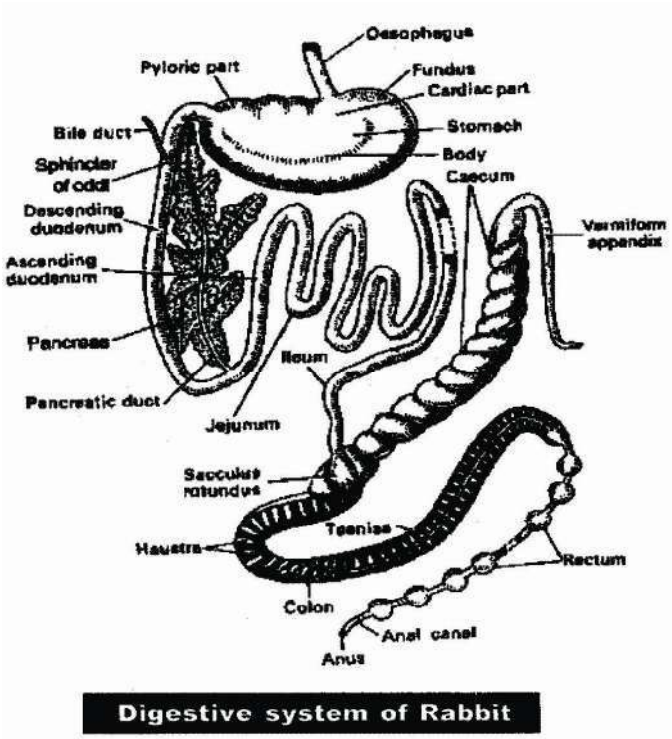
(A) Fore gut / Stomodaeum : Ectodermal. It includes buccal cavity / oral cavity.

(B) Mid gut / Mesodaeum : Endodermal. It includes pharynx, oesophagus, stomach, small intestine, and large intestine.

(C) Hind gut / Proctodaeum : Ectodermal. It includes anal canal and anus.



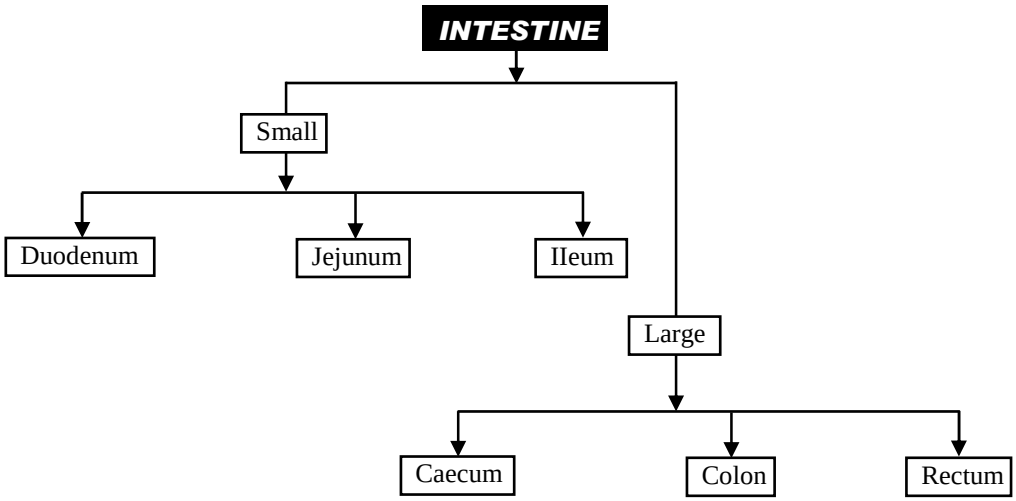
Digestive system of man



Digestive system of Rabbit

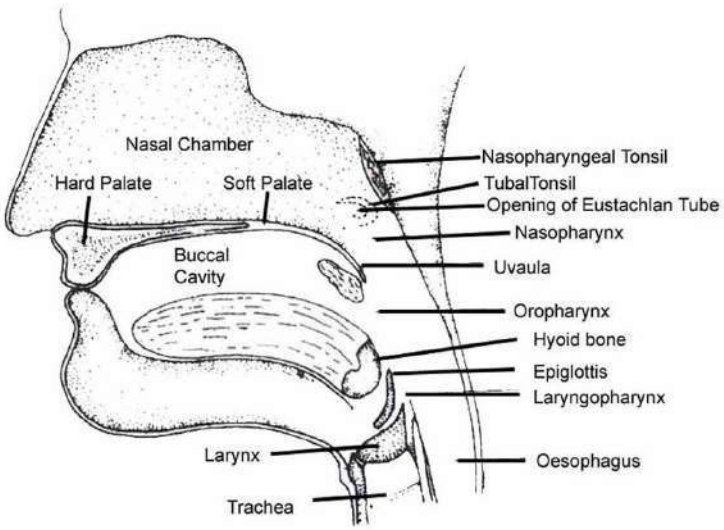
- **The alimentary canal is divided into following parts–**

(1) Mouth and Buccopharygeal cavity
(2) Oesophagus
(3) Stomach
(4) Intestine



(1) Mouth and Buccopharyngeal Cavity – Mouth is a horizontal transverse slit like aperture which is surrounded by upper and lower lip. Orbicualaris oris voluntary muscles. are found in lips. Sebaceous glands are found on the outer part of lip. Serous glands are found on the inner part of lip. Serous glands is the modification of mucus glands. Its secretory substance is watery.

In Rabbit a small cleft is found in the middle part of upper lip, such type of lip is called as **Hare lip.**

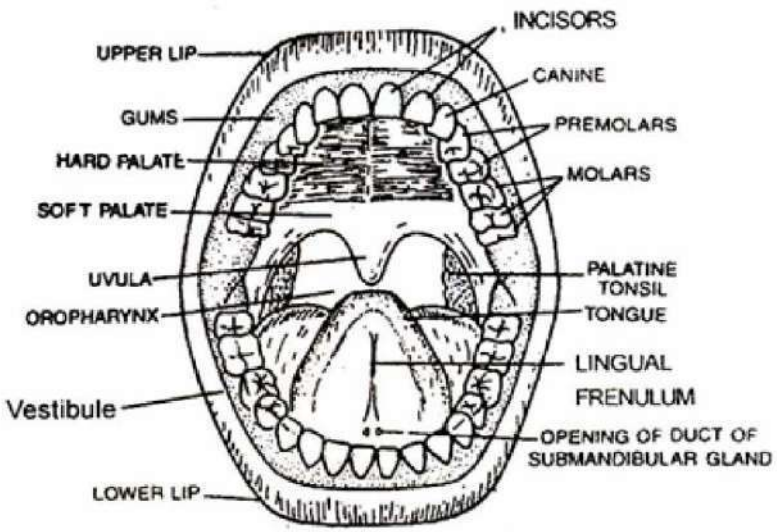


Secation of head showing parts of pharynx

(i) Buccal vestibule – It is a peripheral part which, present between the gums and cheeks where the food is stored temporarily for some time

(ii) Oral cavity – It is inner & central part which, is surrounded by upper and lower Jaw. Lined by stratified squamous epithelium. Upper Jaw is Fixed and Lower jaw is Movable.

The roof of oral cavity is called as **Palate.** This palate is horizontal partition which situated between oral cavity and nasal chamber



Human oral cavity

Palate is differentiated into two parts :

(i) Hard Palate –

It is the anterior part of the palate. It is made up of Maxilla and palatine bone in human. But in Rabbit it is made of Pre-maxilla, maxilla, palatine bone.

On the ventral surface of hard palate, some projection or transverse ridges are present which are called as **palatine rugae.**

These rugae prevent slip out of the food from buccal cavity during mastication.

These rugae are well developed in carnivorous animals.

In rabbit, one pair opening of Nasopalatine duct is present at the anterior part of hard palate, these connect the buccal cavity to the Nasal passage. In Rabbit some olfactory receptor are also found in nasopalatine duct which are called as **Jacobson's organ**. It makes them aware of the smell of food while chewing.

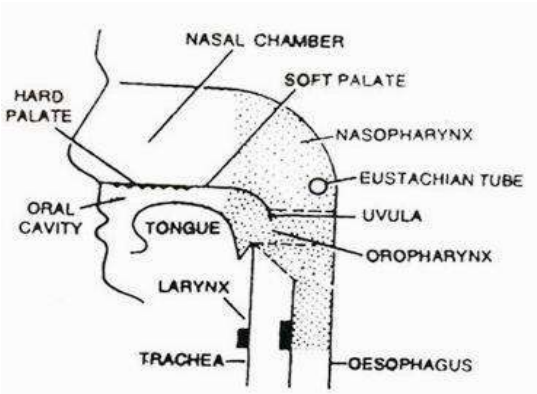


Diagram showing parts of phanyx

(ii) Soft Palate –

It is the posterior part of palate. It is made up of involuntary muscle, fibrous connective tissues and mucous epithelium. (Stratified squamous epithelium)

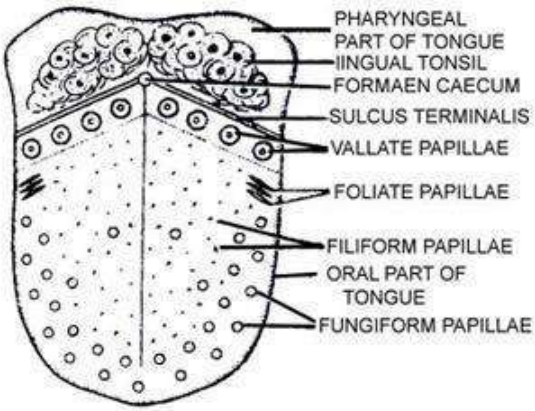
The posterior part of soft palate becomes out grow and hangs down in the form of finger like process called as **Uvula** or **Velum palati**

One pair of large lymph node is present on the posterolateral surface of soft palate, called as **Palatine tonsil** or **Tonsils**

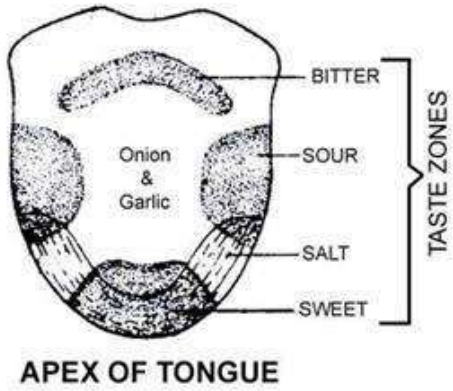
Soft palate is situated in the pharynx and is divided into two parts. Upper and dorsal part of pharynx is called as **Nasopharynx** which is related to the nasal chamber.

The lower and ventral part of pharynx is called **oropharynx** which is related to the oral cavity. One pair of opening of **Eustachian tube** is present in the nasopharynx. This Eustachian tube is related to the middle ear .

TONGUE



Upper surface of human tongua



Human tongue showing four taste arease

On the floor of oral cavity a muscular, flat, fleshy plate like structure is present which is called **tongue.** The anterior part of tongue is free while posterior part of Tongue is connected to the Hyoid bone. The surface of tongue is connected to the floor of buccal cavity through a very flexible membrane/ligamentous fold called as **frenulum linguae**

On the dorsal surface of tongue, it is divided into two unequal parts by a V shaped sulcus, called as sulcus terminalis.

The two limbs of the 'V' meet at a median pit named **Foramen Caecum.**

It is divided into two parts –

(a) Pharyngeal or Lymphoid Part – It is the posterior 1/3 part of the tongue. Many small lymph nodes are present in this part which are called **Lingual tonsil.**

(b) Oral or papillary Part – It is anterior 2/3 part of tongue. Four types of papillae are found in this part in which gustatory or taste receptors are present.

(i) Fungiform Papillae –

It is pink coloured, small & spherical in shape. It is found on the entire surface of tongue but Their maximum concentration at the anterior tip part of tongue. It is attached to tongue with the help of small pedicle. It provides pink colour to the tongue.

(ii) Filliform Papillae (Conical papillae) –

They are thread like, white coloured & conical in shape. They are also found on the entire surface of tongue. They are most numerous.

(iii) Foliate Papillae –

They are found on the mid lateral surface of tongue. They are vestigeal in the human. Their structures is leaf like present in rabbit and other mammals.

(iv) Circumvallate papillae –

They are large spherical shape papillae which are found near to sulcus terminalis. They are least in number (approx 8 to 12)

- **Two type of muscles are present in tongue**

1. **Extrinsic muscle**

   It is found on outer and superficial part of tongue.

   It helps in outward and inward movement of tongue.

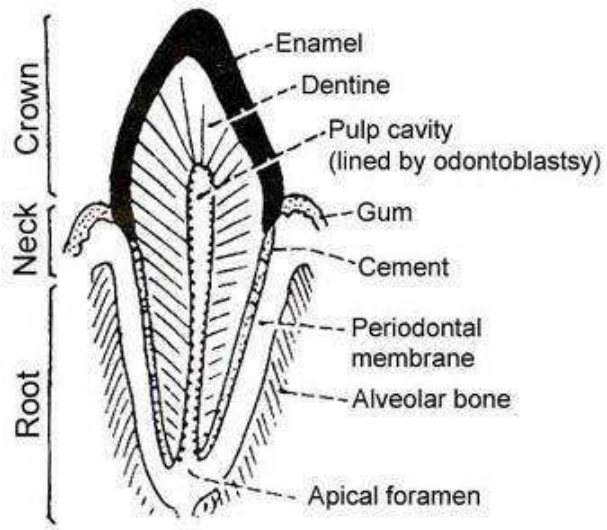
2. **Intrinsic muscle**

   It is situated in the deep part of tongue.

   It help in the change of shape of tongue

TEETH

Teeth are ectomesodermal in origin. Major portion of teeth arises from **Dermis**. Part of tooth present outside the gums only is derived from ectoderm or **Epidermis (Enamel part).**



Parts of Tooth

In human teeth of upper jaw are attached to the maxilla bone. While teeth of lower jaw are attached to Mandible bone. But in rabbit upper incisors are attached to premaxilla. While upper pre molars and molars attached to the maxilla bone. While lower teeth are attached to dentry bone.

- **STRUCTURE OF TEETH**

There are a three parts of the tooth

1. **Crown :** It is the outer part of the tooth, exposed outside gums.
2. **Neck :** It is the middle part of the tooth which is embeded inside the gums.
3. **Root :** It is the part of tooth that is inserted inside the socket of jaw bone. (Alveoli)

The crown part of the tooth is made up of a very hard substance called the Enamel. It is the hardest material of animal kingdom.

Enamel is **ectodermal**. It is secreted by **Ameloblast** cells of the ectoderm. It has maximum amount of inorganic salt (96%) in it, Inorganic salt are mainly found in the form of phosphate and carbonate of Ca, Mg, Na and K. 3% of water is found in the enamel. Along with the keratin & ossein protein (1%) are also found in teeth. Ossein is a protein of bones. Remaining part of tooth develops from mesoderm of embryo.

Dentine is the main part of tooth. Approximately 69% inorganic salts are present in dentine and 65% are present in cement. (62% inorganic salts are present in bones.)

- Dentine surrounds a cavity called **pulp-cavity**. This cavity contains soft connective tissue, blood capillaries, nerve fibres. Pulp cavity is neccessary for the nutrition and survival of the teeth. At the base of pulp-cavity an aperture is present . Through this aperture, blood capillaries and nerve fibres enter inside the teeth. This aperture is called **apical-foramen**. A special type of cells form the lining of the pulp-cavity called the **Odontoblast cells.** These cells are the dentine secreting cells. Cytoplasmic process of odontoblasts are embeded into dentine in the form of fine tubule . These processes are called canaliculi. These canaliculi secretes dentine. The teeth continue to grow till the odontoblast cells remain active. In adults, the adults, the pulp-cavity shrinks and the odontoblasts become inactive so the teeth stops to grow. The cement layer is made up of the cementocytes cells. Between the root and the bones of the teeth a periodontanl membrane is present.
- In Rabbit and rat the pulp-cavity of the incisor remains wide throughout their life, so these teeth grow continuously throughout their life span.

  If one incisor of Rabbit & rat is broken then the opposite incisor grows continuously, finally the animal can neither can close the mouth nor gnaw the food. So the animal dies due to starving.
- **Four type of teeth found in mammals are–**

1. **Incisor** – These are long, chisel like teeth for gnawing the food. They are more developed in gnawing animals e.g. lagomorphs, rodents, tusk of elephant are modification of upper Incisor. Tusk is used to protection from enemies, attack on enemies (not for feeding purpose)
2. **Canines –** These are sharp pointed teeth meant for tearing the food. Canines are most developed in carnivorous animals. canines are absent in herbivorous animals e.g. Rabbits do not have canines. In herbivorous, the space of canine in gums is empty and this empty space is called diastema.
3. **Pre molar** – These teeth are meant for chewing and crushing of food, they are triangular in shape.
4. **Molars (Cheek teeth)** – These also meant for chewing & crushing of food. They are rectangular in shape. Premolar and molar help in the mastication of food. In human teeth of upper jaw are attached to the maxilla bone. While teeth of lower jaw are attached to the mandible bone.

- In animals, except Premolar and Last molar, all type of teeth appear twice in life. Teeth which appear during childhood are called milk teeth or temporary teeth. Due to the activity of osteoclast cells. These milk teeth are shed, off then permanent teeth appear.
- When temporary molars shed, their socket are filled by premolar and new socket are formed for permanent molar. This occurs once in life time.
- In frog, only upper jaw has teeth.
- In Rabbit teeth of upper jaw are attached to the pre maxilla and maxilla bone, while teeth of lower jaw are attached to the dentry bone **Hippocampus, tortoise and birds do not have teeth.**

TYPE OF TEETH

1. **Monophyodont –** The teeth which appear only once in life e.g. Pre Molar & Last molar of man.
2. **Diphyodont –** The teeth which appear twice in life e.g. Incisors, Canines, Molars of human.
3. **Polyphyodont –** The teeth which appear more than twice in life. e.g. Fish, Amphibians.
4. **Thecodont –** The teeth which are present in bony socket of jaw. e.g. Man & crocodile
5. **Pleurodont –** The teeth which are present on the lateral side of jaw bone. e.g. Reptiles
6. **Acrodont** – The teeth which are present on the terminal part of Jaw bone. eg. Fish, amphibian
7. **Heterodont –** When the teeth are of different type in mammals on the basis of structure and function. e.g. Mammal.
8. **Homodont –** Whether all teeth are of similar type in animal on the basis of structures and function e.g. Fish, Amphibians.

Secodont:

These are canine teeth of carnivorous animals.

In this type of structure canine teeth become long and pointed which, is bended towards the backward direction.

Hypsodont (Smiling teeth):

In this type of teeth the crown part is large root is either absent or small such as **incisor** and **canine**. These teeth are also called as smiling teeth.

Brachyodont (Cheek teeth) :

In this type of teeth crown part is small root is long such as **premolar** and **molar**

Wisdom teeth – These are the last molar teeth of humans which appear in the age of 18 to 25 year.

Lophs or Cusps–

The upper surface of premolar & molar is broad and some small projections are present in the upper surface of premolar and molar.

These projections are called Lophs or cusps. On the basis of structure of Lophs, these teeth are of four types–

(i) Lophodont – In this type of teeth the lophs are large, wide and flat such as **rabbit & elephant.**

(ii) Bunodont – In this type of teeth. Lophs are small and spherical in shape , such as **human**

(iii) Solenodont – In this type of teeth the lophs are large and semilunar shape e.g. **Ruminant animals (Cow, Buffalo).**

(iv) Carnesial – in this type of teeth the lophs are long & pointed e.g. **Carnivorous Animal**.

Dental Formula :

Child = $1\frac{2}{2}C\frac{1}{1}PM\frac{0}{0}M\frac{2}{2}=\frac{5}{5}\times 2=\frac{10}{10}=20$

17 yr. old = $1\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{2}{2}=\frac{7}{7}\times 2=\frac{14}{14}=28$

Adult = $1\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{3}{3}=\frac{8}{8}\times 2=\frac{16}{16}=32$

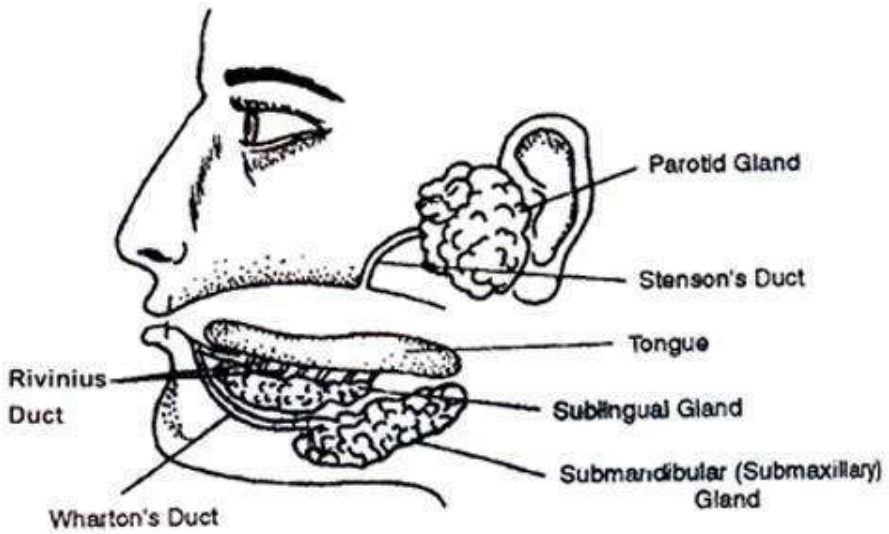
Horse and pig	$\frac{3.1.4.3}{3.1.4.3} = 44$	Cat	$\frac{3.1.3.1}{3.1.2.1} = 30$
Dog	$\frac{3.1.4.2}{3.1.4.3} = 42$	Squirrel	$\frac{1.0.2.3}{1.0.1.3} = 22$
Lemur	$\frac{2.1.3.3}{2.1.3.3} = 36$	Rat	$\frac{1.0.0.3}{1.0.0.3} = 16$
Man	$\frac{2.1.2.3}{2.1.2.3} = 32$	Elephant	$\frac{1.0.0.3}{0.0.0.3} = 14$
Cow	$\frac{0.0.3.3}{3.1.3.3} = 32$	Permanent set milk set	$\frac{2.1.2.0}{2.1.2.0} = 20 / \frac{2.1.0.2}{2.1.0.2} = 20$

Note : In humans, premolar teeth appear in the alveoli of molar teeth while permanent molar teeth are developed in new alveoli.

SALIVARY GLANDS :

In mammals, 4 pair of salivary glands are present

1. **Infra-orbital-glands**
   Gland is located just below the eye-orbit. The duct of these glands open in the upper-jaw near the 2nd molar teeth.
2. **Parotid-glands(largest salivary glands)**
   These glands are located just below the external auditory canal. Their duct is called **Parotid duct/Stenson's duct** which open in the upper jaw i.e. the Buccal-vestibule.
   Whenever in human, these glands are infected by viruses this disease is called as **Mumps**. Due to this, the gland swells up.



Salivary glands of Man

3. **Sub maxillary or submandibular glands** – These are located at the junction of the upper and the lower jaw Their duct is called Wharton's duct (largest salivary duct). These ducts open in the lower jaw just behind the Incisor teeth.

4. **Sublingual glands –** These are the smallest salivary glands. These glands are found in the lower jaw. Many ducts arise from these glands called as the **Ducts of Rivinus** or also the **Bartholin's ducts.** These ducts open in the bucco-pharyngeal cavity on the ventral side of the tongue

- Maximum saliva is secreted by the **Sub-lingual glands** (Smallest salivary duct).

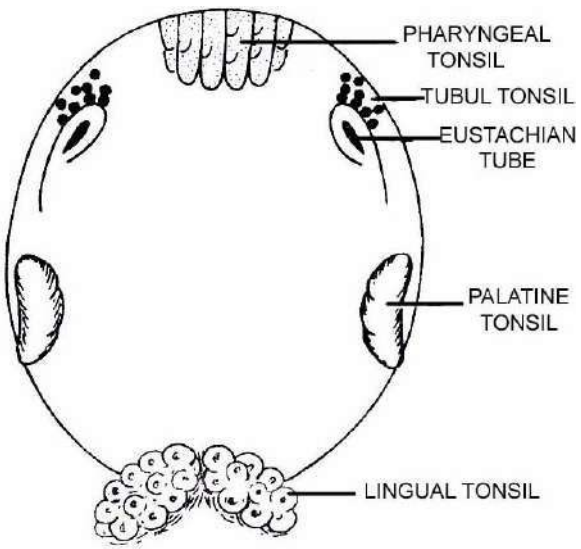
Salivary glands are **Exocrine** glands. The secretion of salivary gland is termed as the saliva. In saliva, water, mucous, starch-digesting **Ptyalin enzyme,** Lysozyme and thiocyanates are present. Ptyalin is secreted only by parotid gland. Lysozyme and Thiocyanates mainly kill bacteria. They also check the growth of bacteria in bucco-pharyngeal cavity.

In addition to it 5^{th} pair of molar gland is found in Cat which is situated near to the upper molar teeth and also open near upper molar teeth.

Waldeyer's Ring :–

The lymphatic tissues of the pharynx and oral cavity are arranged in a ring like manner, which are collectively called Waldeyer's ring (= Waldeyer's lymphatic ring). The ring mainly consists of the following :

(i) Nasopharyngeal Tonsil (= Pharyngeal Tonsil) : - Refer to the nasopharynx. In children nasopharyngeal tonsil may become enlarged and referred as **adenoids.** The resulting swelling may be a cause of obstruction to normal breathing .



Waldeyer's Ring

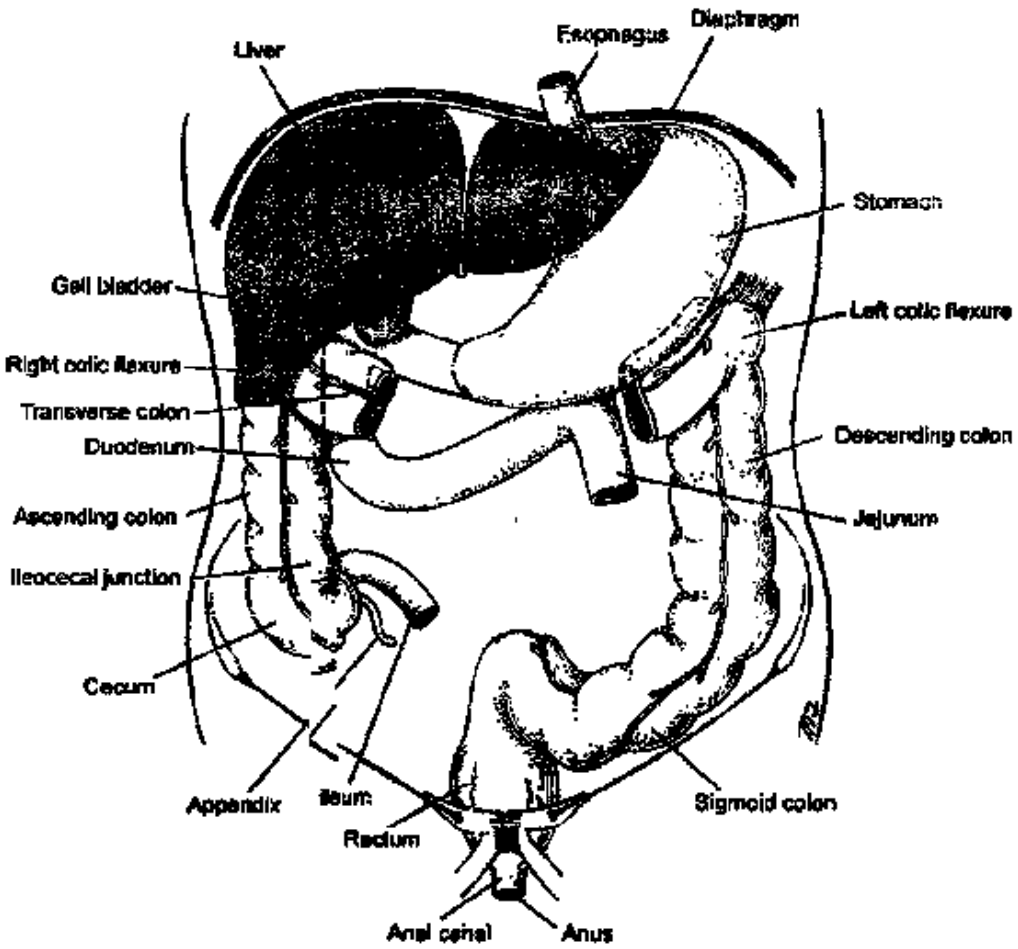
(ii) Tubul Tonsil : – Refer to the nasopharynx.

(iii) Palatine Tonsils (= Faucial Tonsils) : – Refer to the oropharynx. The Palatine tonsils are often infected **(tonsillitis)** leading to sort throat.

Such enlarged tonsils may become a focus of infection and their surgical removal **(Tonsillectomy)** becomes necessary.

(iv) Lingual Tonsil : – They are situated on posterior part of tongue.

ALIMENTARY CANAL



- **Oesopagus :**

  Two apertures are found in central part of Buccopharyngeal cavity

– Ventral or lower aperture is called **Glottis** which is related to the Larynx. Which is guarded by epiglottis
– The Dorsal and upper aperture is called **Gullet** which open into oesophagus.
– Oesophagus is simple uniform tube which runs downward and pierces the diaphragm and finally opens into stomach
– Longitudinal folds are found on the inner surface of Oesophagus
– In it's lumen digestive glands are absent, only mucous glands are present here.
– Voluntary muscles are found on the upper 2/3 part of oesophagus while, involuntary muscles are found in lower 1/3 part of oesophagus.
– The length of oesophagus depends on lengeh of neck so the longest Oesophagus is present in **Giraffe.**

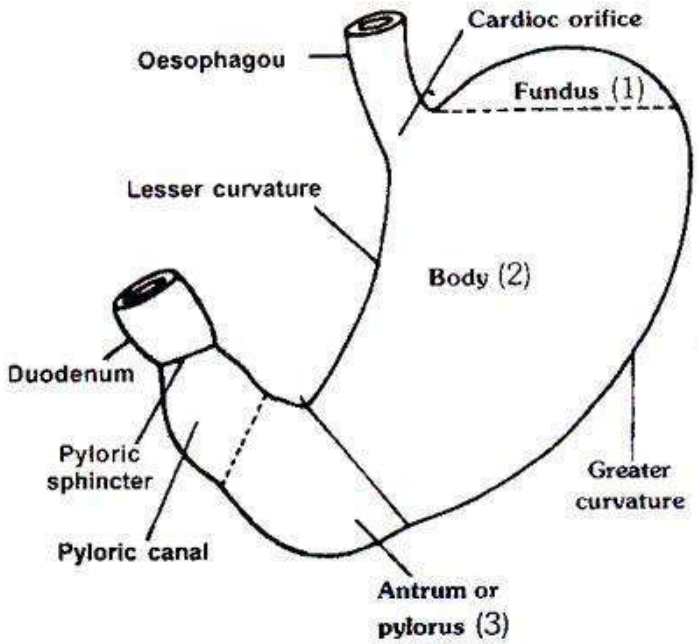
- **Stomach**

  It is situated on left side of abdominal cavity. **It is the widest part of alimentary canal.** It is a bag like muscular structure, J shaped in empty condition. The stomach is divided into three part (Fundus, Body, pylorus or antrum).

  It has two orifices (opening)

(i) Cardiac orifice : It is proximal aperture of stomach which is joined by the lower end of the oesophagus.

(ii) Pyloric orifice : It distal aperture of stomach which opens into the duodenum.



The stomach

Mucous membrane of the stomach is thick. In empty stomach numerous longitudinal folds are found called gastric rugae. They disappear when stomach is distended. Stomach is covered by layer of peritoneum, fat tissue and lymph tissue deposits on the peritoneum. Such type of peritoneum are called Omentum. Left curved surface of stomach is called greater omentum. Right curved surface of stomach is called lesser omentum.

- **Gastric Glands** :

These are numerous microscopic, tubular glands formed by the epithelium of the stomach. The following types of cells are present in the epithelium of the gastric glands.

(i) Chief cells or Peptic cells (=Zymogen cells) are usually basal in location and secrete gastric digestive enzymes as proenzymes or zymogens, **pepsinogen** and **prorennin.** The chief cells are also produce small amount of **gastric amylase** and **gastric lipase**. Gastric amylase action is inhibited by the highly acid condition. Gastric lipase contributes little to digestion of fat. Prorennin is secreted in young mammals. It is not secreted in adult mammals.

(ii) Oxyntic cells : (=Parietal cells) are large and are most numerous on the side walls of the gastric glands. They are called oxyntic cells because they stain strongly with eosin dye. They are called pariental cells as they lie against the basement membrane. They secrete hydrochloric acid and **Castle intrinsic factor**.

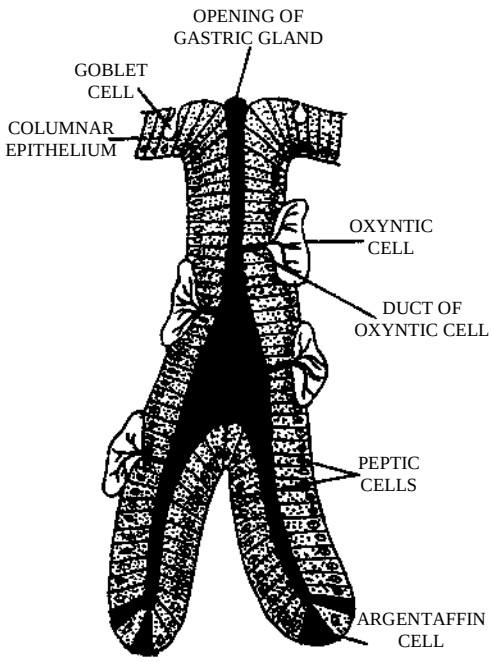


Fig. – L.S. Gastric gland

(iii) Mucous cells : (= Goblet cells) are present through out the surface epithelium and secrete mucus. The epithelium of gastric glands also has the following two parts of cells.

G-cells. **Argentaffin cells** produce **serotonin** (its precursor is 5-hydroxy-tryptamine, 5-HT), **somatostatin** and **histamine** . **Gastrin cells** (G-cells) are present in the pyloric region and secrete and store the hormone **Gastrin.**

Serotonin is vasoconstrictor and stimulates the smooth muscles. Somatostatin suppresses the release of hormones from the digestive tract. Histamine dialates the walls of blood vessels (vasodilator). Gastrin stimulates the gastric glands to release the gastric juice.

(iv) Stomach of ruminants (cud-chewing mammals) :

The stomach of cattles have four parts, as rumen (paunch), reticulum (honeycomb), omasum (psalterium) and abomasum (rennet).

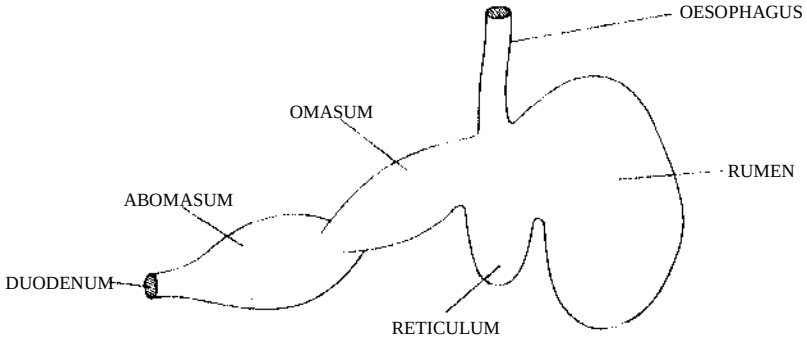


Fig. – The compound stomach of a ruminant

Some authors believe that first three chambers are parts of the oesophagus, the fourth chamber is the real stomach secretes HCl and enzymes.

The embryological studies have proved that all the chambers are parts of the real stomach.

The cattles rumen stores the quickly fed food. So cud chewing animals are called ruminants. *e.g.* cow, buffaloes, goat etc. Rumen is the largest part of stomach. Primitive digestion and bacterial action takes place in rumen.

Which later on moves again to buccal cavity where it is properly chewed, then this food passes into reticulum to omasum which concentrates the food by absorbing water and bicarbonates. Finally, the food reaches in the fourth chamber, abomasum.

First three chamber are lined by cornified epithelium but fourth chamber abomosum is lined glandular epithelium and gastric glands, so it is true stomach. **Camel and deer** lack omasum.

Reticulum is the smallest part and its cells are provided with water pockets for the storage of metabolic water.

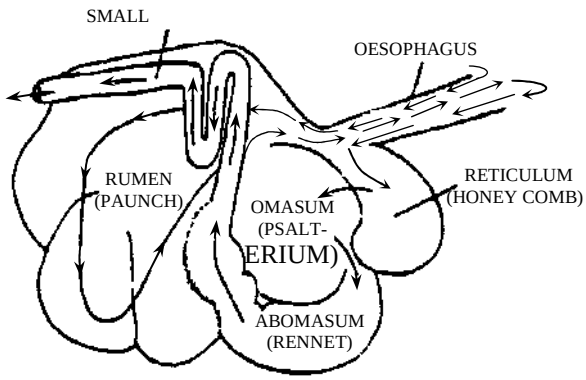


Fig. – Arrow shows course of food

In the rumen, food undergoes mechanical and chemical breakdown. Mechanical breakdown results from thorough churning brought about by muscular contractions and aided by cornified surface of villi.

Chemical breakdown is caused by symbiotic microorganisms (bacteria and ciliates) that release enzymes, cellulase, which act on cellulose and simplify it to short-chain fatty acids, such as acetic acid, butyric acid, propionic acid.

This is called **microbial digestion**. The fatty acids are neutralized by sodium bicarbonate of saliva and are absorbed. These two processes reduce the hard plant food to a pulp.

Intestine (6 to 9 meters) : It is divided into two part

(i) Small intestine (ii) Large intestine

(i) Small Intestine – Small intestine is differentiated in to three part

(a) Duodenum (b) Jejunum (c) Ileum

First part is **duodenum**, it is 25 cm long, c-shaped in humans and has opening of hepatopancreatic duct (bile duct + pancreatic duct)

A small swelling is present at the opening of hepatopancreatic duct and is called 'Ampulla of Vater' or hapatopancreatic ampulla and the opening is regulated by sphincter of oddi.

Next parts of small intestine are **jejunum** and **ileum**. The wall of intenstine has thin layers of longitudinal and circular muscles.Mucosa has folds **plicae circulare** (**folds of Kerkrings** or **Valvulae conniventes**) and **villi** towards lumen of the intestine. Epithelial cells lining the villi have microvilli which further increase the absorptive area. Intestinal glands or **Crypts of Lieberkuhn** have **epithelial cells** (secrete mucus), **Paneth cells** (secrete digestive enzymes) and **argentaffin cells** (probably secrete hormones). In duodenum Brunner's glands are also present (located in submucosa) which secrete mucus. Diffused patches of lymphoid tissue are present through out the small intestine and are aggregated in ileum to form **Peyer's patches**.

Duodenum (Proximal part)	Jejunum (Middle part)	Ileum (Posterior part)
2.5 *cm.* Long Forming *U*-shaped loop before leading to jejunum pancreas lies in the loop.	About 2.4 *m* long and about 4 *cm.* wide. Wall is thicker and more vascular. Villi thicker and tongue-like. Plicae best developed. Peyer's patches are lacking.	About 3.6 *m* long and about 3.5 *cm.* wide. Wall is thinner and less vascular. Villi thinner and finger-like. Plicae less developed. Peyer's patches are present.

- **Glands of small intestine**

Brunner's glands	**Payer's patches**	**Crypts of Leiberkuhn**
Found in duodenum only. Mucus secreating gland as so known as mucus gland.	These are lymph nodules. They produce lymphocytes. Lymphocytes are phagocyte in nature which destroy harmful bacteria.	Known as intestinal gland. Found in duodenum and ilium only. Secrete succus entericus *i.e.* intestinal juice. Formed by folding of lamina propia.

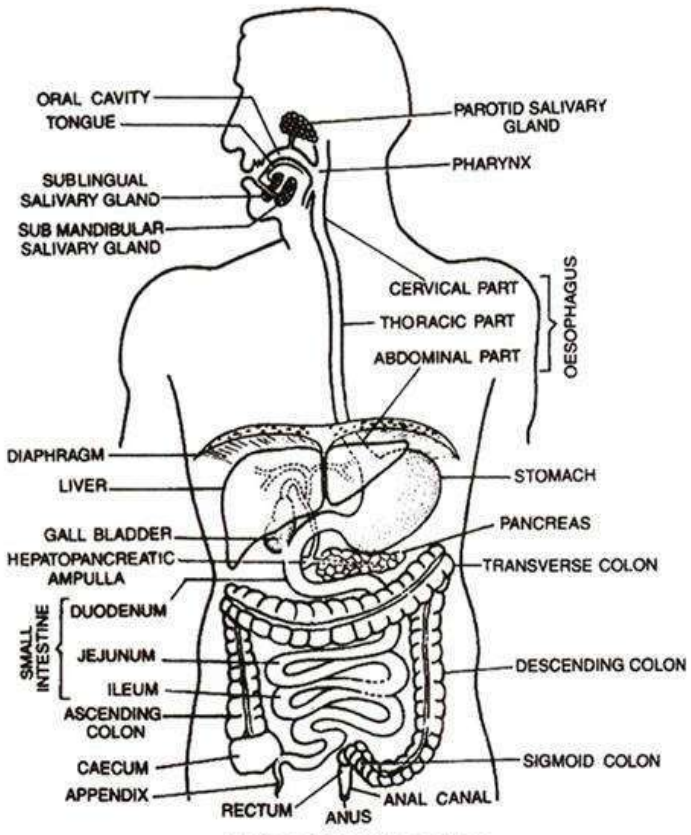
(ii) Large intestine :

It is 1.5 m long and consists of three part **caecum**, **colon** and **rectum**. A blind pounch of caecum is **vermiform appendix**. These parts help in digestion of cellulose in herbivores. Wall of colon has sac like **haustra**. Histologically wall of colon has three bands of longitudinal muscles called taeniae coli. Another

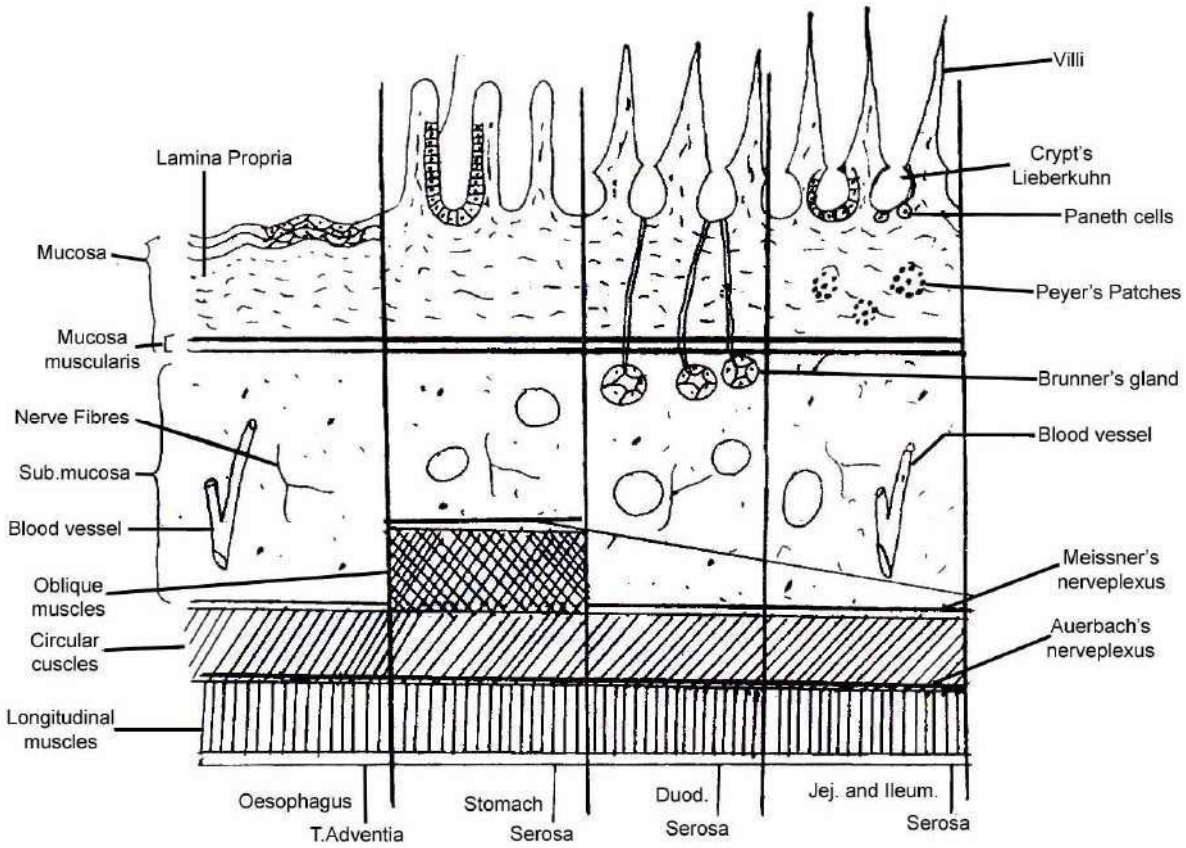
characteristics of colon surface is the presence of small fat filled projections called **epiploic appendages**. The colon part is divisible into ascending, transverse, descending and sigmoid colon. Sigmoid colon is also called as pelric colon .Ascending colon is the smallest and is without mesentry. Last part of rectum is **anal canal** having a strong sphincter. It opens outside by anus. In certain conditions (like persistent constipations) rectal veins can get distanded or enlarged due to weakening of valves of it (varicosity). It leads to swollen areas called **haemorrhoids**.

Differences between small and large intestines

Small intestine	Large intestine
Longer (about 6 *m.*) but narrower than large intestine.	Shorter (about 1.5 *m.*) but wider than small intestine.
Differentiated into duodenum, jejunum and ileum.	Differentiated into caecum, appendix, colon and rectum.
Mucous membrane has plicae circulares and villi.	Mucous membrane is mostly smooth (without plicae and villi). Rectum has longitudinal folds.
Lacks taeniae coli, haustra and epiploic appendages.	Has taeniae coli, haustra and appendices epiploicae.
Peyer's patches are present in the ileum.	Peyer's patches not formed, lymphoid nodules beins scattered.
Completes digestion and absorbs digestion products. Also produces some hormones.	Absorbs water, forms and eliminates faeces, produces vitamins *B* and *K* by bacterial activity and excretes certain inorganic ions.
Mucosal irritation due to infection causes diarrhoea.	Mucosal irritation due to infection causes dysentery.



Human digestive system



HISTOLOGY OF ALIMENTARY CANAL

Wall of alimentary canal is made up of four layer (outer to inner)

(1) **Serosa** : It is outer most layer of alimentary canal , it is called tunica adventia in oesophagus, which is made up of fibrous connective tissue. Except oesophagus, remaining part of alimentary canal in covered by serosa layer which is made up of visceral peritoneum while, tunica adventia is made up of white fibrous connective tissue.

(2) **Muscularis Externa or mucularis coat :** It is made up of two types of muscle outer muscle layer is made up of longitudinal muscle while inner layer is made up of circular muscle. Extra oblique muscles are found in stomach. Thickest muscular coat is found in stomach so maximum peristalsis are found in stomach least muscles are found in rectum so least peristalsis are found in rectum.

(3) **Sub mucosa :** It is made up of loose connective tissue layer with blood lymph vessels and nerves.

(4) **Mucosa** : It is the inner most layer of gut which contains the secretary and absorptive cells.

It is differentiated into 3 parts.

(i) Outer part : Called mucosa muscularis or muscularis interna

– It is made up to longitudinal and circular muscles.

– But these muscles are vestigeal.

– They provide support to the folds of alimentary canal.

(ii) Middle part : Called lamina propria.

– It is made up of reticulate and fibrous connective tissue, dense network of blood capillaries are found in this part.

(iii) Innermost part : Called mucosal layer.

– In oesophagus this layer is made up of non keratinised stratified squamous epithelium.
– Except oesophagus this layer is single layer thick.
– This layer makes the lining of lumen of Alimentary canal.
– This layer is made up of columnar mucous epithelium.
– Folds of oesophagus are less developed
– This layer makes the folds of alimentary canal
– Folds of stomach are finger shaped.
– Folds of small intentine are conical shaped called Villi.
– Small slit like space is found at the base of villi.
– These spaces are called crypts of Lieberkuhn
– Villi of Doudenum are small blunt.
– Villi of jejunum and Ileum are long and pointed.
– Maximum villi are found Jejunum.

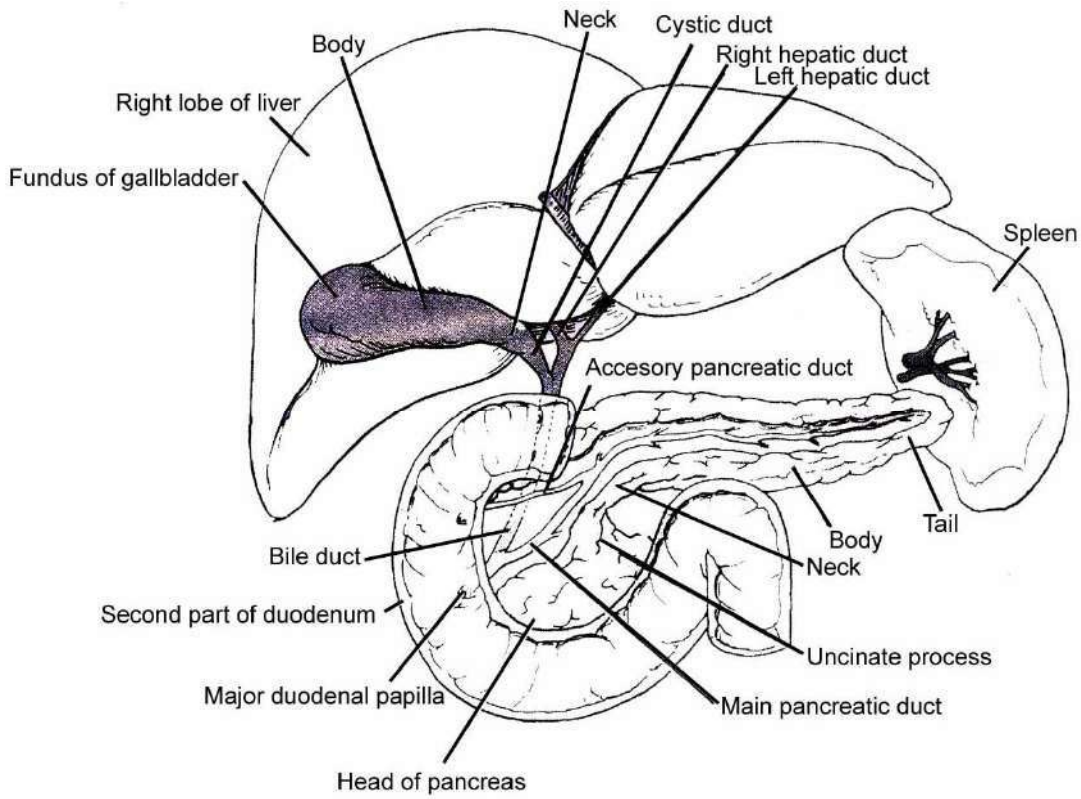
- **Brunner's Gland :**
  – They are small spherical multicellular glands.
  – They open into crypts of lieberkuhn with the help of fine tubules.
  – These glands are found in the submucosa and mucosa of duodenum.
  – They synthesize and secrete the non enzymatic secretion of intestinal juice.
- **Paneth Cells :**
  – These cells are found in mucosal layer of crypts of lieberkuhn of jejunem.
  – They are unicellular gland.
  – They synthesize and secrets enzymes of intestinal juices.
  – The secretory substances of brunner's glands and paneth cells are combindly called intestinal juice or succus entericus.
- **Peyer's patches**
  – They are small lymph nodes which are found in the mucosa of small intestine (Jejunum and Ileum more in number). They are also called intestinal tonsils and provide immunity.
- **Nerve supply :**

  Two types of Nerve plexus are found in muscle of alimentary canal. (These control muscle contraction).

  (1) Auerbach's Nerve Plexus : This nerve plexus is found between longitudinal muscles and circular muscles.

  (2) Meissner's Nerve plexus : Found between circular muscles and sub mucosa but in stomach it is found between oblique muscle & submucosa.

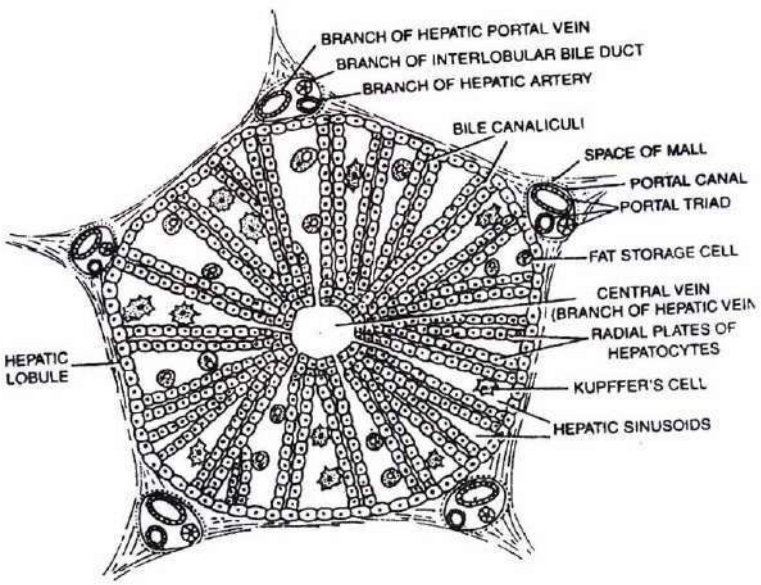
LIVER



In human liver is made up of four lobe. Left lobe is small right proper lobe is large, two addition lobe quadrate and caudate lobe are also found on posterior side of right proper lobe.

It develops from **endoderm.** (Weight 1.5 kg., both exocrine and endocrine)

- In human it is found in right side of abdominal cavity, below the diaphragm.
- The liver is the largest gland of body.
- Right and left liver lobe are separate from each other by the **falciform ligament**, (Fibrous connective tissue) Which is made up of fold of peritoneum.
- Right and left hepatic duct develop from right and left liver lobe Both these ducts combine to form a **Common Hepatic duct**.
- **Gall bladder** is situated below right lobe of liver.
- Cystic duct of gall bladder is connected to common hepatic duct and form a common bile duct which also called **ductus choledocus or common bite duct.**



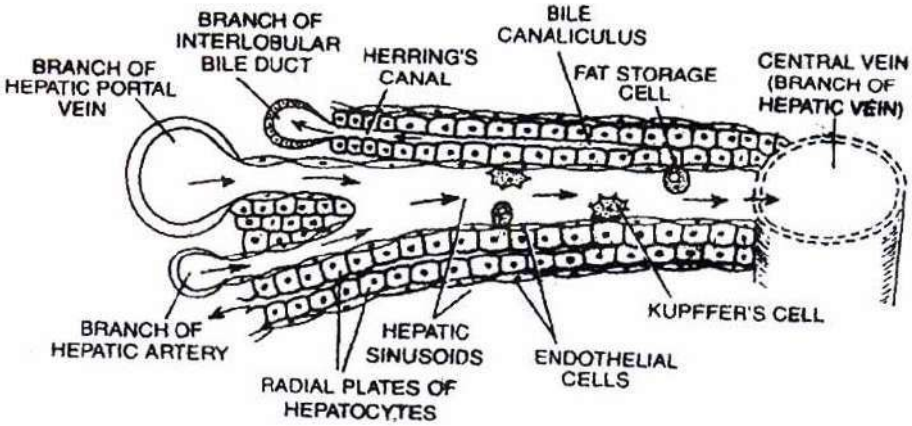
A part of transverse section of mammalian liver

– Internally liver is made up of numerous polygonal lobules. These lobules are covered by fibrous connective tissue, covering layer is called **Glisson's Capsule.**

– Each lobule consists of radial rows of hepatic cells, two row of hepatic cells are combindely called as hepatic cord. Each hepatic cord is lined by endothelial layer.

In between the hepatic cord, a space is present called as hepatic sinusoid. These sinusoids are filled with blood. Sinusoids are lined by the endothelial cells mostly but, a few macrophages cells are also present. These are called as **kupffer's cells**. (Phagocyte cells)

The bile canaliculi run in between the two layers of hepatic cells in each hepatic cord. Hepatocytes (hepatic cells) pour bile into the canaliculi. Canaliculi open into branch of hepatic duct which is situated at the angular part of lobule in the Glisons capsule. All branches of hepatic duct of right and left lobe are combined to form right and left Hepatic duct which come out from the liver and forms a common hepatic duct.



Hepatic artery and hepatic portal vein enter into liver and divide to form many branches. These branches are also found at the angular part of Glisson's capsule. Its fine branches open in to hepatic sinusoids. Branch of hepatic portal vein, branch of hepatic artery and branch of hepatic duct are collectively called as Portal triad. All hepatic sinusoids of one Glisson's capsule are open into central vein or intra lobular vein, all Central veins are combined and form one pair hepatic vein which, comes out from liver and opens into inferior vena cave.

- **Function of liver :** (Liver is known as chemical factory of the body)

Most of the biochemical functions of the body are done by the liver.

1. **Secretion & synthesis of bile** – This is the main function of liver. Bile is yellowish-green, alkaline fluid. In bile juice, bile salts, sodium bicarbonate, glycocholate, taurocholate, bile pigments, cholesterol, Lecithin etc. are present. Bile salts help in emulsification of fats. Bile prevents the food from putrification. It kills the harmful bacteria.
2. **Carbohydrate Metabolism** – The main centre of carbohydrate metabolism is liver. Following steps are related with carbohydrate metabolism.

(a) Glycogenesis – The conversion and storage of extra amount of glucose into glycogen from the digested food is called glycogenesis. The main stored food in the liver is glycogen

(b) Glycogenolysis – The conversion of glycogen into glucose back when glucose level in blood falls down is called glycogenolysis.

(c) Gluconeogenesis – At the time of need, liver converts non-carbohydrate compounds (e.g. Amino acids. Fatty acids) into glucose. This conversion is called gluconeogenesis. This is the neo-formative process of glucose.

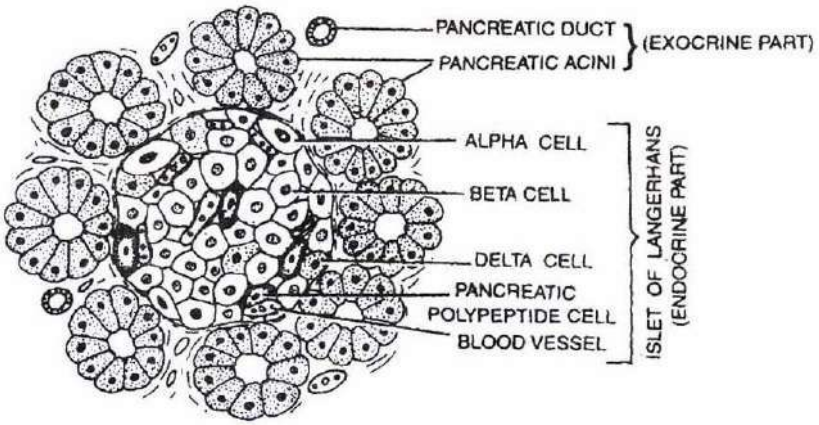
(d) Glyconeogenesis – Synthesis of glycogen from lactic acid (which comes from muscles) is called glyconeogenesis

3. **Storage of fats –** Liver stores fats in a small amount. Hepatic cell play an important role in fat metabolism. The storage of fats is increases in the liver of alcohol addict persons (Fatty liver). This storage of fats decreases the activity of liver. the damage of liver due to alcohol intake is called Alcoholic Liver cirrhosis.
4. **Deamination and Urea formation** – Deamination of amino acids is mainly done by liver (Amino acid $\rightarrow NH_3$ separation of ammonia from the amino acids is done by the liver) Liver converts ammonia (obtained form deamination) into urea through **orinithine** cycle. So after the spoilage of liver, the ammonia level in the animal body is increased and the animal dies.
5. **Purification of blood –** The spleen and liver separate dead blood cells and bacteria from the blood. Kupffer cells in liver and phagocytes in spleen perform this function.
6. **Synthesis of plasma proteins–** Many types of proteins are present in blood plasma. Except gamma globulins all type of plasma proteins are synthesized in the liver.
7. Most of the blood clotting factor are synthesized in the liver.
8. **Synthesis of heparin**– Heparin is an anticoagulant (Mucopolysaccharide).

- Some heparin is also formed by basophills, that are special type of white blood cells

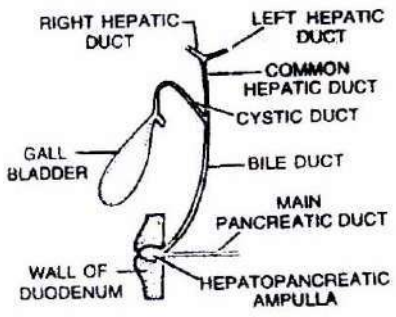
9. **Synthesis of Vitamin A** – The liver converts the β-carrotene into vitamin A : β- caroteine is a photosynthetic pigment which is obtained from plants. It is abundantly found in carrot.
10. Liver stores **vitamin A, D, E, K and B_{12}**
11. **Storage of minerals–** Liver stores iron in the form of ferritin. Liver also stores the, copper, zinc, cobalt, molybdenum etc Liver is a good source of iron.
12. **Detoxification –** In this process liver converts the toxic substances into non-toxic substances. The toxic substances are formed by metabolic activities of the body. e.g. Prussic acid is converted into neutral Potassium sulfocynide (It is a non-toxic salt) by the liver.
13. **Heamopoiesis –** The formation of blood cells is called haemopoesis. In empbryonic stage R.B.C. and WBC are formed by liver.
14. **Yolk synthesis –** Most of the yolk is synthesized in liver.
15. **Secretion of enzymes –** Some enzymes are secreted by liver, participate in metabolism of proteins, fats and carbohydrates e.g. Dehydrogenase, cytochrome oxidase etc.
16. Prothrombin and fibrinogen proteins are also formed in hepatic cells. These help in blood clotting
17. Factors I, II, V, VII, IX and X are formed in liver, which are responsible for blood clotting.

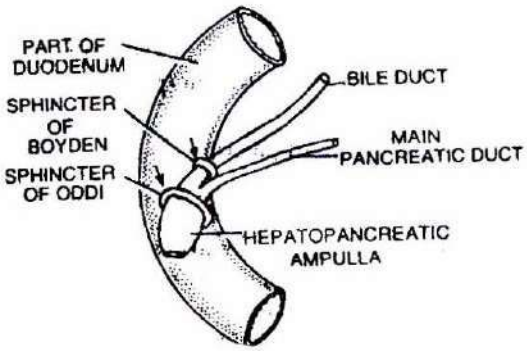
PANCREAS (SWEET BREAD)



Section of pancreas

- Develop from **endoderm.**
- It is soft, lobulated and elongated organ..
- It is made up or numerous acini. Acini is a group of secretory cells surrounding a cavity.
- Each acini is lined by pyramidal shaped cells. These acinar cells secrete the enzyme of pancreatic juice.
- Each acini opens into pancreatic ductule. Many penacreatic ductule combine to from main pancreatic duct **(duct of wirsung**). The main Pancreatic duct is join with the bile duct to form the hepatopancreatic ampulla which opens into duodenum. The accessory Pancreatic duct **(duct of santorini)** opens into duodenum with separate openings located above the opening of main Pancreatic duct.
- Some group of endocrine cells also found in between group of acini called **islets of Langer han's**. These islets secrete insulin & glucagons hormone. So this gland is exocrine as well as endocrine. **Its 99% part is exocrine** while **1% part is endocrine** (Heterocrine)



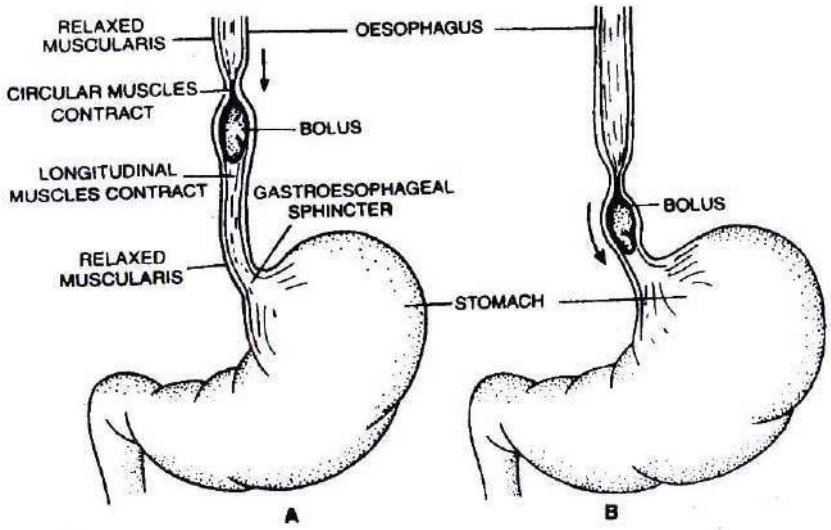


- In rabbit, bile duct and pancreatic duct both are separately open into Duodenum.
- Bile duct opens into proximal limb of duodenum and is controlled by **sphincter choledocus**.
- Pancreatic duct opens into distal limb of duodenum and is controlled by **sphincter pancreaticus**.
- In humans both bile duct and main pancreatic duct combine to form common duct called as **Hepto-Pancreatic duct**. The terminal end of common duct is swollen and is called as **Ampulla of Vater** or **Hepato Pancreatic ampulla. Ampulla of Vater** opens into middle part of Duodenum and is controlled by **sphincter of Oddi** while, bile duct is controlled by **sphincter of Boyden**

PHYSIOLOGY OF DIGESTION

1. DIGESTION IN ORAL CAVITY

Food enters through mouth food is tasted in oral cavity and mixed with saliva, tongue mixes the food with saliva. This food with saliva is called bolus. This saliva (pH 6.8 – 7.0) contains water (99.5 %) and electrolytes (Na^+, K^+, Cl^-, HCO_3^- , Thiocynate)



PERISTALSIS IN OESOPHAGUS

- **Chemical digestion : -**

In this type of digestion saliva act with food particles.

Saliva contain 99.5 % water & 0.5 % salts.

These salts are organic and inorganic type

The main contents are Mucin, Lysozyme, Thiocynate and Ptyalin

(A) Mucin

It is a glycoprotein. It lubricates the food particles. It helps in the swallowing of food.

(B) Lysozyme

It is an enzyme which kills the harmful bacteria. Due to this reason saliva is a antiseptic lotion.

(C) Thiocynate

It is a special salt which kills the harmful bacteria. So it is called bacterioscidal salt.

(D) Ptyalin

$$\text{Starch} \xrightarrow{\text{ptyalin}} \text{Maltose} + \text{Limit Dextrin}$$

Ptyalin is found in human saliva, because human food is mainly made up of starch. Ptyalin digest only ripe and cooked starch. It does not digest the raw starch.

Note: Ptyalin is absent in saliva of rabbit and carnivorous animal, because food of rabbit is mainly made up of cellulose.

Bolus is pushed inward through the pharynx into the oesophagus. The tongue blocks the mouth. Soft palate close off the nasopharynx and larynx rises so that epiglottis bend and closes off the glottis food move downward into the oesophagus A traveling wave of contractions are called peristalsis puhes the Bolus (food) downward. **Peristalsis is produced by involuntary contactions of circular muscles, which is preceded by a simultaneous contraction of the longitudinal muscle and relaxation of the circular**

muscle lining the gut. When a peristaltic wave reaches the end of the oesophagus. (Digestion or digestive enzymes are absent in Oesophagus) The sphincter opens allowing the passage of bolus food to the stomach. Gastroesophageal sphincter of the oesophagus and stomach normaly remains closed and does not allow contents of the stomach to move back.

- Secretion of saliva is mainly controlled by nervous type. Sympathetic nerve decreases the secretion of saliva while secretion of saliva increases by parasympathetic nerve.
- Secretion of saliva also controlled by reflex action e.g. smell of food, sight reflex etc.

2. DIGESTION OF FOOD IN STOMACH

When the food enters into stomach G-cells secrete gastrin hormones which stimulate the secretion of gastric juice by gastric glands.

Secretion of gastric juice is controlled by nerve, hormones and chemical substances.

Secretion of gastric juice is divided into 3 phases–

I. Cephalic Phase – This phase is mediated by parasympathetic. It is the first of step of secretion. When person see the food then due to sight or optic reflex small amount of gastric juice secretes in the stomach.

II. Gastric phase – When food enter into stomach then gastric phase is started. When food particles strikes to the fundic part of stomach then small amount of gastric juice is secreted due to strike reflex action and distension. Gastric juice developes the peristalsis movement in the stomach. Due to peristalsis food particles are rubbed on mucosal layer of stomach.

Due to rubbing process cells stimulates and secretes gastrin hormone. This hormone powerfully stimulate the gastric glands for secretion of gastric juice.

Some drinking substances also stimulates the secretion of gastric juice such a soup, alcohol, caffeine, histamine. These drinking substance and gastric juice stimulate the desire of appetite. So these substances are called Appetiser juice.

III. intestinal phase – When food reaches at the Ileum then mucosal layer of ileum secretes a chemical substance. Its nature is similar to the histamine or gastrin. This chemical substance goes into stomach through blood circulation where it stimulates the secretion of gastric juice.

Its actual cause is yet unknown. But it is believed that this phase starts after 8–10 hour of taking of meal.

Composition of Gastric juice

Water = 99.5 %

HCl = 0.2 – 0.3 %

pH = 1.5 to 2.5 (very acidic)

rest part = mucous water, HCl and gastric enzymes (Pepsinogen, Prorennin, Gastric Lipase Gastic amylase etc.)

Functions of HCl

1. The main function of HCl is to convert inactive enzymes (zymogens) into active enzymes.

$$\text{Pepsinogen} \xrightarrow{\text{HCl}} \text{Pepsin}$$

$$\text{Prorennin} \xrightarrow{\text{HCl}} \text{Rennin.}$$

Pepsinogen and Prorennin are inactive enzymes.

2.. It destroys harmfull the bacteria present in the food.

3. HCl stops the action of saliva on food. In stomach, the medium is highly acidic.

4. It dissolves the hard portions of the food and makes it soft.
5. It releases the fat globules from tissue or cells which found in food
6. $\text{Nucleoproteins} \xrightarrow{\text{HCl}} \text{Nucleicacid} + \text{protein.}$
7. HCl of gastric juice converts Fe^{+3} into Fe^{+2} which makes the absorption of iron possible.

Digestion by Rennin (Chymosin)

Renning is active in the childhood stage of mammals only. It converts milk into curd like substance (clot the milk) .

Rennin, acts on milk protein **casein.** Casein is a soluble protein.

In the presence of Rennin, Casein gets converted into insoluble **Calcium-paracaseinate**, This process is termed as **Curdling of milk**. After becoming insoluble, milk can remain in the stomach for a loger time. Rennin is absent in human (clotting of milk is done by HCl in human).

Digestion by Pepsin–

Inactive pepsinogen on getting proper pH conversts into active pepsin.

Peptidase – An enzyme which breakes the peptide bond. These peptidase are of two types.

(a) Exopeptidase : The peptidase enzyme which breaks the outer and marginal bond of polypeptide called exopeptidase. In this process amino acid and polypeptides are formed.

(b) Endopeptidase : The peptidase enzyme which breaks the inner peptide bond of large polypeptide and forms the small polypeptides such as peptone, proteoses and peptides.

Pepsin is a strongest **Endopeptidase**. It breaks proteins into smaller molecules.

$$\text{Proteins} \xrightarrow{\text{Pepsin}} \text{Peptones} + \text{Proteoses} + \text{Peptides}$$

In stomach, endopeptidases are found so only digestion of proteins can take properly in the stomach.

Digestion by Gastric Lipase –

It converts fats into fatty-acids and glycerol. It is secreted in a less amount so less digestion of fats takes place here.

This lipase acts on emulsified fat and convert it into fatty acid & glycerol. 1% emulsified fat is already present in the food. **Peristalsis.** Continues during the process of digestion so the gastric-juice mixes properly with the food. Due to peristalsis the food is converted into a paste. This form which is thick. Acidic & semi digested in the stomach is called chyme.

After short intervals, the pyloric valves on opening and closing so the chyme is enters the intestine in installments

3. DIGESTION OF FOOD IN DUODENUM

When food leaves the stomach through its pyloric end enters the duodenum it is called chyme (Acidic). The HCl of chyme stimulates the wall of duodenum to secrete hormones. It secretes various hormones–

1. **Hepatocrinin –** It promotes the synthesis and secretion of Bile juice from liver.
2. **Cholecystokinin –** It stimulates the liver and the gall bladder (mainly gall bladder) to secrete bile juice.
3. **Secretin** : It is the most important hormone of digestive tract and also first discovered hormone. This hormone stimulates pancreas for synthesis and secretion of non enzymatic part of pancreatic juice. It also stimulates liver for secretion of bile juice and inhibit the gastric juice secretion in stomach and reduce rate of contraction of stomach.
4. **Pancreozymin** – It stimulates the synthesis as well as secretoion of enzymatic part of pancreatic juices.

- Secretin promotes the sectretion of the non enzymetic part of the pancreatic-juice. While pancreozymin promotes the secretion of enzymatic part of the pancreatic juice.

5. **Duocrinin -** It stimulates the Brunner's gland for synthesis and secretion of non-enzymatic part of intestinal juice.
6. **Enterocrinin -** This hormone stimulated Paneth cells for synthesis and secretion of enzymatic part of intestinal juice.
7. **Villikinin –** It stimulates the activity of villi.
8. **Enterogasterone –** It inhibits the secretion of HCl in stomach.
9. **Gastric inhibitory polypeptide (GIP) –** It inhibits the secretion of gastrin hormone.
10. **Vasoactive intestinal peptide and somatostatin –** They inhibits the motility of stomach

BILE-JUICE :

In the proximal part of the duodenum bile-juice is secreted. The parenchyma cells of the liver produce bile-juice and it is stored in the Gall-bladder. Bile-juice does not contain any digestive enzyme. Therefore it is not a true digestive juice (Pseudodigestive-juice).

Composition of Bile-juice –

Bile juice is a greenish (Biliverdin) yellow (Bilirubin) coloured alkaline fluid.

	Bile juice
pH	8.0
H_2O	98 %

Organic constituent are bile acid, bile pigment, cholesterol, Lecithin, inorganic constituents

Na^+, K^+, HCO_3^- etc

Bile-pigments are the excretory-substances of the liver.

Bile-salts are of two types–

(**a) Inorganic salts –** Bile-juice contains NaCl, Na2CO3, NaHCO3 etc in it. Inorganic salts neutralize the acidity of the food and make the medium basic. It is necessary for the medium to become basic because the pancreatic-juice enzymes can act only in basic medium.

(b) Organic salts – Organic salt like Na-glycocholate and Na-taurocolate are found in Bile juice. The main function of these salts is the emulsification of fats. Because pancreatic **Lipase** can act only on emulsified fats.

Bile salts also help in the absorption of fat and fat-soluble vitamin (A, D, E, K) Bile salts combine with fats and these vitamins to form compounds called **Micelles** which are absorbed rapidly.

Bile-sallts promote-peristalsis in the small-intestine.

Bile-pigments, cholesterol and Lecithin are the excretory substances found in Bile-juice.

Gall Stone–Sometimes the passage inside the bile-duct gets blocked or becomes narrow, so the cholesterol gets deposited or precipitated in the gall-bladder. This is termed as the Gall-stone (Cholelithiasis)

Obstructive Jaundice - If the passage of bile is blocked then the amount of bilirubin increases in the blood. So the yellowish colouration of body like skin, cornea and nails appear yellow. Urine also becomes yellow.

Pancreatic juice :

Pancreozymin stimulates the acini and glandular cells so pancreatic juice are secreted.

The pancreatic-juice is secreted by the exocrine cells of the pancreas.

Pancreatic juice is highly odouriferous, colourless basic fluid which contains enzymes and salts.

- **Compostition of Pancreatic juice-**

  Total amount in man = 500 – 800 ml/day

  Water = 98%, pH = 7.5– 8.3, Salts =2 %

  *Pancreatic juice contains only inorganic-salts

  The action of enzymes present in the pancreatic juice is as follows–

(1) Pancreatic α-Amylase : Amylase or Amylopsin dissociates starch into Maltose. Majority of starch breaks up into the duodenum.

(2) Trypsinogen and Chymotrypsinogen – The step of these enzymes is as follows–

$$\text{Tripsinogen} \xrightarrow[\text{EnterokinaseorEnteropeptidase}]{Ca^{++}} \text{Trypsin}$$

$$\text{Chymotrypsinogen} \xrightarrow{\text{Trypsin}} \text{Chymotrypsin}$$

Ensterokinase is secreted by the **Duodenal mucosa.**

Trypsin and chymotrypsin are **Endopeptidase** type of enzymes. They dissociate protein into peptones and proteoses. Majority of proteins are broken into the stomach and the remaining are broken into the duodenum.

$$\text{Proteins} \xrightarrow[\text{Chymotrypsin}]{\text{Trypsin and}} \text{Large peptide}$$

(3) Procarboxy Peptidase – These are also called zymogens. Trypsin convert it into active **Carboxy-peptidase**.

$$\text{Large peptides} \xrightarrow[\text{peptidase}]{\text{Carboxy}} \text{Amino-acid}$$

(4) Large Peptides $\xrightarrow{\text{Amino peptidase}}$ Oligopeptide

(5) Elastin $\xrightarrow{\text{Elastase}}$ Oligopeptides

(6) Fat Digesting enzyme – In pancreatic-juices various Fat-digesting enzymes are found which are collectively called **steapsin.**

(i) Pancreatic Lipase – It converts triglyceride into monoglyceride, fatty acid, glycerol

(ii) Cholesterol esterase – It digest **cholesterol esters**. These esters are made up of cholesterol and fatty-acid Like- **Lanolin**, (cholesterol and Palmitic acid).

(iii) Phospholipase – These digest phospholipids.

(7) DNase and RNase – For digestion of DNA and RNA.

4. DIGESTION IN JEJUNUM AND ILEUM

These hormones stimulate the crypts of lieberkuhn to secrete **Succus-entericus** or intestinal juice. This **succusentericus** mainly contain water (99%) and digestive enzymes (< 1%). Intestinal juice act on food (chyle).

Succus- entericus mainly contains the following enzymes-

1. **Peptidase or Erepsin -** This is a type of **Exopeptidase.** It converts oligopeptides into amino-acids
2. **Disaccharidases**

$$\text{sucrose} \xrightarrow{\text{Sucrase}} \text{Glucose} + \text{Fructose}$$

Sucrase – It is also known as invertase. It converts sucrose into **glucose** and **fructose.**

Maltase – It convers moltose sugar into **Glucose** molecules.

$$\text{maltose} \xrightarrow{\text{maltase}} \text{Glucose} + \text{Glucose}$$

Lactase – This enzymes is found only in mammals. It converts milk sugar lactose into **Glucose** and **Galactose.**

$$\text{Lactose} \xrightarrow{\text{Lactase}} \text{Glucose} + \text{Galactase}$$

3. **Intestinal Lipase–** This fat-digesting enzyme converts fats into **Fatty-acids and Glycerol**.
4. **Nucleotidase and Nucleosidase** –These act in the following way–

(i) $\text{Nucleotides} \xrightarrow{\text{Nucleotidase}} \text{Nucleosides} + \text{Phosphate}$

(ii) $\text{Nucleosides} \xrightarrow{\text{Nucleosidase}} \text{Pentose} + \text{Nitrogen base}$

* maximum digestion of carbohydrates is done in duodenum, but its digestion is completed in Jejunum.

5. DIGESTION IN CAECUM

In herbivores, the symbiotic bacteria and protozoans present in the caecum help in digestion of cellulose into glucose. So the digestion of cellulose takes place in caecum by the process of **decompostion.** This **decomposition** process is very slow. So very less amount of cellulose is digested at a time in caecum.
In the last part of the large intestine faeces is temporarily stored.

Maximum digestion of food – Duodenum
While digetion of food complete in – Jejunum
Maximum absorption of food in – Jejunum

Millions of microscopic folds or finger like projection are present in the lumen of gut which are called villi. These villi are supplied with a network of blood capillaries and Lymphatic vessels. Largest of which is central Lacteal. The cells that line the surface of villi numerous microscopic bristle like projections are called microvilli or brush border. These further increase the surface area for the absorption of the nutrients/digested food. On the surface of the mucous epithelium are billions of single cell mucous glands called mucous or goblet cells. These cells mainly secrete mucus that acts as a lubricant and protects the epithelial surface from damage and digestion.
The lining cells of the villi are columnar epithelial cells called **enterocytes.** On the surface of entrocytes, numerous **microvilli** are found, they increase the surface area of mucous membrane

Summary of physiology of digestion

Major gastrointestinal enzyme in mammals

Name of gland	Name of digestive juice & optimum pH	Name of enzyme	Site of action	Substrates	Products
Salivary glands	Saliva (6.8)	Ptyalin / Salivary amylase	Mouth	Starch, dextrins, glycogen	Dextrins, maltose, isomaltose and limit dextrin.
Gastric glands	Gastric Juice (1-3)	Pepsin	Stomach	Proteins, casein (Milk)	Peptones, paracasein (curd). Proteases

		Rennin	Stomach	Casein	Paracasein
		Gastric lipase	Stomach	Fats	Fatty acid and Glycerol.
Bile juice	Liver	No enzymes	Duodenum	Fat	Makes the food alkaline, emulsifies fat and kills the harmful bacteria.
Liver	Bile (7.7 – 8.0)	No enzyme but useful digestive juice, provides alkaline medium, stops the action of HCl. Emulsifies fats and kills – harmful bacteria.			
Pancreas	Pancreatic Juice (7.3 – 8.6)	Amylase/Diast-ase	Small intestine	Starch, dextrins, glycogen.	'Limits' dextrins, maltose, isomaltose.
		Trypsin	Small intestine	Proteins, Chymotry-psinogen (inactive) procarboxy pept-idases (inactive) Fibrinogen (blood) Casein (milk)	Peptides, Chymotrypsin (active) carboxy pepti-dases (active) Elastase (active), Fibrin (clot) Para-casein (curd)
		Chymotrypsin	Small intestine	Peptones	Peptides
		Carboxy-peptidases	Small intestine	Peptides	Smaller peptides and Amino acids.
		Lipase / Steapsin	Small intestine	Triglycerides	Mono-glycerides, fatty acids
		DNA ase	Small intestine	DNA	Deoxyribonucleotides
		RNA ase	Small intestine	RNA	Ribonucleotides
Intestinal glands	Intestinal Juice (7.6–8.3)	Enteropeptidase (enterokinase)	Small Intestine	Trypsinogen (inactive)	Trypsin (active)
		Aminopeptidase	Small Intestine	Peptides	Smaller peptides and amino acid
		Dipeptidases	Small Intestine	Dipeptides 'Limit' dextrins	Amino acids
		Isomaltase	Small Intestine	Isomaltose	Glucose

		Maltase	Small Intestine	Maltose	Glucose
		Sucrase/ Invertase	Small Intestine	Sucrose	Glucose, fructose
		Lactase	Small Intestine	Lactose	Glucose, galactose
		Lipase	Small Intestine	Triglycerides	Monoglycerides, fatty acids
		Nucleotidase	Small Intestine	Nucleotides	Nucleosides, inorganic phosphate
		Nucleoside Phosphorylases	Small Intestine	Nucleosides phosphate	Purine, pyrimidine, pentose, phosphate

Gastrointestinal hormones in mammals

Hormone	Source	Stimulus for secretion	Target organ	Action
Gastrin	Mucosa of pyloric stomach	Distension of stomach on food entry	Stomach	Stimulates secretion of gastric juice. Constricts cardiac sphincter.
Enterogastrone	Duodenal epithelium	Chyme entry into duodenum	Stomach	Slows gastric contractions to delay its emptying. Stops secretion of gastric juice.
Secretin	Duodenal epithelium	Acidic chyme entry into duodenum	Pancreas Liver Stomach	Release of sodium bicarbonate in pancreatic juice. Steps up secretion of bile. Inhibits secretion of gastrin.
Cholecystokinin (Pancreozymin)	Duodenal epithelium	Presence of fats in duodenum	Pancreas Gall Bladder	Release of enzymes in pancreatic juice. Release of bile from gall bladder.
Villikinin	Intestinal epithelium	Food in small intestine	Intestine	Accelerates movements of villi.
Duocrinin	Intestinal epithelium (Duodenal mucosa)	Acidic chyme in intestine	Intestine (Brunner's gland)	Release of viscous mucous from Brunner's glands.
Enterocrinin	Intestinal epithelium (Duodenal mucosa)	Acidic chyme in intestine	Intestine (crypts of Lieberkuhn's)	Release of enzymes from Lieberkuhn's crypts.

Summary of chemical digestion of food

Chemical digestion of protein	Chemical digestion of carbohydrates	Chemical digestion of fats	Chemical digestion of nucleic acid
Protein Food ↓ ← Pepsin (gastric juice) **Proteoses and Peptones** ↓ Trypsin and Chymotrypsin (pancreatic juice) **Tri and Dipeptides** ↓ Peptidases (intestinal juice) **Amino acids** (monopeptides)	**Polysaccharides** (starches) ↓ ← Ptyalin (saliva) ← Amylase (pancreatic juice) **Disaccharides** (sugars) ↓ ← Maltase, Lactase Sucrase (intestinal juice) **Monosaccharides** (glucose, fructose, galactose)	**Fat** ↓ ← Bile salts (bile) **Emulsified Fats** ↓ Lipase (pancreatic and intestinal juice) **Fatty acids and glycerol**	**Nucleid acid** ↓ (DNA and RNA) Pancreatic nucleases (DNAase & RNAase) **Nucleotides** ↓ Intestinal Nucleotidases and Nucleosidases **Nitrogen bases** Pentose sugars and inorganic phosphate

ABSORPTION OF DIGESTED FOOD

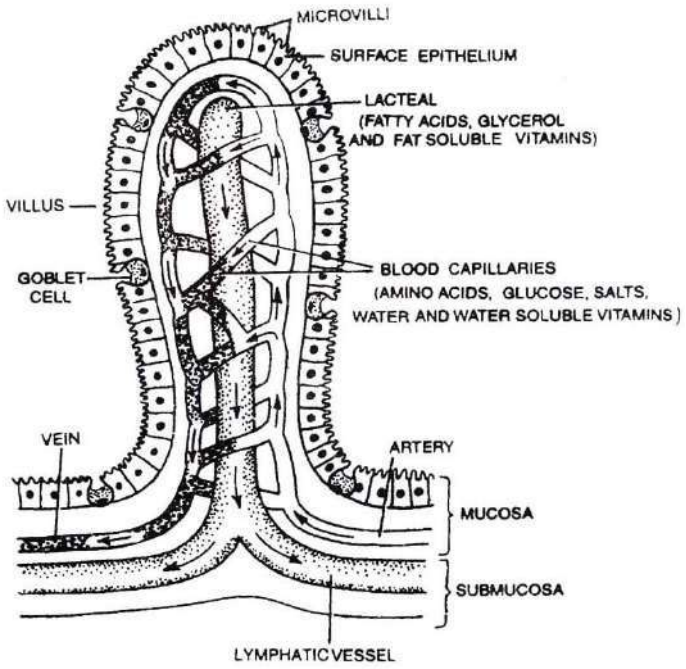
The process through which the food stuff diffuses through the intestinal mucous membrane and reaches the blood, is termed as **absorption**. The process of absorption. The process of absorption in different parts of the alimentary takes place in the following manner.

(1) Absorption in Buccal-Cavity

No absorption of food takes place in the oropharynx and the oesophagus. Only some chemicals/medicines and alcohol are absorbed in oro-pharyngeal cavity.

(2) Absorption in stomach

In the stomach, absorption of water, some salts, alcohol and glucose takes place, complete absorption of alcohol takes place in the stomach.



VILLUS AND ABSORPTION OF DIGESTED NUTRIENTS IN IT

(3) Absorption in duodenum–

Iron & calcium ion are absorbed in the duodenum.

(4) Absorption in Jejunum–

Maximum absorption take place in jejunum.

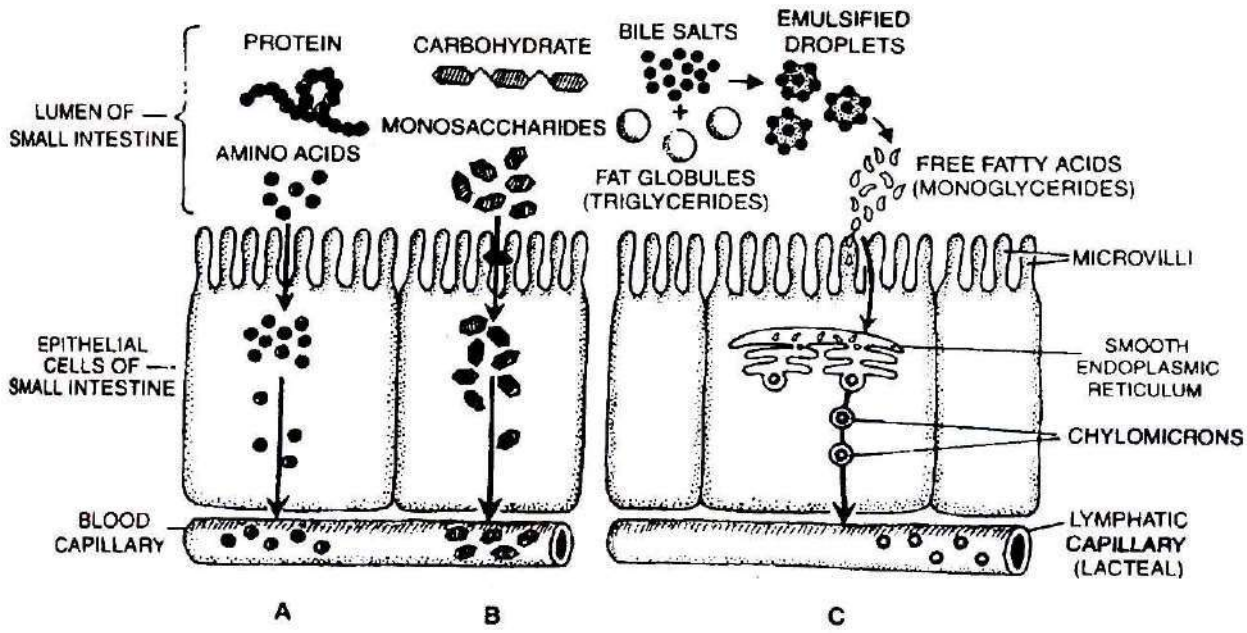
Carbohydrate

The principal carbohydrate of our food is usually starch (from rice or wheat) which is broken down by the pancreatic amylase. Disaccharides are broken down to their monsaccharide by enzymes of the succus-entricus. Monosaccharides are absorbed via the capillary blood with in the villus to finally reach into portal vein. **Absorption of glucose molecules occurs along with Na+ by active symport. Fructose is absorbed passively.**

Digestion and absorption of amino acid–

All these proteins are exposed to pepsin, trypsin, chymotrypsin, carboxypeptidases etc and as a result they are converted into tri and dipetides or free amino acids. Amino acid are of two types L-amino acid & D-amino acid. The **L-amino** acids are absorbed by **active** process against the concentration gradient while **D-amino acid** are absorbed **passively** by diffusion.

Di–and tripeptide enter the enterocytes where they are hydrolyzed to amino acids by dipeptidases and then absorbed via portal blood.



Digestion and absorption of Fat–

One molecule of triglyceride is hydrolyzed into one molecule of monoglyceride and two molecule of fatty acids by pancreatic lipase.

After hydrolysis, the bile salt, monoglyceride and the fatty acid together produce a complex called a **mixed micelle.** These are water soluble & enter in the enterocytes. Monoglyceride and fatty acid

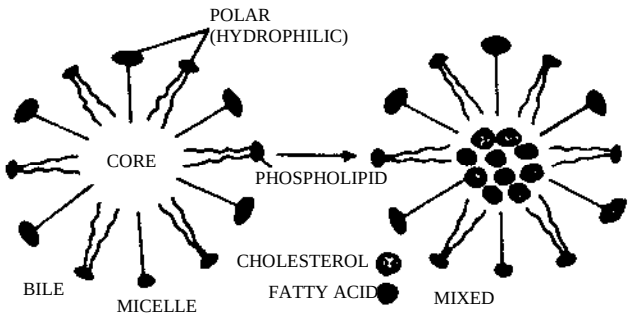


Fig. – Formation of micelle

are resynthesized with in enterocyte to form a molecule of trigylyceride (T_G).T_G combines with a small amount of protein Phosphate and cholesterol and resultant complex is called **chylomicron** (150μm, white) Chylomicron enters the lacteal.

Fat soluble vitamins are absorbed along with dietary fat whereas water soluble vitamins are absorbed by passive diffusion. Vit. B_{12} is absorbed with intrinsic factor by forming a complex.

In ileum Vit. B_{12} & Bile salt are absorbed. In colon only metabolic water is absorbed.

All lymph-capillaries coming out of the alimentary canal and unite to form **Lymph-vessels.** All lymph-vessels coming from the alimentary canal open into **the Left Thoracic Lymph Duct**. This duct now opens into the **Left Subclavian vein.** Through the blood, fats reaches the heart and from here it is distributed throughout the body.

** Besides fats, other substances of the digested food like-sugars, amino-acids, vitamins, minerals-salts after being absorbed, enter the blood capillaries. All blood-capillaries coming out of the alimentary canal, join together to form the **Hepatic portal vein.** This vein takes the digested food material into the liver. From the liver, the Hepatic vein and the inferior or post – caval vein takes them to the heart. Heart distributes them throughout the body. Liver performs some necessary and important actions on the digestive food.

Maximum water absorption occurs from upper part of small intestine passively.

(5) Absorption in colon – Colon absorbs metabolic water form the undigested food. Due to **Haustra** the water-absorbing surface of colon increases and it efficiently increases absorption of water.

(6) Assimilation :

The use of absorbed digested food by the body is termed as **assimilation.** Amino-acids synthesise proteins, which in turn synthesis enzymes and new protoplasm. Glucose fatty-acids and glycerol on oxidation provide energy.

(7) Defaecation –

** The excreta of rabbit is given out of the body in the form of small **Pellets.** The process of removal of undigested food from the body is termed as the **Defaecation.** The process of defaecation is **involuntary** in rabbit**,** thought it is voluntary in most animals.

Symbiotic bacteria found in colon. Bacteria synthesis vitamin-K, B_1 , B_2 ect.

Undigested food goes into rectum where it gets converted into faeces contains – water and solid matter. Solid matter contains dead bacteria 30%, fat 10-12%, proteins 2-4% and others.

These faeces ejected outside through anus.

In the morning the excreta of rabbit is in the form of semi-solid pellets. It has more amount of undigested cellulose in it. Cellulose is a colloid substance, Colloid have the capacity to bind water on their surfaces, so complete absorption of water is not possible in intestine . To completely digest the cellulose rabbit again ingests the semi-solid excreta so again digestion of cellulose takes place in the caecum.

In the evening the excreta of rabbit is in the form of solid, dry pellets. These have less amount of undigested cellulose in them. This nature of rabbit of eat is own excreta is termed as **Coprophagy** or **Caecotrophy** or also **Pseudorumination.** Double Circulation of food through the alimentary-canal is termed as **Caecotrophy**. Food of rabbit mainly consists of cellulose so this activity is necessary for rabbit.

Brown colour of the excreta is due to 2 pigments-**Sterobilin** and **Urobilin.** Both of them are formed due to the degradation of **Bilirubin.** Foul smellof the excreta is due to **Indole, Scatole** and **Typtophan**. CH_4 ,

NH_3 , H_2S. These are found in the colon due to the decomposition of undigested protein by bacteria. Pellets of rabbit don't have a foul smell because it has minimum amount of proteins in its diet. Carnivores have excess protein-rich diet so there is highly foul-smelling.

Calorific Value :

The amount of heat liberated from complete combustion of 1 gm food in a bomb calorimeter (a closed metal chamber filled with O_2) is its gross calorific value or gross energy value (G.C.V.).

The actual amount of energy liberated in the human body due to combustion of 1 gm of food is the physiologic calorific value (P.C.V.) of food.

Food substance	G.C.V. (in K.cal/gm)	P.C.V. (In K. cal/gm)
Carbohydrate	4.1	4.0
Protein	5.65	4.0
Fats	9.45	9.0

Nutritional imbalances and disorders

(i) Balanced diet : The diet which contain the various nutrients in such proportions as can satisfy all the various needs of our body, is called a "balanced diet". The proportion of carbohydrates, proteins and fats into fulfill energy requirement is 4 : 1 : 1 *i.e.* 65% of energy is obtained from carbohydrates and 10–20% each from proteins and fats. This amount of energy is fulfilled by intake of 400–600 gm of carbohydrates, 80–100 gm of proteins and 50–60 gm of fats. The balanced diet must also contain sufficient amount of minerals and vitamins.

(ii) Metabolic rates :

(a) **Basal metabolic rate :** Amount of energy required daily by a person to maintain its basal metabolism and is about 1600 *k cal*/day.

(b) **Routine metabolic rate :** Amount of energy required daily by a person to do his routine work. It is about 2800 k cal/day for males and 2300 k cal for female.

(c) **Active metabolic rate :** Amount of energy required daily by a person to maintain its high metabolic rate during heavy physical work and is about 6000 k cal/day for males and 4500 k cal for females. It has been scientifically determined that a child of 4–6 years approximately requires 1500, a child of 13–15 years requires 2500 and a youth of 16–18 year requires 3000 k cal of energy per day. The average metabolically available energy for each gram of carbohydrate is 4.0 k cal, for proteins is 4.0 k cal and for fats, it is 9.1 k cal.

(iii) Nutritional disorders : Every organism requires an adequate supply of nutrients in proper proportion in their diet for proper growth and development. There are two types of nutritional disorders

(a) Under nutrition (malnutrition)

(b) Over nutrition

(a) Diseases due to deficiency of nutrition (malnutrition)

Name of the Deficiency	Deficient Nutrient	Symptoms
Anaemia (microcytic)	*Fe*	Haemoglobin and number of erythrocytes gets reduced.
Megaloblastic anaemia	Folic acid and B_{12}	Presence of immature erythrocytes in blood.
Pernicious anaemia	Vitamin B_{12}	Immature RBC without Hb. This may be fatal unless treated with vitamin B_{12} injection.
Xerophthalmia	Vitamin *A*	Thickened, keratinised, opaque ulcerated cornea. Prime cause of blindness in India, especially among children.
Night Blindness	Vitamin *A*	Less rhodopsin in rod cells of retina. So no vision in dim light.
Rickets (in children)	Vitamin *D*	Weak, soft, thin bones due to poor deposition of Ca and P. Bent long bones and painful swelling on wrist, elbow and knee joints.
Osteomalacia (adults)	Vitamin *D*	Weak bones of vertebral column, pelvis gets bent and deformed by body weight.
Sprue	Folacin	Ulceration of mouth, inflammation of bowel, indigestion, diarrhoea, weakness.
Pigeons breast	Vit. – D	Incomplete ossification at the end of limb bone, deformed ribs leading to pigeons breast.
Beri – beri	Vitamin B_1 (Thiamine)	Reduces aerobic carbohydrate metabolism. So peripheral nerves inflammed causing pain, numbness and weakness of limb muscles. Paralysis. Fluid accumulation in tissues or oedema of hands and legs. Cardiac oedema.
Scurvy	Vitamin *C*	Fragile blood vessels because of defective collagen fibres in their walls. Bleeding gums, teeth fall, bones fragile. Wound healing delayed, vitamin C recommended in serious injury.
Bleeding disease (Hypoprothrombin anaemia)	Vitamin *K*	Delayed blood clotting (s) so profuse bleeding.
Marasmus	Protein / Malnutrition	Growth and replacement of tissue proteins imparted so emaciated body with their limbs and prominent ribs, dry, thin and wrinkled skin, Diarrhoea.
Kwashiorkor	Protein	Wasting muscles, thin limbs, Retarded growth of body and brain, Oedema, Diarrhoea.
Pellagra	Nicotinamide	Swollen lips, thick pigmented skin of hands and legs. Irritability.
Osteoporosis	*Ca*	Weakning of bones, tooth decay.
Goitre	I_2	Enlargement of thyroid gland.
Muscular cramps	*NaCl*	Pulling of muscles due to dehydration.
Dental cramps	Fluorine	Tooth decay.

Daily Dietary Requirements of Nutrients

(Recommended by Indian Council of Medical Research)

Individual	Total *kcal*	Protein (*gms.*)	Calcium (*gms.*)	Iron (*mgs.*)	Vitamin *A* (*µg.*)	Thiamin (*mgs*)	Riboflavin (*mgs.*)	Niacin (*mgs.*)	Folacin (*µg.*)	Vitamin B_{12} (*µg.*)	Vitamin *C* (*mgs.*)	Vitamin *D* (IU)
(1) Man Moderately active	2800	55	0.4-0.5	24	750	1.4	1.7	19	100	1	40	
(2) Woman	2200	45	0.4-0.5	32	750	1.1	1.3	15	100	1	40	
(i) Moderately active	2700	59	1.0	40	750	1.3	1.5	17	300	1.5	40	
(ii) Pregnant												
(iii) Lactating	2750	70	1.0	32	1150	1.4	1.6	19	150	1.5	80	
(3) Boy (16-18 years)	2820	53	0.5-0.6	25	750	1.4	1.7	19	100	1	40	200
(4) Girl (16-18 years)	2200	44	0.5-0.6	35	750	1.1	1.3	15	100	1	40	200

(b) Diseases due to over nutrition

(1) **Fluorosis :** Caused due to excess of fluorides. It results in tooth and bone decay.

(2) **Obesity :** This is over–nutritional disorder. It is caused when "energy inputs exceeds energy output". It results in deposition of excess fat in the body.

(3) **Constipation :** Slow movement of faeces down the large intestine causes accumulation of dry and hard stool is colon. It is generally caused by irregular bowel habits.

(4) **Diarrhoea :** Rapid movement of faecal matter down the large intestine causes loose stools called diarrhoea. It may be also caused by viral or bacterial infections of intestinal tract, particularly of large intestine and by nervous tension.

(5) **Piles or haemmorhoids :** Enlargement of the anal veins. It may be either hereditary or may be caused due to rapid changes in the diet.

(6) **Hypercholesterolemia :** Caused due to excess of saturated fats like butter, ghee, hydrogenated vegetable oils and eggs etc. It results in increased level of cholesterol in blood, arteriosclerosis, coronary thrombosis, heart attack etc.

(7) **Hypervitaminosis *A* :** It results in loss of appetite, body hairs, painful swelling etc.

(8) **Hypervitaminosis *D* :** It results in deposition of calcium ion in the soft tissues of the body.

Differences between Kwashiorkor and Marasmus

Kwashiorkor	*Marasmus*
(1) It is caused by deficiency of protein in the diet.	(1) It is caused by prolonged deficiency of proteins and calories in the diet.
(2) It commonly affects babies between 1-3 years of age.	(2) It affects infants under one year of age.
(3) Subcutaneous fat persists.	(3) Subcutaneous fat is used up, making ribs very prominent.
(4) Oedema affects legs and face.	(4) No oedema occurs

(5) Skin and hair change colour.	(5) No change in skin and hair colour.
(6) Body becomes under weight.	(6) Body becomes very under weight.
(7) Appetite is reduced.	(7) Appetite is not effected.
(8) Patient needs proteins to recoup.	(8) Patient needs proteins as well as carbohydrates and fats to recover.

REGULATION OF FOOD INTAKE

1. Hunger :

Hunger is defined as the intrinsic (involuntary) desire or craving for food. Hunger is associated with a number of objective sensations. For instance, food deprival for many hours causes intense rhythmic hunger contractions in stomach, which even causes intense pain (hunger pangs) send sensory impulses to a "hunger or feeding centre", located in the lateral regions of hypothalamus.

When glucose levels fall in blood, hunger centre stimulated. Hunger centre transmits impulses to wall of stomach and wall of empty stomach start contraction or hunger pangs. After taking meal satiety centre which located in hypothalamus stimulates and feeding is stopped. During high fever person does not feel like taking meal because high temperature shuts off the appetite centre.

2. Thirst :

Subconscious desire for water is called thirst. It is also induced by a hypothalamic "thirst centre". When amount of water decreases in body fluids (blood, lymph, tissue fluid, cerebrospinal fluid etc.) due to fever, exercise and sweating, copious urination, diarrhoea, etc. This induces the feeling of thirst. Presumably, a fall in glucose level in the blood also induces thirst.

3. Theory of regulation of food intake : They are following –

(a) Neuronal theory : According to this theory, two different type of centers are present in the hypothalamus which regulates hunger. These centre are appetite and satiety. Appetite centre is often used to imply a conscious desire for specific or selected type of food. Interoceptors of stomach wall, stimulated by the muscular contraction, send sensory impulses to the hunger centre located in the lateral region of hypothalamus. Satiety is the conscious sensation of food sufficiency leading to a voluntary cessation of eating. The centre is located in the ventromedian regions of hypothalamus.

(b) Glucostatic theory : When the blood glucose level decreases we feel hungry. It is also caused due to low level of amino acids and fatty acids, and when the level of these substances increases in blood, satiety centre stimulates.

(c) Thermostatic theory : Decrease in body temperature increases hunger due to increased metabolic rate. Conversely, an exposure to heat, or increases in body temperature reduces hunger due to decreased metabolic rate. These conditions are caused by interactions between hypothalmic temperature regulating and food intake–regulating system.

PROTEIN ENERGY MALNUTRITION

1. Kwashiorkor –

- it is a protein deficiency disease.
- it commonly affects infants and children between 1 to 3 year of age.

Symptoms –

Underweight, stunted growth, poor brain development, loss of appetite, anaemia, oedema on lower leg and face.

Cure –

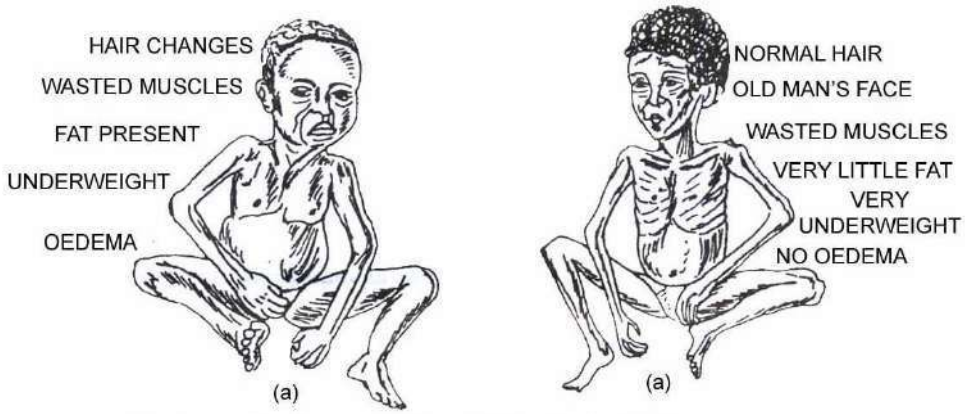
Proteins are necessary for growth, repair of tissue and for body defence therefore adequate amount of proteins must be present in the diet.

Daily requirement –

1 gm protein per kg. body weight in adult.

2 gm protein per kg body weight in growing children.

Sources in food – Cereals pulses, meat, fish, milk, groundnut, peas, leafy vegetables etc.



Two types of inadequate nutrition. (a) Kwashiorkor (b) Marasmus

2. **Marasmus –**

It is caused by Protein-Energy-Malnutrition (PEM) or deficiency of protein and total food caloric value.

Symptoms –

Impairs physical growth, subcutaneous fat diseappears, ribs become very prominent, limbs become thin and skin becomes dry, thin & wrinkled. There is no oedema on leg and face but loss of weight occurs.

Cure –

Diet with adequate proteins and proper caloric value should be given to the infants.

Source in food – Same as kwashiorkor.

3. **Hypercholesterolemia –**

It is caused due to intake of excess of saturated fat such as butter, ghee, red meat, egg. Cholesterol level in blood rises abnormally (hypercholesterolemia) this may cause thrombosis and heart attack.

4. **Obesity –**

It is caused by excessive intake of high caloric nutrients such as sugar, honey and saturated fat. Fat accumulates in the tissue. This may cause high blood pressure, diabetes and heart diseases. Regular exercise and taking of green leafy vegetable are recommended to such persons.

5. **Hypervitaminosis –**

It is caused by excessive intake of vitamin. Such as excess of vitamin D causes deposition of calcium in soft tissue. Excess of vitamin A causes lack of appetite, itching rash etc. Hypervitaminosis of vitamin 'D'- Nausea, anorexia, hypocalcaemia, hyperphosphetemia, calcification of soft tissue.

6. **Fluorosis –**

It is caused by excessive intake of fluorine. It is characterized by mottled (brownish discolouration) teeth.

7. Constipation –

Because of show reaching of excreta into the large-intestine hard and dry excreta deposits in the colon.

8. Diarrhoea –

Fast and rapid removal of excreta from the large-intestine is called Diarrhoea. It may be due to viral or bacterial infection in the intestine.

Types of food relative to their nature of Nutrients and Basic Functions

Major Food	**Nutrient**	**Function**
Sugar, glucose , sugarcane, honey and milk	**Carbohydrates**	
	Sugars	
Wheat, bread, maize, corn, rice and potatoes	Starch	
Butter, sunflower oil, seeds and vegetable oils, nuts, almonds, cheese, liver oils and egg yolk	**Lipids**	
	Fats and oil	**Energetic**
Flesh (meat, chicken, fish), milk, pulses, cereals, egg (albumen and yolk) and cheese	**Proteins**	
	Amino acids	
Table salts, pickles and butter	**Minerals**	
	Sodium	
Table salts, pickles and butter	Chlorine	**Constructive**
Jaggary, banana, date palm and potato	Potassium	
Milk, cheese, curd, fish, eggs, pulses, carrot, cabbage and dark green leaves	Calcium	
Meat, fish, milk, cheese, egg, pulses and cereals	Phosphorus	
Meat, liver, egg-yolk, fish, green leaves, nuts, fig, and pulses	Iron	
Sea-fish, sea-weed, onion and iodised table salt	Iodine	
Cod and shark liver oil, kidneys, egg-yolk, green and yellow vegetables, (carrot, mango, lettuce, cabbage), tomato, yeast, milk and butter	**Vitamins**	
	A (Retinol)	
Whole cereals, dried beans, pork meat, egg-yolk, yeast	B_1 (Thiamine)	
Meat, liver, fish, milk, egg, cheese, legumes and green leafy vegetables	B_2 (Riboflavin)	
Pulses, cereals, meat, liver, fish, intestinal bacteria and yeast (Also synthesized in the human body from the amino acid, tryptaphan)	PP (Pellagra preventing) or nicotinamide	**Protective**
Citrus fruits, vegetables, tomato, and peppers	C (Ascorbic acid)	
Cod and shark liver oil, chicken, egg-yolk, milk, butter, etc. (Also synthesized in human skin in presence of sunlight.)	D (Calciferol)	

VITAMINS

- The study of vitamins is called as vitaminology.
- Vitamins were discovered by "Lunin" **.**
- The term "Vitamin" was given by "Funk" and "Hopkins" (B_1 from unpolished rice – 1912)
- Vitamins are micronutrients, biological regulators and metabolic regulators (Vitamin theory)
- Vitamins are important to maintain health, but cannot synthesize in the body.
- Earliest known vitamin - vitamin 'C' (James Lind – Scottish naval surgeon – 1747.)
- Earliest extracted vitamin = Vitamin - B_1

Vitamins are following types –

(1) Fat soluble

(2) Water soluble vitamin

1. FAT – SOLUBLE VITAMIN

Vitamin- 'A' (Retinol) –

- Can be synthesized in liver from yellow and red carotenoid pigment.
- It is also known as anti-infectious and anticancer vitamin.
- It is also known as anti-xeropthalmic vitamin.
- Isomer of vitamin 'A' are –
- (i) A_1 – Retinol for vision.

  (ii) A_2 – Dehydro retinol which is essential for epithelial lining of glands and tear production. It is essential for growth and epithelical cell division.

Deficiency diseases –

(1) Night blindness – Due to deficiency of A_1

It is also known as Nyctolopia (Inability to see in dark)

(2) Xeropthalmia – due to deficiency of A_2

Tear formation is absent.

In this disease conjunctiva & cornea become dry due to keratinzation of conjunctiva & cornea .

It is the main problem of blindness in children throughout the world.

Source – Good source is carrot, other sources are Guava, papaya, mango, spinach etc.

(3) Vitamin – ''D'' (Calciferol)

It is also known as "Sunshine vitamin" or "Anti Ricket" vitamin.

Synthesized in skin from cholesterol by UV light.

It is necessary for bone & teeth.

It regulates the absorption of calcium & phosphorous.

It organize the calcium in bone and teeth.

Deficiency diseases –

Rickets in children and osteomalacia in adult.

Source – Good source cod liver oil and shark liver oil for both 'A & 'D', Other sources are meat, liver, egg, milk etc

Vitamin 'E' (Tocopherol) –

- It is also known as "antisterility" vitamin or "beauty"' vitamin.
- This vitamin removes scar & wrinkles from skin.
- It is essential for gametogenesis, pregnancy and muscular work.
- It maintains the cell membrane of RBCs.

Deficiency diseases – Sterility, Fragile anaemia.

Source – Egg, meat, cotton, seed oil.

Vitamin 'K' (Naphthoquinone) –

- It is alos known as "antihaemorrhagic" vitamin.
- Essential for synthesis of prothrombin.

Menadione is the important source of the synthetic vitamin K.

Deficiency diseases – Bleeding or delayed blood clothing. (Hypoprothrombinemia).

Source – Carrot, tomato, liver, cabbage etc.

2. WATER – SOLUBLE VITAMIN

Vitamin B_1 (Thiamine) –

- It is also known as "anti beri-beri" factor or antineuritic factor.
- Beri-Beri affects peripheral nervous system, alimentary canal & cardiovascular system.
- It is essential for formation of coenzyme carboxylase in carbohydrate and amino acid metabolism.

Deficiency disease – Beri-Beri, Wernicke's encephalopathy. Anorexia, constipation, weak-Heart best muscle catrophy.

Source – Rice, wheat, egg and fish etc.

Vitamin B_2 (Riboflavin)

- It is also known as vitamin "G" or lactoflavin or yellow enzyme.
- It is essential for formation of FMN & FAD.
- It maintain the oral epithelial lining.

Deficiency Diseases – Cheliosis (Cracked lips at the corner of mouth) sore mouth and ulceration, digestive disorder, Pellagra like, beri-beri like.

Source – Cow's milk, egg, liver, yeast etc.

Vitamin B_3 (Niacin or Nicotinic acid) –

It is also known as "antipellagra" factor or vitamin PP (Pellagra preventing factor)

It forms essential component of NAD & NADP.

It maintains the epithelial lining of lumen of alimentary canal.

Deficiency Diseases – Pellagra in human beings (diarrhoea, dermatitis, dementia) and black tongue (hyper pigmentation) disease in dogs.

Source – Kidney, liver, milk, yeast, egg etc.

Vitamin B_5 (Pantothenic acid) – greek work pantothen = everywhere

– It is also known as yeast factor or chick antidermatitis factor.

– It is help in formation of acetylcholine and co enzyme A. It regulated the secretion of steroid hormones.

Deficiency Diseases – Burning feet syndrome, fatigue & paralysis of muscles.

Source – Liver, meat, yeast, milk, egg, meat etc.

Vitamin B_6 (Pyridoxine)

Function as co-enzyme. It is also known rat **antidermatitis factor.**

Deficiency diseases – Dermatitis, Anaemia, nervousness.

Source – Liver, meat, yeast, egg etc.

Vita B_7 (Biotin)

It is also known as vitamin 'H' or antiegg white injury factor (egg white contain avidin protein which is antagonist to vit. B_7) – Dermatitis, hair loss, nervous symptom).

It is essential for fat synthesis and energy production

Deficiency Diseases – Dermatitis

Source – Vegetables, yeast, wheat egg etc.

Vitamin B_{12} (Cyanocobalamine) – Extrinsic factor of castle

It is also known as " antipernicious anaemic" factor or " RBC maturing" factor

It promotes DNA synthesis & Maturation of RBCs.

Deficiency Diseases – Pernicious anaemia.

Source – meat, liver etc.

Folic Acid –

It is also known as folacin or Vitamin M.

It is needed for formation of RBC & synthesis of DNA

Deficiency disease – Anaemia.

Source – green foliage of plant – cabbage, cauliflower.

Vitamin ' C' (Ascorbic Acid)

It is also known as **'' anti-scurvy''** or anti-viral, anti-cancer vitamin.

It is necessary for healing of the wound and formation of collagen fibre

Deficiency disease – Scurvy (deficient formation of collagen fibres).

Source-Amla, Tomato, orange, Guava, Lemon (citrus fruit).

Fat Soluble Vitamin				
Name of vitamins and chemical formula	**Vitamin K** or Phylloquinone or anti haemorrhagic vit-amin $C_{31}H_{46}O_2$	**Vitamin E** or α Tocopherol or anti sterility vitamin $C_{29}H_{50}O_2$	**Vitamin D** or Ergocalciferol or sunshine vitamin or anti rachitic vitamin $C_{28}H_{44}O$	**Vitamin A** or **Retinol** or anti xero-phthalmic or anti infection vitamin $C_{20}H_{20}O$
Discovery	Dam and Droisy **(**1935**)**	Evan and sore **(**1922**)**	Steenbock and Hess 1924**)**	Mc-Collumn and Davis (1913)
Sources	Fresh green vegetables. to matoes, liver, soyabean, cheese, egg.	Fresh green vegetables, meat, yolk, vegetable oils, butter and cheese, peanuts	Cod liver oil, butter, fish, eggs, milk, brain, lung, and spleen.	Vegetables butter liver oils egg yolk, mango and orange, carrot.
Daily requirement per day	0.07 – 0.14 mg	20 mg	0.01 mg	2 mg
Functions	Synthesis of prothrombin for normal clotting of blood.	Antioxidant and some role in ETS.	Facilitates absorption of calcium and phosphorus by intestine and their retention in body and deposition in	Part of visual pigment, maintenance of epithelia and prevention of keratini-zation of epithelium.
Name of Deficiency Disease	Haemorrhage	Anaemia Sterility Muscular atrophy	Rickets in children Osteomalacia in adults.	Xerophthalmia Night blindness or nyctalopia Keratomalacia. Dermatosis
Symptoms	Reduced ability of blood to clot and also leads to haemorrhages.	Destruction of RBC. In male causes sterility and in female abortion may occur of offspring. Effect not proved in man.	Deformities of bones like bowlegs pigeon chest Weak bones liable to easy fracture	– Drying of eyeball – Unable to see in dim light – Epithelium keratinised – Dry scaly skin
Other Features	Vitamin K is synthesised by intestinal microbes present in the intestine. Destroyed by–prolonged use of antibiotics.	Destroyed by UV – rays. It is also used for curing tumour and cancer	Synthesized in the body on exposure of skin (7-hydroxy cholesterol) to light. Destroyed by – oral contraceptives	Synthesized and stored in the liver. Destroyed by - strong light.

Vitamin B_3 Yeast factor or pantothenic acid or anti graying factor on chick antidermatitis factor $C_9H_{17}O_5N$	**Vitamin** B_2 or G or yellow enzyme or Riboflavin or Lactoflavin or $C_{17}H_{26}N_4O_6$	Vitamin B_1 or Thiamine or anti neuritic or antiberiberi $C_{12}H_{16}N_4SO$	**Name of Vitamins and Chemical Formula**
Williams **(**1933**)**	Warburg and Christain	C. Funk **(**1926**)**	**Discovery**
All foods, more in yeast, kidney, liver, egg, meat, milk, ground nut	Cheese, egg, yeast, meat, liver, cereals, green, vegetable.	Branrice, whole wheat flour, egg, meat, liver yeast etc.	**Sources**
5-10 mg	1-2 mg	1-1.5 mg	**D.R.**
Part of co-enzyme A. needed for cell respiration, necessary for normal skin and nerves.	Required for cell growth. Form pair of coenzyme (FMN, FAD).	Act as co-enzyme in cellular respiration, role in nutrition of nerve cells. Essential for carbohydrate metabolism, protein synthesis and control water balance in body.	**Function**
Burning feet syndrome, Nervous disorder	Cheilosis Glossitis Keratitis	Beri- beri – or Dry beri - beri (man) Polyneuritis or (animals) wet beri - beri Cardiovascular atrophy	**Name of Deficiency Disease**
Nerve degeneration	Cracking of skin at corners of mouth Inflammation of tongue Inflammation of skin	Loss of appetite and weight, retarded growth, muscular dystrophy. Nerves to become extremely irritable. Heart enlargement	**Symptoms**
It occurs in all types of plants and animal tissues. Its deficiency cause graying of hair	Stored in liver, Excess of this is eliminated in urine. It is associated with the physiology of vision	Beri-beri disease was discovered by Eijkman Destroyed by – cooking	**Other Features**

Folic Acid or Vitamin M or folacin or Anti anaemic factor	**Vitamin H** or **B_7** or Biotin or coenzyme R or Avidin $C_{10}H_{16}N_2O_3S$	**Vitamin B_6** or pyrido-xine or Rat anti dermat-ities factor $C_8H_{11}O_3N$	**Vitamin** B_5 or Niacin or Nicotinic acid or pellagra preventing factor $C_6H_5NO_2$
Day **(**1935**)**	Bateman and Allison **(**1916**)**	Gyorgyi **(**1928**)**	Goldberger (1912)
Green vegetable (spinach) Banana, orange and Liver.	Yeast, vegetables and egg yolk	Brewer's yeast, liver, egg, yolk, kidney, milk, and vegetables.	Fresh meat, liver, fish, milk, cereals, pulses, yeast etc.
0.4 mg	150-300 mg	2 mg	16-20 mg
It forms coenzymes and play essential role in cell metabolism, Necessary for erythropoiesis, required for DNA synthesis.	It acts as coenzymes and essential for fat synthesis and energy production.	It is essential component of coenzyme pyridoxal phosphate. It promotes growth in rats used for curing tuberculosis.	It is an essential component of NAD and NADP thus form coenzymes, metabolism of carbohydrates, functioning of gastrointestinal tract and nervous system
Megaloblastic anaemia. Sprue	Dermatitis	Anaemia Dermatitis, paralysis & death of rats. Mental disorder Dermatitis	Pellagra, Dermatitis, Diarrhoea Dementia Death (4-D syndrome)
Enlarged RBCs Ulceration of mouth	Scaly and itchy skin	Nausea, lack of RBC (blood) Disturbance of central nervous system Skin leisons	Rough skin Inflammation of skin which becomes scaly and papillated Dehydration Neural deterioration which may lead to madness
It is also synthesized by intestinal bacteria Destroyed by - cooking	It is synthesized by intestinal bacteria Destroyed by – prolonged use of antibiotics	Term B_6 was coined by Gyorgy. Destroyed by – cooking and oral contraceptives	It is characterised by 3D's *i.e.* dermatitis diarrhoea and dementia Destroyed by – cooking Pellagra preventing factor Goldberger also called Goldberger's p-p factor It is also synthesized by colon bacteria

Vitamin C or Ascorbic Acid $C_6H_6O_6$	Szent Gyorgyi (1928)	Citrus fruits such as lemon, mango, amla, plumes, guava.	40-60 mg	Functions as part of oxidation-reduction system. Helps in secretion of collagen cement dentine. Helps body to develop resistance to diseases. Helps in absorption of Ca and Fe in the intestine. Wound healing.	Scurvy.	Spongy and bleeding gums, fragile blood vessels and bones.	Required by primates, all other vertebrates and some other invertebrates can synthesize vitamin C. It is the earliest known vitamin. It is wound healing vitamin. Destroyed by – Heating
Vitamin B_{12} or Cyanocobalamine or Animal protein factor (APF) or Intrinsic factor of castle $C_6H_6O_{14}N_{14}PCO$	Rickets (1948)	Meat, egg, liver, fish, synthesized by intestinal bacteria.	0.003 mg	Required for chromosome duplication and formation of blood corpuscles.	Pernicious anaemia	Reduced formation of erythrocytes in bone marrow	It is also known as anti pernicious factor Also synthesized by intestinal bacteria in human colon Destroyed by– excessive heat

Name of Vitamin	Function	Symptoms of deficiency
Inositol or mouse antialopecia factor	Stimulate growth of mice. Spectacle-eye condition in rat can be treated keep a limit on the cholesterol level in the blood of man.	Causes reduced growth and alopecia (loss of hair) in the mice. Also causes hemorrhagic degeneration of the adrenal gland.
Choline	It is an important lipotropic factor which prevent excessive development of fatty liver. It takes part in the formation of acetylcholine which involved conduction of nerve impulse.	Chronic deficiency causes cirrhosis in the liver also causes haemorrhagic changes in kidney.
Vit.P or citrin	Control the permeability and fragility of the capillary wall to plasma protein.	Its deficiency causes subcutaneous bleeding due to break down of capillary walls.

POINT TO REMEMBER

1. Spoil hay of Sweet clover (melilotus indica) (Fodder and green manure) contains a substance called dicumarol. Dicumarol prevents the action of vitramin 'K'.
2. Non-secretion of HCl is called as achlorhydria condition.
3. Chalogogues are substances which cause. The contraction of gall bladder.
4. Choloretic are substances which increase bile juice from liver.
5. "Achalasia Cardia" condition is characterized by failure of cardiac sphincter to relax completely on swallowing causing accumulation of food in oesophagus and proximal oesophagus dialates.
6. One pair of vomerine teeth is found in the palate of frog.
7. Fangs are the poison teeth of snakes, these are the maxillary teeth.
8. Upper incisor teeth are modified in tusk in elephant.
9. Upper canine teeth are modified in tusk in walrus.
10. Homodont type dentition are found in toothed whale.
11. Enamel is absent in sloth and Armadillo.
12. Salivary glands are absent in whale.
13. The tongue is non-motile in whale.
14. Gall bladder is absent in lemprey, whale, rat and horse.
15. The main pancreatic duct is also known as **duct of wirsung** while accessory pancreatic duct is known as **duct of santorini.**
16. Citrin is also known as vitamin 'P' and controls vascular permeability.
17. Vitamin B_{17} – It is recently discovered anticancer vitamin.
18. Vitamin Q – helps in blood clotting.
19. Vita B_{15} – It is also known as pogonic acid, deficiency causes disorder in liver.
20. Vitamin B_6 also used in the treatment of tuberculosis.
21. Thecodont teeth are also found in crocodile.

Comparative Study of digestive system of Rabbit & Human

Rabbit	Human
1. It is herbivorous animal, depends cellulose based food.	It is omnivorous, and depends on vegetarian and non-vegetarian food.
2. A small cleft is present in mid part of upper lip.	Cleft is absent.
3. Canine teeth are absent.	Canine teeth are present.
4. Dental formula : $i-\frac{2}{1}c\frac{0}{0}pm\frac{3}{2}m\frac{3}{3}\times 2=28$	Dental formula : $i-\frac{2}{2}c\frac{1}{1}pm\frac{2}{2}m\frac{3}{3}\times 2=32$
5. Infraorbital, Parotid, Sublingual and Submaxillary glands are present.	Parotid, Sublingual, Submaxillary glands are present but infraorbital is absent.
6. Caecum and Vermiform appendix are present where digestion of cellulose takes place.	Caecum & Vermiform appendix are vestigeal.
7. Rectum is beaded.	Rectum is non-beaded.
8. Faeces are ejected outside in form of pelletes.	Faeces are ejected out side in form of semi solid stool.
9. Coprophagy nature is present.	Coprophagy nature is absent.

EXERCISE - 1

Q.1 Gastric juice contains which of the following enzymes

(1) Pepsin and renin

(2) Amylase & pepsin, and lipase

(3) Amylase & pepsin

(4) Insulin & glucagon

Q.2 Which of the following kinds of papilla (taste buds) occur over the tip of tongue of Rabbit-

(1) Fungiform and fili form

(2) Circumvallate

(3) Circumvallate

(4) Foliate

Q.3 Absorption of a solution against a concentration gradient by the intestinal epithelium is accompanied by

(1) Osmotic pressure

(2) Active transport

(3) Brownian movement

(4) Donanum equilibrium

Q.4 Which of the following teeth appear only once in the life of a man-

(1) Incisors (2) Canines

(3) Premolars (4) Molars

Q.5 Hydrolysis of phospholipids yields

(1) Glycerol, phosphoric acid and fatty acids

(2) Glycerol, phosphoric acid and nitrogen base

(3) Glycerol & fatty acids

(4) Acetyl Co A

Q.6 The food that gives more calories per unit mass of food is

(1) Protein (2) Carbohydrates

(3) Fat (4) Water

Q.7 Which is the element that hardens the tooth enamel ?

(1) Calcium (2) Fluorine

(3) Iodine (4) Sodium

Q.8 Canine teeth are absent in rabbit because it is-

(1) Herbivorous (2) Carnivorous

(3) Omnivorous (4) Saprophytic

Q.9 The secretions that mix with food in the small intestine are

(1) Saliva, gastric juice & bile

(2) Gastric juice, bile & pancreatic juice

(3) Bile, pancreatic juice & intestinal juice

(4) Pancreatic juice, intestinal juice and gastric juice

Q.10 Essentially the work digestion means

(1) Breaking food for energy

(2) Building of proteins from amino acids

(3) Changing organic molecules

(4) Breaking complex organic molecules into smaller ones

Q.11 Which of the following part in Rabbit have hare lip or cleft lip

(1) Lower lip (2) Upper lip

(3) Both of these (4) None of these

Q.12 When teeth are different in shape, size & function then these are called

(1) Acrodont (2) Pleurodont

(3) Homodont (4) Heterodont

Q.13 Dental formula of Rabbit is

(1) $\frac{2}{2}\frac{1}{1}\frac{2}{2}\frac{3}{3}$ (2) $\frac{1}{1}\frac{0}{0}\frac{2}{1}\frac{4}{3}$

(3) $\frac{2}{1}\frac{0}{0}\frac{3}{2}\frac{3}{3}$ (4) $\frac{1}{1}\frac{0}{0}\frac{2}{0}\frac{0}{3}$

Q.14 The incisor teeth are meant for

(1) Biting & cutting

(2) Mulching

(3) Munching and chewing

(4) Chewing

Q.15 The enormously long tusks in elephant are-

(1) Upper incisors (2) Upper canines

(3) Lower canines (4) Lower incisors

Q.16 How many teeth in man are monophyodont ?

(1) 4 (2) 12

(3) 22 (4) 32

Q.17 In Rabbit incisor teeth keep on growing because of

(1) Persistence open pulp cavity

(2) Open apical pore

(3) Constant division of odontoblasts

(4) All of the above

Q.18 Due to the absence of canines in Rabbit a gap is left in between incisor and premolar teeth, it is called

(1) Dental lamina (2) dental groove

(3) Diastema (4) Dental cavity

Q.19 Which of the following food reserves would be first used in a starving person-

(1) Muscle proteins (2) Skin adipose tissue

(3) Liver glycogen (4) Liver proteins

Q.20 The digestions of starch in alimentary canal of human starts in

(1) Buccal cavity (2) Ileum

(3) Stomach (4) Duodenum

Q.21 Which of the following substance can be assimilated unchanged

(1) Vitamin (2) Starch

(3) Proteins (4) Lipids

Q.22 Root of tooth contains all the following except-

(1) Cementum (2) Enamel

(3) Dentine (4) Pulp cavity

Q.23 Which of the following part of gut does not posses mesentery ?

(1) Jejunum (2) Ileum

(3) Appendix (4) Ascending colon

Q.24 Which is true about parotid gland ?

(1) Stenson's and Wharton's ducts join and open at upper 2nd molar

(2) Stenson's duct open opposite upper 2nd molar

(3) Parotid duct pierces master

(4) Developed from mesoderm

Q.25 Oxyntic cells are found in-

(1) Kidney and secrete renin

(2) Gastric epithelium and secrete HCl

(3) Gastric epithelium and secrete pepsin

(4) Islets of langerhans & secrete glucagon

Q.26 Which of the following is not a salivary gland

(1) Brunner's gland (2) sublingual gland

(3) Submaxillary gland (4) Parotid gland

Q.27 Maltose on digestion gives

(1) Two molecules of glucose

(2) One molecule of glucose and fructose

(3) Two molecules of fructose

(4) One molecule of glucose and galactose

Q.28 The foul smell of faeces is due to

(1) Skatol, Indole (2) Ammonia

(3) Small and large intestine

(4) Methyl mercaptan

Q.29 Maximum ammonia is formed during metabolism in

(1) Stomach (2) Liver

(3) Large intestine (4) Small intestine

Q.30 The main purpose of large intestine is to absorb

(1) Alcohol (2) Water

(3) Fatty acids (4) Disaccharides

Q.31 Hydrolysis of lactose yields

(1) Glucose and fructose

(2) Glucose and galactose

(3) Fructose and galactose

(4) Glucose and xylose

Q.32 Pepsin differ from trypsin in that it digests-

(1) Protein in alkaline medium in stomach

(2) Protein in acidic medium in duodenum

(3) Protein in acidic medium in stomach

(4) Protein in alkaline medium in duodenum

Q.33 Man cannot digest cellulose but cow and other herbivorous animals can take food containing cellulose because-

(1) They have enzyme cellulase in their stomach

(2) They masticate it well by chewing teeth

(3) They have bacteria in their alimentary canal which digest cellulose

(4) None of the above

Q.34 Enzyme responsible for coagulating milk in stomach of calves-

(1) Lactase (2) Trypsin

(3) Rennin (4) Pepsin

Q.35 The receptors for the bitter taste on our tongue are located on its
(1) Posterior portion (2) Middle part
(3) Lateral portion (4) Tip part

Q.36 Pseudormination is a process of
(1) Eating own faeces
(2) Egesting faecal matter
(3) Swallowing the bolus
(4) Chewing the regurgitated food

Q.37 Which of the following acts both as an endocrine as well as exocrine glands
(1) Thymus (2) Ovary
(3) Pancreas (4) All of the above

Q.38 Gastric glands are
(1) Simple tubular
(2) Simple coiled tubular
(3) Branched tubular
(4) Compound tubular

Q.39 Referred pain of gall bladder is felt at the tip of-
(1) Left shoulder (2) Right shoulder
(3) Sternum (4) Cystic duct

Q.40 Jaundice may be caused by retarded function of-
(1) Lungs (2) Liver
(3) Heart (4) Kidneys

Q.41 Which cells of liver act as phagocytes ?
(1) Acinar cells (2) Kupffer cells
(3) Hansen's cells (4) Dieter's cells

Q.42 Dentition of most of the mammals is
(1) Heterodont (2) Diphyodont
(3) Thecodont (4) All of the above

Q.43 The normal method of feeding in Rabbit is called
(1) Gnawing (2) Rumination
(3) Pseudo rumination (4) Coprophagy

Q.44 Which of the following substances is most quickly absorbed by buccal cavity
(1) Alcohol (2) Morphine
(3) Sugar (4) Salts

Q.45 Crypts of Lieberkuhn are the examples of which kind of glands
(1) Simple coiled tubular
(2) Simple alveolar
(3) Tubular alveolar
(4) Compound tubular

Q.46 Duct of Santorini is-
(1) Accessory pancreatic duct
(2) Main pancreatic duct
(3) Parotid duct
(4) Bile duct

Q.47 If liver becomes functionless, percentage of which will increase in blood ?
(1) Uric acid (2) Ammonia
(3) Urea (4) Proteins

Q.48 Surgical removal of gall bladder in Rabbit would lead to
(1) Jaundice
(2) Impairment of digestion of fats
(3) Increased acidity in the intestine
(4) Stop the process of glycogenesis in liver

Q.49 Sacculus rotundas is found at the junction of
(1) Oesophagus & stomach
(2) Small & large intestine
(3) Ileum, colon & caecum
(4) Duodenum & ileum

Q.50 The liver lobe is an aggregation of
(1) Glisson's capsules (2) Lobules
(3) Lobes (4) Hepatic chords

Q.51 Food and air passages in buccal cavity are separated by
(1) Palate (2) Tongue
(3) Upper jaw (4) None of the above

Q.52 Right and left lobes of human liver are separated by falciform ligament. The right lobe is differentiated into-
(1) Right lobe proper (2) Quadrate lobe
(3) Caudate lobe (4) All of these

Q.53 A common site of gall stones is-
(1) Cystic duct
(2) Ampulla of gall bladder
(3) Fundus of gall bladder
(4) Hepatic duct

Q.54 Assimilation of food takes place in
(1) Stomach (2) Ileum
(3) Duodenum (4) Body tissues

Q.55 In people addicted to alcohol the liver gets damaged because liver
(1) Has to detoxify the alcohol
(2) Is over stimulated to secrete bile
(3) Stores much glycogen
(4) Accumulates excess fats

Q.56 Wharton's ducts are associated with
(1) Salivary glands (2) Caecum
(3) Sacculus rotandus (4) Colon

Q.57 Stenson's ducts carry saliva from which salivary glands
(1) Infra orbital (2) Parotid
(3) Sub lingual (4) Sub maxillary

Q.58 Jacobson's organ in Rabbit is located
(1) On the floor of buccal cavity
(2) On the roof of buccal cavity
(3) Inside nasopalatine ducts
(4) Over the tongue

Q.59 Caecum is meant for
(1) Digestion of cellulose
(2) Digestion & absorption of cellulose
(3) Storage of fats
(4) Storage of faecal matter

Q.60 The movement in the alimentary canal is known as-
(1) Systole (2) Diastole
(3) Peristalsis (4) Metachronal

Q.61 The human intestine is long because-
(1) Bacteria in food can be killed gradually
(2) It provides more space for food storage
(3) It increases surface area for absorption of food
(4) None of the above

Q.62 Outer most layer of crown part of a tooth is
(1) Dentine (2) Enamel
(3) Cement (4) Pulp

Q.63 Gall bladder of Rabbit is located in which lobe of liver
(1) Right central lobe (2) Left central lobe
(3) Caudate lobe (4) Spigelian lobe

Q.64 Kupffer's cells are found in
(1) Pancreas (2) Liver
(3) Kidney (4) Spleen

Q.65 Teeth forming cells are called
(1) Chondroblasts (2) Osteoblasts
(3) Odontoblasts (4) Osteoclasts

Q.66 The sphincter of Boyden surrounds the-
(1) Opening of the bile duct before it is jointed with the pancreatic duct
(2) Opening of the hepatopancreatic ampulla into the duodenum
(3) Opening of the pancreatic duct into the hepatogen creatic ampulla
(4) Opening of the accessory pancreatic duct into the duodenum

Q.67 Digestion of proteins is necessary because-
(1) Proteins are not absorbed as such
(2) Proteins are large molecules
(3) Proteins have complex structure
(4) Proteins are made up of amino acids

Q.68 Which one of the following does not aid in increasing surface area in the small intestine ?
(1) Plicae circularis (2) Taenia coli
(3) Villi (4) Microvilli

Q.69 Three longitudinal muscular bands found in the wall of colon are called
(1) Haustra (2) Taeniae
(3) Beads (4) Acini

Q.70 Largest gland found in the body of Rabbit is
(1) Spleen (2) Liver
(3) Pancreas (4) Sebum

Q.71 The secretory units of pancreas are called
(1) Alveoli (2) Acini
(3) Crypts (4) Lobules

Q.72 The toxic substances of diet are detoxified in body by
(1) Stomach (2) Liver
(3) Spleen (4) Kidney

Q.73 Drowsiness after a heavy meal is due to-
(1) Increased blood pressure
(2) Decreased pulse rate
(3) Reduced blood pressure
(4) Increased pulse rate

Q.74 Deficiency of calcium causes-
(1) Rickets (2) Scurvy
(3) Gigantism (4) Addison's disease

Q.75 Which of the following minerals is responsible to control our heart beat-

(1) Sulphur (2) Sodium

(3) Potassium (4) Iron

Q.76 The centre of liver lobule is formed by

(1) Portal vein (2) Hepatic artery

(3) Bile duct (4) Intralobular vein

Q.77 The portal tract or radical or canal is composed of

(1) Central vein, portal vein and hepatic artery

(2) Central vein, bile duct, lymphatics & artery

(3) Portal vein, hepatic artery, bile duct & lymphatics

(4) Arteries, veins & bile ducts

Q.78 The sinusoids found between radical cords of hepatic cells connect

(1) Portal vein to hepatic artery

(2) Hepatic artery & Portal vein to the intralobular vein

(3) Central vein to the bile duct

(4) Hepatic artery to bile duct

Q.79 Deficiency of Riboflavin causes-

(1) Beri-beri

(2) Cheilosis

(3) Pellagra

(4) Megaloblastic anaemia

Q.80 Most important property of water for which it is needed in the body is-

(1) It is tasteless, colourless and odourless

(2) It is a universal solvent

(3) It is a liquid

(4) Its O_2 is used in cellular metabolism

Q.81 Xerophthalmia in children and nyctalopia (night blindness) in adults is caused by the deficiency of vitamin-

(1) A (2) D

(3) E (4) K

Q.82 Liver sinusoids are lined by

(1) Kupffer's cells (2) Paneath's cells

(3) Peyer's patches (4) Goblet cells

Q.83 Peyer's patches manufacture

(1) Erythrocytes (2) Lymphocytes

(3) Mucous (4) Digestive enzymes

Q.84 The enzyme invertase converts

(1) Lactose into glucose & galactose

(2) Sucrose into glucose & fructose

(3) Maltose into glucose

(4) Starch into maltose

Q.85 Enzymes in the body of Rabbit occur

(1) Only in pancreas (2) Only in liver

(3) Almost in all cells (4) Only in kidney

Q.86 Secretin is

(1) An enzyme (2) A hormone

(3) A vitamin

(4) An excretory product

Q.87 Pellagra is caused due to deficiency of vitamin-

(1) Thiamine

(2) Calcified

(3) Nicotinic acid (Niacin)

(4) Ascorbic acid

Q.88 Which of the following pair is characterized by swollen lip, thick pigmented skin of hands and legs and irritability ?

(1) Thiamine – Beri beri

(2) Protein – Kwashiorkor

(3) Nicotinamide – Pellagra

(4) Iodine – Goitre

Q.89 Vitamin containing cobalt is-

(1) A (2) B_1

(3) B_6 (4) B_{12}

Q.90 Inner most surface of small intestine of Rabbit has

(1) Only epithelial tissue

(2) Only muscular tissue

(3) Both of the above

(4) Muscles & connective tissue

Q.91 Dental formula of Homo sapiens is

(1) $\frac{2}{2}\frac{1}{1}\frac{2}{2}\frac{3}{3}$ (2) $\frac{2}{1}\frac{1}{1}\frac{1}{1}\frac{3}{4}$

(3) $\frac{2}{2}\frac{1}{1}\frac{2}{2}\frac{4}{3}$ (4) $\frac{1}{1}\frac{2}{2}\frac{3}{2}\frac{3}{3}$

Q.92 Glycogen is stored in Rabbit's body in

(1) Muscles only

(2) Liver cells only

(3) Muscles & spleen

(4) Liver & muscle cells

Q.93 If the intake of food in Rabbit is more than its energy use, it will be deposited in the form of
(1) Proteins (2) Fats
(3) Glycogen (4) Fats & glycogen

Q.94 In digestion of food some energy is produced in the form of
(1) Kinetic energy (2) Potential energy
(3) Heat (4) Radiant energy

Q.95 Hormone responsible for initiating the secretion of pancreatic juice is
(1) Enterogastrones (2) Cholecystokinin
(3) Secretin & pancreozymin
(4) Gastrin & pancreozymin

Q.96 Scurvy which is caused by the lack of vitamin C is characterised by-
(1) Nervous disorders
(2) Haemorrhage in the gums
(3) Intestine disorders
(4) Malfunction of kidney

Q.97 Antihaemorrhagic vitamin is also known as-
(1) Vitamin A (2) Vitamin B
(3) Vitamin E (4) Vitamin K

Q.98 Lamina propria is
(1) A connective tissue component of mucosa
(2) An epithelium
(3) A fibrosa
(4) A connective tissue component of muscular is mucosae

Q.99 Salivary secretion in Rabbit is controlled by
(1) Reflex action (2) Hormones
(3) Pressure (4) Will power

Q.100 Glisson's capsules in Rabbit are present
(1) In cortex of kidney
(2) In seminiferous tubules
(3) Between two adjacent hepatic lobules
(4) Between two adjacent hepatic lobes

ANSWER KEY

EXERCISE - 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	2	3	1	3	2	1	3	4	2	4	3	1	1	2	4	3	3	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	2	4	2	1	1	1	2	2	2	3	3	3	1	1	3	1	1	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	4	1	2	4	1	2	2	2	2	1	4	1	4	1	1	2	3	1	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	2	1	2	3	1	2	2	2	2	2	2	3	1	2	4	3	2	2	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	1	2	4	3	2	3	1	4	1	1	4	4	3	3	2	4	1	1	3

EXERCISE - 2

Q.1 Cannibals feed on-
(1) Carcases
(2) Blood
(3) Carnivores
(4) Member of own species

Q.2 Detrivores are-
(1) Parasite
(2) Blood sucking
(3) Feeding on decaying organic matter
(4) Feeding on living

Q.3 Which of the following process does not occur when glucose is eaten-
(1) Ingestion (2) Digestion
(3) Absorption (4) Assimilation

Q.4 Two roots are found in which kind of teeth-
(1) Incisors (2) Canine
(3) Premolar (4) Molar

Q.5 Histiocytes found in liver sinusoids, lymphoid tissue and bone marrow of Rabbit are functionally-
(1) Degenerative (2) Regenerative
(3) Connective (4) Phagocytic

Q.6 The secretion of liver consists of -
(1) No enzymes and no hormones
(2) Digestive enzymes
(3) Hormones
(4) Succus entericus

Q.7 Transverse rugae occur on -
(1) Hard palate (2) Soft palate
(3) Tongue (4) Stomach

Q.8 Bunodont teeth occur in-
(1) Elephant (2) Giraffe
(3) Horse (4) Humans

Q.9 Secretion of gastro- intestinal juices and movements after ingestion are mostly controlled by-
(1) Brain
(2) Sympathetic
(3) Hormones
(4) Parasympathetic nerves

Q.10 Acidic medium of stomach is due to-
(1) Gastric juice (2) Bile
(3) Saliva (4) None of these

Q.11 Normally in ruminants the stomach has four chambers, but in camel, which of the following chamber is missing-
(1) Reticulum (2) Rumen
(3) Ommasum (4) Abomassum

Q.12 Little fluoride is added to drinking water to strengthen our-
(1) Bones (2) Teeth
(3) Muscles (4) Hair

Q.13 In which part of Rabbit's stomach digestion occurs mainly-
(1) Cardiac (2) Pyloric
(3) Fundic (4) All of the above

Q.14 Chewing of food is regarded good for digestion because-
(1) Enzymes only act on grinded food
(2) It increases the time and surface area of exposure to enzymes
(3) Enzymes are only activated during chewing
(4) Chewing mixes food well with enzymes

Q.15 Intracellular digestion occurs in-
(1) Sponges (2) Molluscs
(3) Insects (4) Vertebrates

Q.16 Extracellular digestion takes place in-
(1) Amoeba (2) Sycon
(3) Paramecium (4) Man

Q.17 The teeth which bear transverse ridges on the are called-
(1) Thecodont (2) Lophodont
(3) Diphyodont (4) Pleurodont

Q.18 In rabbit cellulolytic bacteria are found in-
(1) Caecum (2) Colon
(3) Rectum (4) Ileum

Q.19 Find out the correct sequence of enzyme, substrate & end product-
(1) Peptidases – Proteins – Amino acids
(2) Peptidases – Glycogen – Amino acids
(3) Trypsin – Fats – Amino acids
(4) Maltase – Maltase – Glucose & Galactose

Q.20 Which of the following teeth are not deciduous-
(1) Incisors (2) Canines
(3) Premolars (4) Molars

Q.21 Teeth of Rabbit are-
(1) Living structures (2) Dead structures
(3) Partly dead & partly living
(4) Exact nature is not known

Q.22 The pulp of a tooth is surrounded by-
(1) Dentine (2) Crone
(3) Enamel (4) Root

Q.23 The quick movement of food into oesophagus is due to-
(1) Lubrication of food by saliva
(2) Peristalsis
(3) Gravitational pull (4) All of the above

Q.24 The lamina propria & muscularis mucosa belong to-
(1) Serosa (2) Sub mucosa
(3) Mucosa (4) None of these

Q.25 The neck of tubular gastric glands consist mainly of-
(1) Zymogen cells (2) Parietal cells
(3) Oxyntic cells (4) Mucous glands cells

Q.26 The folds of mucosa of the empty contracted stomach are known as-
(1) Taeniae (2) Rugae
(3) Ceacae (4) Favolae

Q.27 Parotid salivary glands are present-
(1) Below the tongue (2) Below the ears
(3) In the angle between two jaws
(4) Below the eye orbits

Q.28 A sensitive fleshy, soft process hanging in the throat of mammals is called-
(1) Rugae (2) Rumen
(3) Tonsil (4) Uvula

Q.29 After absorption of digested lipids by lymphatics of small intestine, these become milky, then these lipoprotein droplets are called as-
(1) Chyme (2) Chyle
(3) Chylomicron (4) Micelles

Q.30 The conversion of harmful substance prussic acid into potassium sulphocyanide takes place in-
(1) Liver (2) Lymph glands
(3) Spleen (4) Bone marrow

Q.31 The swallowing of food from buccal cavity into oesophagus is a reflex action controlled by-
(1) Brain (2) Medulla oblongata
(3) Hormones (4) Peripheral nerves

Q.32 The gastric mucosa of rabbit is protected from damage by HCl, because-
(1) HCl is too dilute
(2) It is covered with a mucous coat
(3) It is resistant to action of HCl
(4) HCl is neutralized by alkaline bile

Q.33 Digestion of proteins, fats and carbohydrate is completed in-
(1) Stomach (2) Duodenum
(3) Ileum (4) Ilium

Q.34 Teeth of carnivores are-
(1) Solenodont (2) Secodont
(3) Lophodont (4) Pleurodont

Q.35 Odontoblasts produce-
(1) Dentine (2) Cement
(3) Enamel
(4) Peridontal membrane

Q.36 The chief function of bile is to-
(1) Digest fats by enzymatic action
(2) Eliminate excretory products
(3) Regulate digestion of proteins
(4) Emulsify the fats

Q.37 A good source of lipase is-
(1) Pancreatic juice (2) Gastric juice
(3) Bile (4) Succus entericus

Q.38 The products of protein digestion the amino acids are absorbed in the ileum through-
(1) Lacteals of villi
(2) Blood capillaries of villi
(3) Both of the above
(4) Muscularis mucosa of villi

Q.39 Succus entericus is secreted by-
(1) Villi of intestine (2) Brunner's glands
(3) Crypts of lieberkuhn
(4) Brunner's glands and crypts of lieberkuhn

Q.40 The ductus choledochus in Rabbit carries -
(1) Bile (2) Saliva
(3) Sperm (4) Ova

Q.41 Cardiac sphincter protects back flow of-
(1) Food into oesophagus
(2) Blood into heart
(3) Blood into auricle
(4) Blood into venae cavae

Q.42 Haemorrhoids are-
(1) Small pouches of colon
(2) Enlarged rectal veins
(3) Outgrowths of anal canal
(4) Longitudinal folds of rectum

Q.43 The centre of hunger or centre which regulates the amount of food we eat or out appetite is located in-
(1) Medula (2) Cerebrum
(3) Hypothalamus (4) Alimentary canal

Q.44 The functional units for the absorption of digested food in Rabbit are-
(1) Brunner's glands (2) Villi
(3) Peyer's patches
(4) Crypts of Lieberkuhn

Q.45 The lymph vessels called lacteals are found in-
(1) Mammary glands (2) Pancreas
(3) Mucosa of intestine (4) Villi of ileum

Q.46 Pylorus occurs between -
(1) Ileum and rectum
(2) duodenum and ileum
(3) stomach and deodenum
(4) Oesophagus and stomach

Q.47 The bony sockets of Rabbits jaw in which the teeth are enclosed, are as-
(1) Fossae (2) Alveoli
(3) Dentaries (4) Diastema

Q.48 Which is different from others-
(1) Gastrin (2) Secretin
(3) Insulin (4) Pepsin

Q.49 The stimulation of gastric glands to produce gastric juice is a process mainly under the control of-
(1) Nerves (2) gastrin
(3) Wish of animals
(4) Sense of smell & taste

Q.50 By the rhythmical contractions of stomach the solid food is converted into a semifluid state, it is called-
(1) Chyle (2) Bolus
(3) Chyme (4) Chylomicron

Q.51 Which of the following contents of bile are concerned with digestion-
(1) Bile salts (2) Bile pigments
(3) Cholesterol (4) Phospholipids

Q.52 In the small intestine of Rabbit the optimum pH, for digestion is-
(1) 6.8 (2) 7.2
(3) 8.2 (4) 1.2

Q.53 Mumps is infection of salivary glands-
(1) Submandibular (2) Submaxillary
(3) Sublingual (4) Parotid

Q.54 Chymotrypsin is a component of-
(1) Bile (2) Pancreatic juice
(3) Succus entericus (4) Gastric juice

Q.55 Brunner's glands open at the -
(1) Bases of villi (2) Tips of villi
(3) Bases of crypts of Lieberkuhn
(4) Base of pylorus

Q.56 The watery emulsion of food found in small intestine is termed-
(1) Chyle (2) Chyme
(3) Bolus (4) Jelly

Q.57 The gastrointestinal hormones namely secretin and cholecystokinin secreted by duodenal epithelium activate respectively which organs to discharge their secretions-
(1) Pancreas & gall bladder
(2) Gall bladder & pancreas
(3) Pancrease & stomach
(4) Stomach & small intestine

Q.58 Polysaccharides are converted into monosaccharides by-
(1) Bile and lipase (2) Insulin & glucagon
(3) Glycosidases (4) Peptidases

Q.59 Bilirubin and biliverdin are the pigments found in-
(1) Blood of mammals (2) Bile of mammals
(3) Rods and cones of cycas
(4) Skin and hair

Q.60 Caloric value of carbohydrate per gram is-
(1) 9.45 kcal (2) 5.65 kcal
(3) 4.1 kcal (4) 9.0 kcal

Q.61 Keratomalacia is deficiency symptom on-
(1) Vitamin A
(2) Protein energy malnutrition
(3) Phylloquinone (4) Nicotinamide

Q.62 Lower jaw of mammals is composed of-
(1) One bone only (2) Three bones
(3) Five bones (4) Six bones

Q.63 Parietal (oxyntic) cells of gastric mucosa secrete-
(1) Pepsin (2) Mucin
(3) Dil HCl (4) All of these

Q.64 The enzymes present in saliva of rabbit acts mainly upon-
(1) Proteins (2) Fats
(3) Carbohydrates (4) Vitamins

Q.65 Gastric glands develop from which of the parts of stomach-
(1) Submucosa (2) Mucosa
(3) Serosa
(4) Muscularis mucosae

Q.66 If stomach doesnot produce HCl then which enzyme will work for longer period than its usual time-
(1) Pepsin (2) Ptyalin
(3) Rennin (4) Trypsin

Q.67 The concentration of HCl in gastric juice is nearly-
(1) 2% (2) 4%
(3) 0.4% (4) 0.04%

Q.68 Zymogen cells (chief cells) of gastric glands secrete-
(1) Mucin (2) HCl
(3) Pepsinogen (4) All of the above

Q.69 Regurgitation of food from stomach is normally prevented by-
(1) Pyloric sphincter (2) Cardiac sphincter
(3) Muscularies mucosae
(4) Circular muscles

Q.70 The roof of buccal cavity contains-
(1) Throat (2) Glottis
(3) Epiglottis (4) Palate

Q.71 Marasmus differs from kwashiorkor in-
(1) Absence of oedema
(2) Match stick legs
(3) Protruded belly
(4) Anaemia

Q.72 Osteomalacia is deficiency disease of-
(1) Infants due to protein energy malnutrition
(2) Adults due to protein energy malnutrition
(3) Infants due to vitamin D/calcium deficiency
(4) Adults due to vitamin D/calcium/phosphorus deficiency

Q.73 Enterokinase help in the conversion of -
(1) Pepsinogen in to pepsin
(2) Caseinogen into casein
(3) Trypsinogen into trypsin
(4) Proteins into polypeptides

Q.74 Cholesterol, sodium taurocholate and sodium glycocholate are found in-
(1) Pancreatic juice (2) Bile
(3) Succus entericus (4) Gastric juice

Q.75 Gastrin-
(1) Helps in digestion of fats
(2) Helps in digestion of milk protein
(3) Influences secretion of gastric juice
(4) Repairs gastric glands

Q.76 Lacteals found in intestinal villi help in the absorption of digested-
(1) Proteins (2) Lipids
(3) Carbohydrate (4) Vitamin

Q.77 Gluconeogenesis is the process in which-
(1) Sugars are converted into glycogen
(2) Sugars are converted into fats
(3) Amino acids and fatty acids are converted into carbohydrates
(4) None of the above

Q.78 The enzymes which help in digestion are called-
(1) Desmolases (2) Oxidases
(3) Dehydrogenase (4) Hydrolases

Q.79 Duodenum produces hormones-
(1) Renin and gastrin
(2) Epinephrine and norepinephrine
(3) Enterogastrone and cholecystokinin
(4) Pituitrin

Q.80 The swallowing of food from bucco-pharyngeal cavity to stomach is called -
(1) Deglutition (2) Mastication
(3) Peristalsis (4) None of the above

Q.81 The pancreatic juice contains-
(1) Trypsin, amylase and pepsin
(2) Trypsin, erepsin and amylase
(3) Pepsin, erepsin and amylase
(4) Trypsinogen, chymotrypsinogen, amylase and steapsin

Q.82 Rennin helps in the digestion of-
(1) Proteins (2) Milk protein
(3) Lipids (4) Milk carbohydrate

Q.83 The enzyme that takes part in the digestion of carbohydrate is-
(1) Trypsin (2) Chymotrypsin
(3) Amylase (4) Pepsin

Q.84 Cystic duct is found in-
(1) Liver (2) Stomach
(3) Salivary glands (4) Gall bladder

Q.85 The toothless space found in buccal cavity of rabbit is called-
(1) Diastema (2) Mitral space
(3) Chiasma (4) Vestibule

Q.86 Rabbit is a-
(1) Omnivorous animal (2) Herbivorous animal
(3) Carnivorous animal (4) Insectivorous animal

Q.87 Ptyalin is secreted by-
(1) Pancreas (2) Stomach
(3) Salivary glands (4) Liver

Q.88 The wall of colon in rabbit is constricted into a series of chambers called-
(1) Taeniae (2) Haustra
(3) Crypts of Lieberkuhn
(4) Alveoli

Q.89 Gastric digestion takes place efficiency in-
(1) Acidic medium (2) Alkaline medium
(3) Neutral medium
(4) Highly alkaline medium

Q.90 Which one is a common passage in swallowing food and breathing-
(1) Larynx (2) Gullet
(3) Glottis (4) Pharynx

Q.91 Mammals may drink water and also get it from-
(1) Breakdown of glycogen into glucose
(2) Secretion of saliva
(3) Oxidation of glucose
(4) Conversion of oxyhaemoglobin to haemoglobin

Q.92 How many pairs of salivary glands are found in rabbit-
(1) One (2) Two
(3) Three (4) Four

Q.93 Teeth of Rabbit are of diphyodont type because they-
(1) Appear twice in life
(2) Are divisible into two parts
(3) Are present in both the jaws
(4) Are arranged in two rows

Q.94 In rabbit liver is divided into how many lobes-
(1) Two (2) Four
(3) Five (4) Six

Q.95 Which prevents the digestive enzymes from digesting the cells of the alimentary canal itself-
(1) Secretion of protease in inactive stage
(2) Regular replacement of gut wall
(3) Mucous covering the inner gut wall
(4) All of the above

Q.96 Fatty acids cannot be absorbed in the absence of-
(1) Bile acid (2) Bile pigments
(3) Bile salts (4) Glycerol

Q.97 Which of the following teeth have regular growth in rabbit-
(1) Incisors (2) Canines
(3) Molars (4) Premolar

Q.98 Functionally goblet cells are-
(1) Protective (2) Secretory
(3) Sensory (4) Absorptive

Q.99 Function of HCl in stomach is to-
(1) Give acidic medium for gastric digestion
(2) Dissolve hard parts of food
(3) Convert pepsinogen into pepsin and to inhabit bacterial growth
(4) All of the above

Q.100 Paneth's cells are found in-
(1) Crypts of Lieberkuhn
(2) Peyer's patches
(3) Organ of corti
(4) Islets of Langerhans

Q.101 Which one of the following is not the function of liver-
(1) It helps in digestion
(2) It helps to store excess glucose
(3) It manufacture urea
(4) It secrets digestive enzymes and hormones

Q.102 Bile pigments are mostly formed from degradation of-
(1) Dead liver cells (2) Dead RBC
(3) Dead WBC (4) All of these

Q.103 Polyhedral cells are found in
(1) Liver (2) Intestine
(3) Lung (4) All of these

Q.104 Succus entericus is
(1) A connection between ileum & colon
(2) Gland of Gut
(3) An intestinal juice
(4) None of these

Q.105 Auerback's plexus is present in-
(1) Oesophagus (2) Stomach
(3) Small intestine (4) Colon

Q.106 A man is said to be starving when-
(1) Stomach is not being filled by food
(2) Food is stored as reserved food
(3) Food taken does not meet the loss of energy
(4) Food taken meet loss of energy

Q.107 In which region of alimentary canal is the digested food is absorbed mostly
(1) Oesophagus (2) Stomach
(3) Ileum (4) Rectum

Q.108 Which word should be used to describe the action of bile on food
(1) Digestion
(2) Emulsification or saponification
(3) Dissolution
(4) None of these

Q.109 The large intestine of Rabbit is divided into
(1) Colon and rectum (2) Coon and taeniae
(3) Colon & haustra (4) Anus & colon

Q.110 Absorptive surface of small intestine is increased due to the presence of
(1) Crypts of Lieberkuhn
(2) Villi
(3) Brunner's glands (4) All of the above

Q.111 The small intestine is adapted for efficient absorption of digested food because it has
(1) A good nerve supply
(2) Short length
(3) Muscular wall (4) Folds and villi

Q.112 The inhibition of gastric secretion and peristalsis is brought about by
(1) Pancreozymin (2) Cholecystokinin
(3) Gastrin (4) Enterogastrone

Q.113 Among the enzymes digesting proteins some act on the peptide links in the interior of the protein molecules. They are called
(1) Exopeptidases (2) Endopeptidases
(3) Proteases (4) Peptidases

Q.114 Space between the gums and the lips is called-
(1) Ovula (2) Foramen caecum
(3) Vestibule (4) Sulcus terminalis

Q.115 The first temporary tooth to erupt is-
(1) Upper central incisor
(2) Lower central incisor
(3) Canine
(4) First molar

ANSWER KEY

EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	2	3	4	1	1	4	4	1	3	2	2	2	1	4	2	1	1	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	2	3	1	2	2	4	3	1	4	2	3	2	1	4	1	2	4	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	3	2	4	3	2	4	2	3	1	3	4	2	1	1	1	3	2	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	1	3	3	2	2	3	3	2	4	1	4	3	2	3	2	3	4	3	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	2	3	4	1	2	3	2	1	4	1	3	1	3	4	3	1	2	4	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115					
Ans.	4	2	1	3	2	3	3	2	1	2	4	4	2	3	1					

Q.1 Point out the one – **[MP-PMT-90]**
(1) Rennin (2) Secretin
(3) Calcitoin (4) Oxytocin

Q.2 Which one is not an enzyme of digestive system– **[CPMT-90]**
(1) Enterokinase (2) Amylase
(3) Trypsin (4) Enterogasterone

Q.3 Mainly Secretin stimulates the production of – **[AIPMT-90, CPMT-90]**
(1) Saliva (2) Gastrin
(3) Bile (4) Pancreatic juice

Q.4 Peyer's patches produce – **[RPMT-87, CPMT-90]**
(1) Enterokinase (2) Lymphocyte
(3) Mucous (4) Trypsin

Q.5 In pancrease, pancreatic juice and hormone are secreted by – **[AIPMT-90]**
(1) Same cells (2) Different Cells
(3) Same cells at different times
(4) None of these

Q.6 Def. of Vit E brings about – **[CPMT-91]**
(1) Scurvy (2) Beri-Beri
(3) Slow clotting of blood
(4) Impotence

Q.7 Which teeth are absent in rabbit – **[CPMT-91]**
(1) Incisor (2) Canine
(3) Molar (4) Premolar

Q.8 In mammals carbohydrate are stored in the form of – **[CPMT-91]**
(1) Lactic acid in muscles
(2) Glycogen in liver and muscles
(3) Glucose in liver and muscles
(4) Glycogen in liver and spleen

Q.9 The cells in the wall of intestine are stimulated to produce secretin by – **[CPMT-91]**
(1) Cholycystochynin (2) Bile juice
(3) Acid in Chyme (4) Gastrin

Q.10 Pancreatic lipase acts upon – **[CPMT-91]**
(1) Glycogen (2) Triglycerides
(3) Disaccharides (4) Polypeptides

Q.11 Types of teeth in Rabbit – **[CPMT-91]**
(1) Thecodont (2) Acrodont
(3) Pleurodont (4) Homodont

Q.12 In whose milk percentage of lactose is highest– **[CPMT-92]**
(1) Human mother (2) Cow
(3) She buffalo (4) She goat

Q.13 Which of these will leave the stomach first in Man – **[CPMT-92]**
(1) Bear (2) Proteins
(3) Fats (4) Carbohydrates

Q.14 Amount of fat increases in the body due to excess intake of – **[CPMT-92]**
(1) Vitamins (2) Minerals
(3) Carbohydrates (4) None of these

Q.15 In frog, the surface of attachment of tongue is– **[CPMT-92]**
(1) Hyoid apparatus (2) Pterygoid
(3) Palatine (4) Sphenoid

Q.16 Bile is formed in – **[CPMT-92]**
(1) Gall bladder (2) Liver
(3) Spleen (4) Blood

Q.17 Cholecystokinin is secretion of – **[MP-PMT-92]**
(1) Duodenum that causes contraction of gall bladder
(2) Goblet cells of ileum stimulates secretion of succus entericus
(3) Liver and controls secondary sex characters
(4) Stomach that stimulates pancreas to release juice

Q.18 Enzyme trypsinogen is changed to trypsin by – **[JKCEE-92, RPMT-90]**
(1) Gastrin (2) Enterogastrone
(3) Enterokinase (4) Secretin

Q.19 Castle's intrinsic factor is connected with internal absorption of – **[AMU-92]**
(1) Pyridoxine (2) Riboflavin
(3) Thiamine (4) Cobalamine

Q.20 Aminopeptidase, a digestive enzyme produces– **[AMU-92]**
(1) Dipeptides (2) Smaller peptides
(3) Peptones (4) Amino acids

Q.21 Highest BMR occurs in – **[AMU-92]**
(1) Elephant (2) Rabbit
(3) Human (4) Whale

Q.22 Beri-Beri, Scurvy and Rickets are respectively caused by def. of – **[CPMT-93]**
(1) B_1, D & C (2) B_1, C & D
(3) D, B_1 & A (4) A, D & C

Q.23 Vit K is a required for – **[AIPMT-93]**
(1) Change of Prothrombin to thrombin
(2) Synthesis of Prothrombin
(3) Change of Fibrinogen to Fibrin
(4) Formation of thromboplastin

Q.24 Which of the following pair is characterised by swollen lips, thick pigmented skin of hands and legs and irritability - **[AIPMT -93]**
(1) Thiamine-Beri-Beri
(2) Protein-Kwashiorkor
(3) Nicotinamide-Pellagra
(4) lodine-goitre

Q.25 Maximum number of enzymes occur in – **[CPMT - 93]**
(1) Omnivores (2) Herbivores
(3) Carnivores (4) None of the above

Q.26 Excessive intake of alcohol caused – **[MP-PMT-93]**
(1) Jaundice (2) Dermatitis
(3) Liver Cirrhosis (4) Lung Fibross

Q.27 Inhibition of gastric and stimulation of gastric, Pancreatic and bile secretion are controlled by– **[AIPMT-94]**
(1) Gastrin, secretin, Enterokinin and CCK
(2) Enterogasterone, gastrin, pancreozymin and CCK
(3) Gastrin, Enterogasterone, CCK and pancreozymin
(4) Secretin, Enterogasterone, Secretin and enterokinin

Q.28 Lacteals take part - **[CPMT-94]**
(1) Digestion of Milk
(2) Absorption of fat
(3) Digestion of lactic acid
(4) None of the above

Q.29 Muscular contraction of Alimentary canal are – **[MP-PMT-94]**
(1) Circulation (2) Deglutition
(3) Churning (4) Peristalsis

Q.30 Vit-D is produced in human body by – **[J.K.M. CEE-94]**
(1) Muscles (2) Nerves
(3) Skin (4) None of these

Q.31 Fatty acids and glycerol are first absorbed by – **[AFMC-94]**
(1) Lymph Vessels (2) Blood
(3) Blood Capilaries
(4) Hepatic portal Vein

Q.32 During rest, metabolic requirements are minimum. This is indicated by - **[AFMC-94]**
(1) Pulse
(2) Breathing
(3) O_2 take and CO_2 output
(4) All the above

Q.33 During Prolonged fasting - **[AFMC-94]**
(1) First fats are used up, followed by carbohydrate from liver and muscles, and protein in the end
(2) First carbohydrate are used up, followed by fat and proteins towards end
(3) First lipids, followed by proteins and carbohydrates towards end.
(4) None of the above

Q.34 Which of the following is absorbed in ileum – **[BHU-95]**
(1) Fat (2) Bile salts
(3) Vit-K (4) Carbohydrate

Q.35 A dental disease characterised by mottling of teeth due to ingredient in drinking water, namely - **[AIPMT-95]**
(1) Fluorine (2) Chlorine
(3) Boron (4) Mercury

Q.36 In rabbit the Hard palate is formed of - **[CPMT-90]**

(1) From Premaxilla, Vomer and dentary bones
(2) Premaxilla, maxilla and Palatine Bones
(3) Sphenoid, nasal and dentary bones
(4) From nasal, maxillae and ethanoid bone

Q.37 Posterior part of soft palate, hangs down in pharynx, called - **[RPMT-88]**

(1) Palatine (2) Tonsils
(3) Velum Palati (4) Jacobson's organ

Q.38 Nasal chambers and buccal cavity are separated by - **[RPMT-86]**

(1) By uvula (2) By palate
(3) By Palatine (4) None of these

Q.39 Cheek teeth are - **[RPMT-86]**

(1) Incisors and Canines
(2) Canines and Premolars
(3) Premolars and Molar
(4) Canines and Molars

Q.40 Presence of water amount in enamel cell is- **[RPMT-90]**

(1) 90 – 92 % (2) 75 – 80 %
(3) 40 – 50 % (4) ≈ 3%

Q.41 Jacobson's organs are related with – **[RPMT-90]**

(1) With touch (2) With pressure
(3) With smell (4) With hearing

Q.42 In which animal tongue control the temperature – **[RPMT-90]**

(1) Rabbit (2) Dog
(3) Man (4) Cow

Q.43 How many lobes of liver are present in rabbit – **[RPMT-84]**

(1) 2 (2) 4
(3) 5 (4) 6

Q.44 In which part of stomach mainly digestion occurs - **[RPMT-84]**

(1) Cardiac Region (2) Fundic Region
(3) Pyloric Region (4) All above

Q.45 Largest gland of body – **[RPMT-90]**

(1) Pancreas (2) Duodenum
(3) Liver (4) Thyroid

Q.46 Which food substance is absorbed during digestion - **[RPMT-91]**

(1) Carbohydrates (2) Proteins
(3) Vitamins (4) Fats

Q.47 Insulin in secreted by pancreatic cells – **[RPMT-89]**

(1) α-cells (2) β-cells
(3) Delta cells (4) Gama Cells

Q.48 Which substance of saliva destroy the harmful bacteria - **[RPMT-91]**

(1) Cerumin (2) Chyme
(3) Lysozyme (4) Secretin

Q.49 Hormone which control the secretion of intestinal juice is - **[RPMT-88]**

(1) Enterogasterone (2) Enterocrinin
(3) Duo-crinin (4) Both (2) and (3)

Q.50 Parietal cells of mucosa in stomach is secretes:- **[RPMT-89]**

(1) Mucin (2) Pepsin
(3) HCl (4) All of these

Q.51 Contraction in gall bladder stimulated by : - **[AIPMT-98]**

(1) CCK (2) PZ
(3) Secretin (4) Enterogasterone

Q.52 Enamel of teeth is secreted by : - **[AIPMT-98]**

(1) Ameloblast (2) Odontoblast
(3) Osteoblast (4) Osteoclast

Q.53 Deficiency of protein leads to : - **[AIPMT-98]**

(1) Rickets (2) Scurvy
(3) Kwashiorker (4) Carotenemia

Q.54 Lactose composed of : - **[AIPMT-98]**

(1) Glucose + galactose
(2) Glucose + fructose
(3) Glucose + glucose (4) Glucose + mannose

Q.55 Vitamin which induces maturation of R.B.C. : **[AIPMT-98]**

(1) B_1 (2) A
(3) B_{12} (4) D

Q.56 Lower jaw composed of in Rabbit : - **[AIPMT-98]**

(1) Dentry (2) Maxilla
(3) Premaxilla (4) Palatine

Q.57 Which of the following stimulates the secretion of gastric juice : - **[AIPMT-98]**

(1) Gastrin (2) Enterogasterone

(3) Secretin (4) Hepatocrinin

Q.58 CCK and secretin secreted by : - **[AIPMT-99]**

(1) Stomach (2) Ileum

(3) Duodenum (4) Colon

Q.59 Suspensory ligaments are found in : - **[AIPMT-99]**

(1) Brain (2) Eyes

(3) Liver (4) Pancreas

Q.60 In stomach after physical and chemical digestion food is called : - **[AIPMT-99]**

(1) Chyme (2) Chyle

(3) Amino acid (4) Bolus

Q.61 A normal human being requires how much calories per day : - **[AIPMT-99]**

(1) 2500 k. cal (2) 4000 k. cal

(3) 5000 k.cal (4) 686 k cal

Q.62 Fully digested food reaches to liver by : - **[AIPMT-99]**

(1) Hepatic portal vein (2) Hepatic artery

(3) Hepatic vein (4) All the above

Q.63 Pantothenic acid & Biotin associated with : **[AIPMT-99]**

(1) Vitamin D (2)Vitamin B complex

(3) Vitamin K (4) Vitamin E

Q.64 Which one is wrong pair : - **[AIPMT-99]**

(1) Scurvy – Vitamin C

(2) Rickets – Vitamin D

(3) Night blindness (Xerophthalmia) – Vit. A

(4) Beriberi – Vitamin K

Q.65 Dental formula of adolescent human being before seventeen year : - **[AIPMT-99]**

(1) $\frac{2122}{2122}$ (2) $\frac{2123}{2123}$

(3) $\frac{2102}{2102}$ (4) $\frac{2023}{1023}$

Q.66 In mammals milk is digested by action of : **[AIPMT-2000]**

(1) Rennin (2) Amylase

(3) Intestinal bacteria (4) Invertase

Q.67 Which food should be eaten in deficiency of Rhodopsin in eyes - **[AIPMT-2000]**

(1) Carrot & ripe papaya

(2) Guava, banana

(3) Mango & Potato (4) None

Q.68 Which one correctly matched : **[AIPMT-2001]**

(1) Vit. E – Tocopherole

(2) Vit. D – Riboflavin

(3) Vit. B – Calciferole

(4) Vit. A – Thiamine

Q.69 Most abundant organic compound on earth is – **[AIPMT-2001]**

(1) Protein (2) Cellulose

(3) Lipids (4) Steroids

Q.70 Continuous bleeding from an injured part of body is due to deficiency of : **[AIPMT-2002]**

(1) Vitamin–A (2) Vitamin–B

(3) Vitamin–K (4) Vitamin–E

Q.71 Stool of a person contain whitish grey colour due to malfunction of which type of organ : - **[AIPMT-2002]**

(1) Pancreas (2) Spleen

(3) Kidney (4) Liver

Q.72 Fluoride pollution mainly affects : - **[AIPMT-2003]**

(1) Brain (2) Heart

(3) Teeth (4) Kidney

Q.73 Which one of the following pairs is not correctly matched : - **[AIPMT-2003]**

(1) Vitamin C — Scurvy

(2) Vitamin B_2 — Pellagra

(3) Vitamin B_{12} — Pernicious anaemia

(4) Vitamin B_6 — Beri–beri

Q.74 Which one of the following mineral elements plays an important role in biological nitrogen fixation : - **[AIPMT-2003]**

(1) Copper (2) Manganese

(3) Zinc (4) Molybdenum

Q.75 Which hormones induce secretion of succus entericus : - **[RPMT-2000]**

(1) Insulin

(2) Secretin and cholycystokinin

(3) Glucagon (4) Secretin

Q.76 In both chordates and non-chordates intestine develops from : - **[RPMT-2000]**

(1) Pharyngeal pouch (2) Ectoderm

(3) Endoderm (4) Mesoderm

Q.77 Which pollutant accumulates in liver and kidney : - **[RPMT-2000]**

(1) Cu (2) Hg

(3) Pb (4) Cd

Q.78 A Rabbit eats a lot of gram. Then its digestion starts in : - **[RPMT-2001]**

(1) Mouth (2) Stomach

(3) Duodenum (4) Ileum

Q.79 If the dental formula of Rabbit is $\frac{2033}{1023}$. What does it show : - **[RPMT-2001]**

(1) Total no. of teeth in Rabbit is 15

(2) No. of total incisors in Rabbit is 3

(3) Diastema is present between incisors & premolars

(4) In the formula 2033 is for adult and 1023is for young ones

Q.80 Which of the following is a disaccharide : - **[RPMT-2002]**

(1) Glucose (2) Fructose

(3) Sucrose (4) Galactose

Q.81 Which is correct about the bile of rabbit : - **[RPMT-2002]**

(1) It is synthesised by gall bladder & also stored there

(2) It is an enzyme which emulsify the fats

(3) It contain bile salts & bile pigments

(4) Bilirubin present in it decomposes fats

Q.82 If all the peptide bonds of protein are broken, then remaining part is : - **[RPMT-2002]**

(1) Amide (2) Oligosaccharide

(3) Polypeptide (4) Amino acid

Q.83 Hydrolysis of lipid yields : - **[RPMT-2002]**

(1) Fats

(2) Fatty acids and glycerol

(3) Mannose and glycerol

(4) Maltose and fatty acid

Q.84 Which of the following vessel in rabbit starts with capillaries and ends in capillaries: - **[RPMT-2002]**

(1) Pulmonary artery (2) Renal vein

(3) Hepatic portal vein (4) Renal artery

Q.85 Function of vitamin B_1 is : **[RPMT-2003]**

(1) Formation of R.B.C

(2) Absorption & metabolism of Ca

(3) In the form of Prosthetic group of ATP

(4) In Pyruvate dehydrogenase system

Q.86 Which cells of mucous layer of stomach secrete pepsinogen **[RPMT-2003]**

(1) Chief cell (2) Goblet cell

(3) Parietal cell (4) Oxyntic cell

Q.87 Glucose and galactose unite to form **[RPMT-2003]**

(1) Maltose (2) Sucrose

(3) Isomaltose (4) Lactose

Q.88 Dental formula in adult man is : - **[RPMT-2003]**

(1) $\frac{2123}{2123}$ (2) $\frac{2123}{2124}$

(3) $\frac{2122}{2122}$ (4) $\frac{2132}{2132}$

Q.89 Numbers of pairs of salivary glands present in Rabbit : - **[RPMT-2004]**

(1) One (2) Three

(3) Four (4) Five

Q.90 Vitamin–C is : - **[RPMT-2004]**

(1) Ascorbic acid (2) Citric acid

(3) Phosphoric acid (4) Glutamic acid

Q.91 Injury to vagus nerve in humans is **not** likely to affect - **[AIPMT-2004]**

(1) Gastrointestinal movement

(2) Pancreatic secretion

(3) Cardiac movements

(4) Tongue movements

Q.92 Which one of the following is the correct matching of a vitamin, its nature and its deficiency disease : **[AIPMT-2004]**

(1) Vitamin K-Fat-soluble-Beri-Beri

(2) Vitamin A-Fat-soluble-Beri-Beri

(3) Vitamin K-Water-soluble-Pellagra

(4) Vitamin A-Fat-soluble-Night blindness

Q.93 In man there are about 35,000,000 gastric pits at about : **[CPMT 1992]**

(1) 200/mm^2 (2) 300/mm^2

(3) 1000/mm^2 (4) 100/mm^2

Q.94 Brunner's gland are found in which of the following layers : **[MP PMT 2003]**

(1) Submucosa of stomach

(2) Mucosa of ileum

(3) Submucosa of duodenum

(4) Mucosa of oesophagus

Q.95 The chief function of bile is to : **[BHU 2003]**

(1) Digest fat by enzymatic action

(2) Emulsify fats for digestion

(3) Eliminate waste products

(4) Regulate digestion of proteins

Q.96 The toxic substance are detoxicated in the human body by : **[AIIMS 2001]**

(1) Lungs (2) Kidney

(3) Liver (4) Stomach

Q.97 Crypts to Leiberkuhn are found in between the villi. They secrete : **[MP PMT 2003]**

(1) Glucagon (2) Succus entericus

(3) Insulin (4) None

Q.98 Function of HCl in stomach is to : **[CPMT 1995]**

(1) Kill micro-organisms of food

(2) Facilitate absorption of food

(3) Dissolve enzymes

(4) Activate pepsinogen to pepsin

Q.99 Parotid salivary gland are present : **[MP PMT 1993]**

(1) Below the tongue

(2) Below the external auditory canal

(3) Below the eye orbit

(4) In the angle between two jaws

Q.100 The end product of carbohydrate metabolism is: **[AIIMS 1993]**

(1) CO_2 and H_2O (2) NH_3 and CO_2

(3) NH_3 and H_2O (4) CO_2

Q.101 In rabbit, the digestion of cellulose takes place in : **[MP PMT 2000]**

(1) Colon (2) Ileum

(3) Caecum (4) Rectum

Q.102 The muscular contraction in the alimentary canal is known as : **[RPMT 1999]**

(1) Systole (2) Diastole

(3) Peristalsis (4) Metachronal

Q.103 How many teeth in man grows twice in life: **[AFMC 2002]**

(1) 32 (2) 28

(3) 20 (4) 12

Q.104 End products of protein hydrolysis are : **[NCERT 1964, RPMT 2002]**

(1) Mixture of amino acids

(2) Sugars

(3) Peptides

(4) 25 amino acid

Q.105 Ptyalin is an enzyme of **[CPMT 2003]**

(1) Salivary juice (2) Pancreatic juice

(3) Intestinal juice (4) None of these

Q.106 The hormone 'Secretin' stimulates secretion of **[BHU 2000]**

(1) Pancreatic juice (2) Bile juice

(3) Salivary juice (4) Gastric juice

Q.107 Kupffer cells are found in : **[MP PMT 2002]**

(1) Liver (2) Kidney

(3) Heart (4) Blood

Q.108 Which of the following is not true in digestive system of Rabbit ? **[AIIMS 2003]**

(a) Rectum is beaded

(b) Canine teeth are absent

(c) Five of salivary glands are found

(1) Only a (2) Only c

(3) a and b (4) b and c

Q.109 Brunner's glands are present in : **[MP PMT 2001; AFMC 03]**

(1) Ileum (2) Duodenum

(3) Stomach (4) Oesophagus

Q.110 Which one of the following is fat-soluble vitamin and its related deficiency disease ? **[AIPMT-2007]**

(1) Ascorbic acid – Scurvy

(2) Retinol – Xerophthalmia

(3) Cobalamine – Beri – beri

(4) Calciferol – Pellagra

Q.111 Chymotrypsinogen is produced by **[Uttarachal 2004]**

(1) Liver (2) Pancreas

(3) Stomach (4) Duodenum

Q.112 Scurvy is caused due to deficiency of vitamin : **[Uttarachal 2005]**

(1) 'B' complex (2) C

(3) K (4) D

Q.113 Contraction of gall bladder is carried by : **[Uttarachal 2004]**

(1) citric acid + acetyl Co-A

(2) gastrin

(3) cholecystokinin

(4) none of these

Q.114 In human teeth, which help in cutting **[Bihar 2004]**

(1) Canine (2) Incisor

(3) Molar (4) Premolar

Q.115 HCl is secreted by which of the following cell of stomach **[Bihar 2004]**

(1) Chief cells

(2) Parietal cell (Oxyntic cells)

(3) Peptic cells

(4) Goblet cells

Q.116 Fatty liver syndrome is due to excessive intake of **[Bihar 2003]**

(1) Morphine (2) Alcohol

(3) Tobacco (4) both 1 and 2

Q.117 Carnesial teeth are modified for : **[Bihar 2006]**

(1) Crushing (2) Tearing

(3) Grinding (4) Cutting

Q.118 Glisson's capsules are present in **[UP CPMT 2003]**

(1) LIver (2) Lung

(3) Kidney (4) Stomach

Q.119 Osteomalacia occurs due to the deficiency of **[UP CPMT 2001]**

(1) Vitamin A (2) Vitamin B

(3) Vitamin C (4) Vitamin D

Q.120 Pulp cavity of teeth is lined by **[UP CPMT 2002]**

(1) Odontoblast (2) Chondroblast

(3) Osteoblast (4) Amyloblast

Q.121 Secretion of gastric juice is controlled by **[UP CPMT 2002]**

(1) Gastrin (2)Chlolecystokinin

(3) Enterogastrin (4) None of these

Q.122 Enzyme present in saliva is **[UP CPMT 2003]**

(1) Maltase (2) Ptyalin

(3) Sucrase (4) Invertase

Q.123 Which of the following metal is present in vitamin B_{12} **[UP CPMT 2003]**

(1) Cobalt (2) Copper

(3) Zinc (4) Magnesium

Q.124 Kupffer cells are present in **[UP CPMT 2003]**

(1) Liver (2) Pancreas

(3) Small intestine (4) Large intestine

Q.125 Teeth of rabbits are **[UP CPM 2004]**

(1) Thecodont (2) Diphyodont

(3) Heterodont (4) All of these

Q.126 Crypts of lieberkuhn are present in : **[UP CPMT 2006]**

(1) Intestine (2) Stomach

(3) Oesophagus (4) All of these

Q.127 Succus entericus is also called : **[UP CPMT 2006]**

(1) Gastric juice (2) Intestine juice

(3) Bile juice (4) Saliva

Q.128 Dental formula of rabbit is : **[UP CPMT 2007]**

(1) $\frac{2}{1}\frac{0}{0}\frac{3}{2}\frac{3}{3}$ (2) $\frac{2}{1}\frac{1}{0}\frac{3}{2}\frac{3}{3}$

(3) $\frac{2}{1}\frac{0}{0}\frac{2}{2}\frac{3}{3}$ (4) $\frac{1}{1}\frac{3}{2}\frac{0}{0}\frac{3}{3}$

Q.129 Deamination occurs in **[UP CPMT 2007]**

(1) Kidney (2) Liver

(3) Nephron (4) Both 1 and 2

Q.130 Digestion of protein is completed in **[UP CPMT 2007]**

(1) Stomach (2) Duodenum

(3) Ileum

(4) Duodenum and ileum

Q.131 Enterogasterone is **[UP CPMT 2007]**

(1) Hormone secreted by mucosa

(2) Enzyme secreted by mucosa

(3) Hormone secreted by duodenal mucosa

(4) Secreted by endocrine gland related to digestion

Q.132 Part of bile juice useful in digestion is **[UP CPMT 2007]**

(1) Bile salt (2) Bile pigment
(3) Bile matrix (4) All of them

Q.133 bile secretion is proportional to the concentration of **[MP PMT 2007]**

(1) Protein (2) Fat
(3) Carbohydrate (4) None of these

Q.134 Secretion of pancreatic juice is stimulated by **[MP PMT 2007]**

(1) Gastrin (2) Secretion
(3) Enterogastrone (4) Enterokinase

Q.135 Just as hydrochloric acid is for pepsinogen, so is the : **[MP PMT 2004]**

(1) haemoglobin oxygen
(2) enterokinase to typsinogen
(3) bile juice to fat
(4) glucagons to glycogen

Q.136 What is the function of globlet cells **[MP PMT 2004]**

(1) Production of enzyme
(2) Production of mucin
(3) Production of hormone
(4) Production of HCl

Q.137 Where the lysozymes are found **[MP PMT 2004]**

(1) In saliva and tears both
(2) In tears
(3) In saliva (4) In mitochondria

Q.138 The hormone which lowers the secretion of hydro chloric acid and gastric juice is **[MP PMT 2005]**

(1) Secretin (2) Enterogastrone
(3) Enterokinin (4) Gastrin

Q.139 Which of the following is different from other : **[MP PMT 2005]**

(1) Gastrin (2) Ptyalin
(3) Glucagon (4) Secretin

Q.140 Trypsin differs from pepsin because it digests : **[MP PMT 2005]**

(1) Carbohydrate in alkaline medium in stomach
(2) Protein, in alkaline medium in stomach
(3) Protein, in acidic medium of stomach
(4) Protin, in alkaline medium in duodenum

Q.141 Pancreatic juice is : **[MP PMT 2005]**

(1) Alkaline in nature
(2) Acidic in nature
(3) Enzymatic in nature
(4) Both acidic and alkaline in nature

Q.142 Scurvy disease is due to the **[MP PMT 2005]**

(1) Presnce of h-factor in blood
(2) Deficiency of vitamin E
(3) Virus
(4) Deficiency of vitamin C

Q.143 The chemical name of vitamin D is **[MP PMT 2005]**

(1) Riboflavin (2) Ascorbic acid
(3) Niacin (4) Calciferol

Q.144 From which of the following pepsin is secreted **[MP PMT 2007]**

(1) Lungs (2) Stomach
(3) Salivary gland (4) Sebaceous gland

Q.145 Crypts of Lieberkuhn involved in : **[MP PMT 2006]**

(1) Secretion of succus entericus
(2) Secretion of rennin
(3) Secretion of ptyalin
(4) digestion of food

Q.146 Which of the following vitamin synthesized in animal body by bacteria **[MP PMT 2006]**

(1) B_1 (2) A
(3) E (4) B_{12}

Q.147 Vitamin-C is mainly helpful in :**[MP PMT 2006]**

(1) Growth of bones
(2) Formation of connective tissue
(3) Treatment of anaemia
(4) Formation of visual pigment

Q.148 A person addict for alcohol gets his liver destroyed because : **[MP PMT 2006]**

(1) Liver stores excess of protein
(2) Liver stores excess of fat
(3) Liver stores excess of starch
(4) Liver stores excess of glycogen

Q.149 Bilirubin and Biliverdin are present in : **[MP PMT 2001]**

(1) Pancreatic Juice (2) Saliva
(3) Bile juice (4) Intestinal juice

Q.150 Dental formula of man is : **[MP PMT 2001]**

(1) $\frac{2}{2}\frac{1}{1}\frac{2}{2}\frac{3}{3}$ (2) $\frac{1}{1}\frac{2}{2}\frac{2}{2}\frac{3}{3}$

(3) $\frac{2}{2}\frac{1}{1}\frac{3}{3}\frac{2}{2}$ (4) $\frac{2}{2}\frac{2}{2}\frac{1}{1}\frac{3}{3}$

Q.151 Which of the following vitamins is essential for D.N.A. synthesis and cells division : **[MP PMT 2001]**

(1) Vitamin E (2) Vitamin D

(3) Folic Acid (4) Vitamin K

Q.152 Marasmus disease is caused due to **[MP PMT 2001]**

(1) Protein deficiency (2) Obesity

(3) Dwarfism

(4) Deficiency of vitamins

Q.153 Brunner's gland are found in : **[MP PMT 2001]**

(1) Submucosa of stomach

(2) Submucosa of duodenum

(3) Mucosa of oesophagus

(4) Mucosa of ileum

Q.154 Specific cells found in liver are : **[MP PMT 2001]**

(1) hepatic cells (2) beta cells

(3) Kupffer's cells (4) Islets of Langerhans

Q.155 Which of the following does not belong to vitamin B group : **[MP PMT 2002]**

(1) Riboflavin (2) Nicotin

(3) Cyanocobalamine (4) Tocopherol

Q.156 Deficiency of which vitamin causes night blindness : **[MP PMT 2002]**

(1) Vitamin C (2) Vitamin B

(3) Vitamin A (4) Vitamin D

Q.157 Certain B vitamins are : **[MP PMT 2002]**

(1) Enzymes (2) Co-enzymes

(3) Hormone (4) Digestive substance

Q.158 Deficiency of thiamine causes : **[MP PMT 2002]**

(1) Beri-beri (2) Rickets

(3) Caries (4) Pellagera

Q.159 Anti-sterility vitamin is : **[MP PMT 2002]**

(1) Vitamin B_{12} (2) Vitamin D

(3) Vitamin E (4) Vitamin A

Q.160 Vitamin C is helpful in the : **[MP PMT 2002]**

(1) Formation of visual pigment

(2) Growth of bones

(3) Treatment of pernicious anaemia

(4) Wound healing

Q.161 Secretin hormone stimulates : **[MP PMT 2007]**

(1) Gastric glands (2) Pancreas

(3) Gall bladder

(4) Crypts of Lieberkuhn

Q.162 The longitudinal muscular folds of inner wall of stomach are called : **[MP PMT 2007]**

(1) Papilla of vater (2) Rugae

(3) Villi (4) Fissure

Q.163 Cells of liver which act as phagocytes are : **[MP PMT 2002]**

(1) Dieter's cells (2) Kupffer's cells

(3) Hensen cells (4) Aciner cells

Q.164 The crypts of lieberkuhn secret : **[MP PMT 2003]**

(1) gastrin (2) rennin

(3) cholecystokinin (4) succus entricus

Q.165 The amount of gastric juice secreted per day from man's stomach is about : **[MP PMT 2003]**

(1) 500 ml. to 1000 ml.

(2) 2000 ml to 3000 ml

(3) 100 ml to 500 ml (4) 10 ml to 15 ml

Q.166 In adults the deficiency of vitamin D causes: **[MP PMT 2003]**

(1) Rickets (2) Beri-beri

(3) Scurvy (4) Osteomalacia

Q.167 The function of enterogasterone hormone is: **[MP PMT 2003]**

(1) to control excretion

(2) to inhibit gastric juice secretion

(3) regulate the absorption of food

(4) to stimulate gastric glands to release gastric juice

Q.168 Brunner's glands are located in : **[MP PMT 2003]**

(1) Oesophagus (2) Duodenum

(3) Intestine (4) Stomach

Q.169 Which of the following inhibits secretion of gastric juice : **[MP PMT 2003]**

(1) Enterogasterone (2) Gastrin

(3) CCK (4) PZ

Q.170 Pepsinogen is secreted from : **[MP PMT 2002]**
(1) argentaffin cells (2) goblets cells
(3) chief cells (4) parietal cells

Q.171 Cells of the pancreas is not digested by their own enzymes because : **[MP PMT 2003]**
(1) enzymes are secreted in inactive form
(2) cells are lined by mucous membrane
(3) enzymes are released only when needed
(4) none of the above

Q.172 Continuous bleeding from an injured part of body is due to deficiency of : **[MP PMT 2003]**
(1) Vitamin A (2) Vitamin B
(3) Vitamin K (4) Vitamin E

Q.173 Carrier ions like Na^+ facilitate the absorption of substances like – **[CPMT-2010]**
(1) amino acids and glucose
(2) glucose and fatty acids
(3) fatty acids and glycerol
(4) fructose and some amino acids

Q.174 If for some reason our goblet cells are non-functional, this will adversely affect – **[CPMT-2010]**
(1) production of somatostatin
(2) secretion of sebum from the sebaceous glands
(3) maturation of sperms
(4) smooth movement of food down the intestine

Q.175 Consumption of which one of the following foods can prevent the kind of blindness associated with vitamin 'A' deficiency ? **[AIPMT Pre 2012]**
(1) Canolla
(2) Golden rice
(3) Bt-Brinjal
(4) 'Flaver Savr' tomato

Q.176 Cirrhosis of liver is caused by the chronic intake of : **[AIPMT Pre 2012]**
(1) Alcohol (2) Tobacco(Chewing)
(3) Cocaine (4) Opium

Q.177 Anxiety and eating spicy food together in an othewise normal human, may lead to : **[AIPMT Pre 2012]**
(1) Jaundice (2) Diarrhoea
(3) Vomiting (4) Indigestion

Q.178 Where do certains symbiotic microorganisms normally occur in human body ? **[AIPMT Mains 2012]**
(1) Caecum
(2) Oral lining and tongue surface
(3) Vermiform appendix and rectum
(4) Duodenum

ANSWER KEY

EXERCISE – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	4	4	2	2	4	2	2	3	2	1	1	1	3	1	2	1	3	4	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	2	2	3	1	3	2	2	4	3	1	4	2	2	1	2	3	2	3	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	2	3	2	3	3	2	3	4	3	1	1	3	1	3	1	1	3	2	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	1	2	4	1	1	1	1	2	3	4	3	4	4	4	3	3	2	3	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	4	2	3	4	1	4	1	3	1	4	4	2	3	2	3	2	4	2	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	3	3	3	1	1	1	1	2	2	2	2	2	3	2	2	2	1	1	4
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	2	1	1	4	1	2	1	4	4	3	4	2	2	2	2	1	2	2	4
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	1	4	4	2	1	1	2	2	3	1	3	1	2	3	4	3	2	1	3	4
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178		
Ans.	2	2	2	4	1	4	2	2	1	3	1	3	4	1	2	1	4	1		

These questions consist of two statements each, printed as "ASSERTION" and "REASON". While answering these Questions you are required to choose any one of the following responses.

(1) If both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(2) If both Assertion and Reason are True but Reason is not correct explanation of the Assertion
(3) If Assertion is True but the Reason is False.
(4) If both Assertion and Reason are false.

Q.1 **A :** Maximum absorption of food occur in jejunum
R : Villi & microvilli abundantly present in small intestine

Q.2 **A :** Intrinsic plexus of alimentary canal regulate the peristalsis movement of alimentary canal
R : Muscles of alimentary canal are multiunit type

Q.3 **A :** The second largest digestive gland in our body is pancreas
R : Pancreas function both as an exocrine & endocrine gland

Q.4 **A :** Bile juice is stored mainly in the gall bladder
R : Gall bladder is necessary for digestion

Q.5 **A :** Small intestine is very l9ong and has plica circulares & villi
R : All these increase internal surface area of small intestine for efficient food absorption.

Q.6 **A :** The alcohol in alcohol addict person is converted into protein in the liver
R : Liver cells can produce protein from alcohol by fermentation

Q.7 **A :** Vitamins are not essential for healthy life.
R : Vitamin does not regulate metabolism

Q.8 **A :** G - cells of gastric gland secrete intrinsic castle's factor.
R : This factor help in vita. B_2 absorption.

Q.9 **A :** The second largest digestive gland in our body is liver.
R : Liver functions as in endocrine gland.

Q.10 **A :** Tonsils are also located in the digestive tract.
R : Tonsils produce digestive enzymes.

Q.11 **A :** Removal of gall bladder does affect the protein digestive.
R : Bile juice break the peptide bond.

Q.12 **A :** Gastric glands occur throughout the alimentary canal
R : Gastric juice inhibits movement food through the alimentary canal

Q.13 **A :** Faeces are brown coloured
R : Faeces contain brown pigment named urobilin formed by reduction of bile pigment

Q.14 **A :** Small intestine is very short and has longitudinal fold
R : All these decrease the internal surface area of small intestine for food absorption

Q.15 **A :** Tonsils are located near the of the alimentary and respiratory tract
R : Tonsils produces digestive enzymes

Q.16 **A :** Mucous glands occur throughout the alimentary canal
R : Mucous substances facilitate movement of food through the alimentary canal

Q.17 **A :** Vitamins are essential for healthy life.
R : Vitamins regulate metabolism.

Q.18 **A :** In human, maximum digestion occurs in duodenum.
R : Amupla of vater opens in duodenum.

Q.19 **A :** Chief cells of gastric gland secrete intrinsic castle's factor.
R : This factor help in vita. B_2 absorption.

Q.20 **A :** Emulsification is necessary for the digestion of fat.

R : After fats are emulsified, the action of enzyme amylase gets significantly increase.

Q.21 **A :** Abomassum of alimentary canal of reminant animals harbour numerous bacteria & protozoa.

R : Bacteria & protozoa help in the secretion of gastric juice in abomassum.

Q.22 **A :** Vitamin 'C' occurs only in animal tissue.

R : The vegetarian patients are suggested to take carrot & green vegetables when they suffer from Vita. 'C' deficiency.

Q.23 **A :** Pancreatic amylase digest protein to amino acids.

R : Pancreatic amylase the peptide bond of protein.

Q.24 **A :** Digestion is necessary for the absorption of all macro elements.

R : Digestion makes large complex molecule to simple smaller molecule which can be easily absorbed.

Q.25 **A :** Rumen is regarged as the true stomach in ruminant animal.

R : Fermentation of protein takes place in Rumen.

Q.26 **A :** Carbohydrates are more suitable for the production of energy in the body than protein and fats.

R : Carbohydrate can be stored in epithelial tissue as glycogen for use in the production of energy, whenever necessary.

Q.27 **A :** Gastrectomy causes iron deficiency anaemia

R : Hydrochloric acid secreted by oxyntic cells converts ferric into ferrous and iron is absorbed as ferrous ions.

Q.28 **A :** Cholagogues are substance that cause contraction of gall bladder.

R : These substance cause release of CCK-PZ from duodenum.

Q.29 **A :** Aptyalism patients have higher than normal incidences of dental caries.

R : Aptyalism is caused by the action of Parasympathetic nervous system.

ANSWER KEY

EXERCISE – 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	2	3	1	4	4	4	4	3	4	4	3	4	3
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Ans.	1	1	2	4	3	4	4	4	3	4	3	1	1	3	

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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Animal Physiology–II

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EXCRETORY SYSTEM

DEFINITION

(i) Elimination of metabolic waste from body is called **excretion**.

(ii) Due to metabolic activity in the body numerous waste substances are produced.

Carbohydrate metabolism, Produces CO_2 and H_2O. Protein metabolism produces nitrogenous wastes– **ammonia, urea** and **uric acid**.

HOMEOSTASIS

Maintenance of steady state (Walter Cannon).

Homeostatic mechanism are important for normal life as they maintain condition within a range in which the animals metabolic processes can occur. The process which is concerned with removal of nitrogenous waste materials (e.g.. urea, uric acid, CO_2 , Ammonia, salts, excess water etc.) is termed excretion.

OSMOCONFORMERS & OSMOREGULATORS

Osmoregulation : The regulation of solute movement and hence water movement (which follows solutes by osmosis)

On the basis of osmoregulation, animals are either osmoconformer or ormoregulators.

Osmoconformers : These animals can not actively control the osmotic condition of their body fluids. Instead of this, they change or adapt the osmolarity of body fluids according to the osmolarity of the surrounding medium.

Example :

- All marine invertbrates and some fresh water invertebrates.
- Hagfish (myxine) which is marine cyclostome fish, is the only vertebrate osmoconformer.

Osmoconformes show an excellent ability to tolerate a wide range of cellular osmotic environments.

Osmoregulators :

These animals maintain an internal osmolarity different from the surrounding medium in which they inhabit. Osmoregulator animals must either eliminate excess water if they are in hypotonic medium or they should continously take in water to compensate for water loss if they are in hypertonic medium. Due to this the osmoregulator animals have to spend energy

Strict osmoregulators : Are animals which maintain the composition of body fluids within a narrow osmotic range.

Eg. most vertebrates (except Hag fish and elasmobranch like shark & rays fish)

Water and solute regulation in freshwater environment :

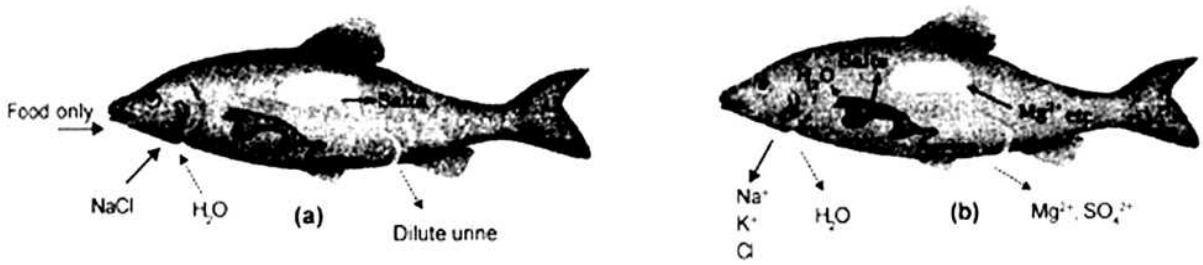
Body fluids of fresh water animals (osmolarity 200-300 m osm L^{-1}) are hypertonic to surrounding medium (osmolarity 50 m osm L^{-1}). Due to this, the freshwater animals constantly face two problems:

(i) They gain water passively due to osmotic gradient

(ii) Continuous loss of body salts to surrounding low salt containing medium occurs.

To encounter these problems the fresh water fishes perform following acts :

- They do not drink water
- Specialised cells called ionocytes or chloride cells are present in the gill membrane of fresh water fish. These cells can actively import Na^+ & Cl^- from surrounding water (containing less than 1mM NaCl against concentration gradient.



Water and solute balance in

(a) freshwater (b) marine bony fish

Water and solute regulation in Marine environmemt :

Body fluids of marine bony fishes is hypotonic to seawater (osmolarity 1000 m osm L^{-1}). So the osmoregulatory problems are opposite here :

(i) Marine fishes loose water from the body through permeable surfaces (like gill membranes, oral and anal membranes.)

(ii) To compensate this water loss the marine fishes have to drink water, this drinking results in gain of excess salts.

These problems are encountered by marine bony fishes by following acts :

(i) The ionocytes or chloride cells of the gill membrae eject out excess of monovalent ions.

(ii) Excess of Divalent cations are excreted with faeces.

- When fishes like Hilsa & Salman (which live in both sea & fresh water) migrate from fresh water to sea water they drink water and excrete excess salts through gill membranes.
- Body fluids of marine invertebrates, ascidians and hag fishes are isosmotic to sea water.
- Elasmobranch fishes (shark & rays) and coelacanths (lobe fin fish) reduce the osmoregulatory challenges by raising the osmolarity of body fluids. This is done by accumulation of osmolytes like urea & trimethylanmine oxide (TMAO). This makes the body fluids of shark and coelacanths slightly hyperosmotic to sea water.
- Osmolarity of human blood is about 300 mosm L^{-1}.

Water and solute regulation in terrestrial environment :

Land animals continuosly loose water through oral, nasal or respiratory surface during breathing. A loss of 12 percent of body water may lead to death in humans. The water loss is compensated by drinking and eating moist food. Some example of water conservation in different animals are as follows.

- Kangaroo rats loose very little water, because they can recover 90 percent of the loss by using metabolic water.
- When water is not available, the camels do not produce urine but store urea is tissues and solely depend on metabolic water. When water is available they rehydrate themselves by drinking upto 80 litres of water in 10 minutes.

Water balance in humans and desert kangaroo rats

		Kangaroo rat	Human
Water gain ($ml\ d^{-1}$)	ingested in	0	1500 (60%)
	Liquid ingested in food	6 (10%)	750 (30%)
	Derived from metabolism	54 (90%)	250 (10%)
		60 (100%)	2500 (100%)
Water loss ($ml\ d^{-1}$)	Evaporation	43.9 (73%)	900 (36%)
	Urine	13.5 (23%)	1500 (60%)
	Faeces	2.6 (4%)	100 (4%)
		60 (100%)	2500 (100%)

ELIMINATION OF NITROGENOUS WASTES

On the basis of type of excretory products (ammonia, urea or uric acid) three types of animals are present.

(1) Ammonotelics : Most aquatic animals excrete nitrogenous water as ammonia, the water soluble ammonia molecules diffuse across the body surface into surrounding water. In fishes most of the ammonia (NH_3) is lost as ammonium ions (NH_4^+) across the gill epithelium.

eg. of ammonotelic animals are teloest (modern bony fish), tadpoles and aquatic insects.

(2) Ureotelics : Animals like mammals, most adult amphibians living on land, marine fish and turtles, face the problem of conserving water. Excretion of urea is beneficial for these animals than ammonia becuase of following reasons.

(i) Urea can be tolerated in much more concentrated form because it is 100000 times less toxic than ammonia.

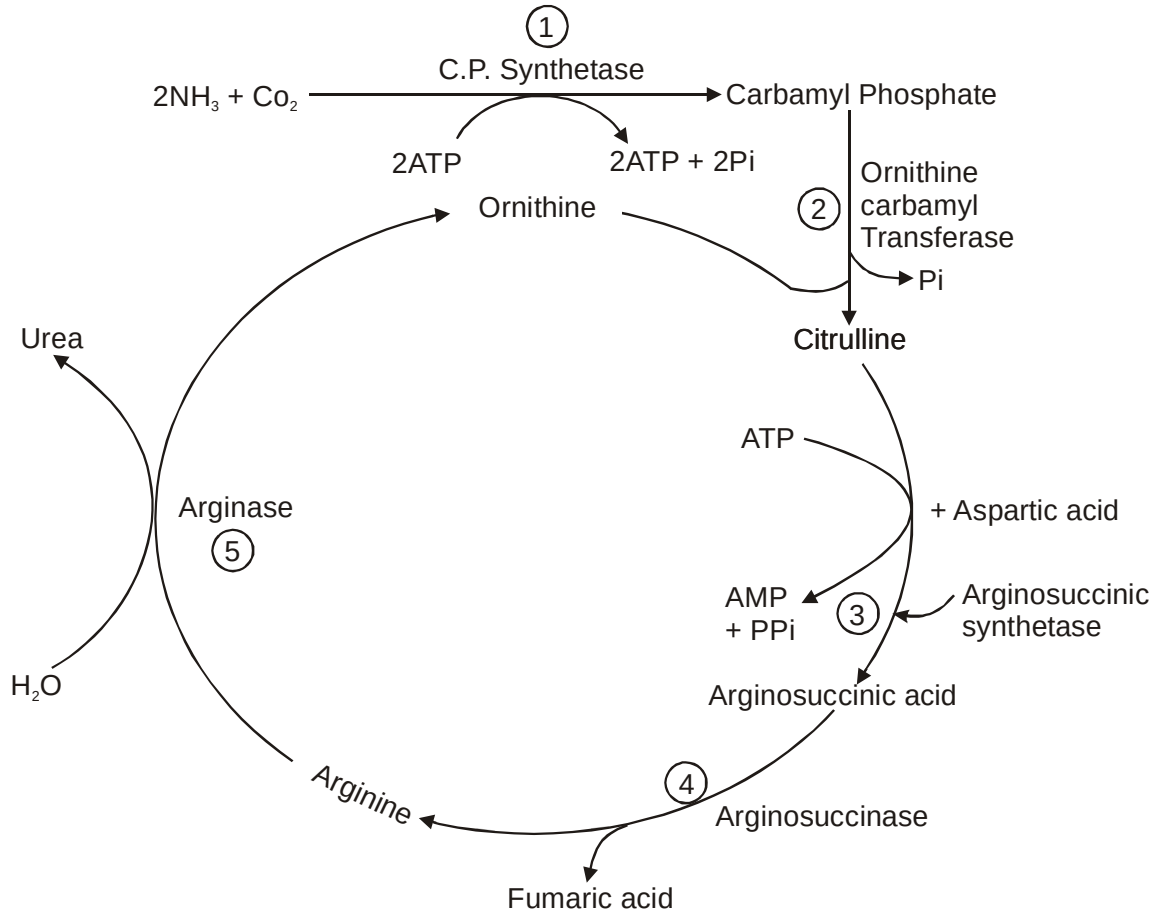
(ii) Urea excretion helps to sacrifice less water while disposing off the nitrogenous wastes.

For excretion of 1 gm of urea 50 ml of water is required.

In mammals **urea is excreted by kidney**. However entire amount of urea produced is not excreted immediately but some portion of it is retained in the kidenys for osmoregulation. (important for water reabsorption)

- Sharks retain some amount of urea produced to balance the osmolarity of body fluids with surrounding sea water. Thus urea here acts as an osmolyte.
- Urea produced in the liver by urea cycle.

Ornithine Cycle : It is also termed as the **Kreb-Henseleit cycle.** In this cycle, 2 molecules of NH_3 react with 1 molecule of CO_2, as a result a molecule of urea is formed. The formation of urea through this cycle takes place by the following steps -



- **Firstly** - 2 molecule of NH_3, 1 molecule of CO_2 combine to form carbamyl-Phosphate. This reaction is catalysed by the carbamyl-phosphate synthetase enzyme. 2 ATP's are used in this reaction.
- **In next step** - carbamyl-phosphate reacts with ornithine amino-acid to form the Citrulline amino-acid.
- **In next step** - Citrulline reacts with Aspartic acid to form Argino-succinnic acid. This reaction is catalysed by Argino-succinic synthetase. 1 moleucle of ATP is used in this process.
- **In next step** - Argino-succinic acid converts into Arginine and Fumaric-acid in the presence of Argino-succinase enzyme
- **Arginine,** now dissociates into ornithine and urea in presence of Arginase enzyme. Ornithine again enters the cycle.

(3) Uricotelics : These animals excrete uric acid as waste products.

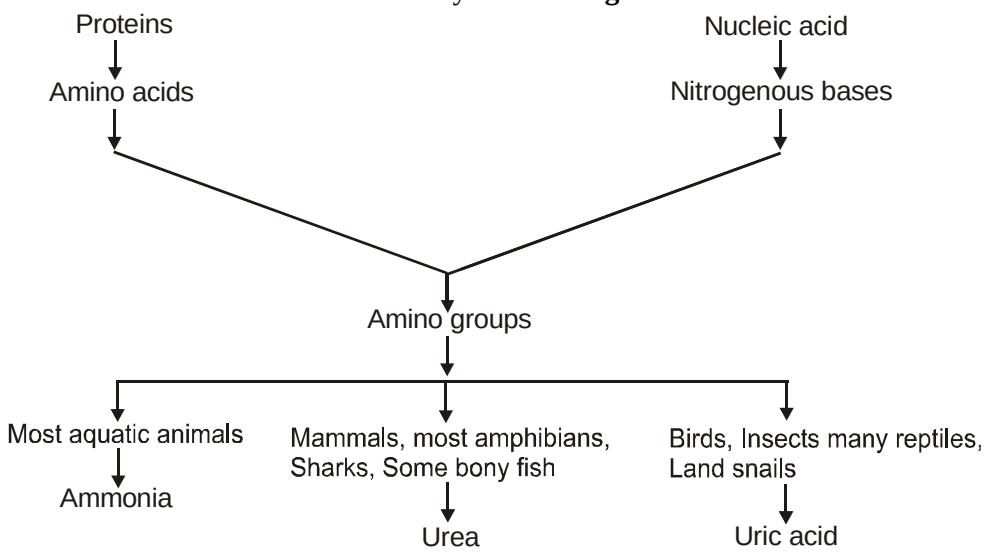
eg. Land snails, insects, birds & many reptiles.

Excretion of wastes in the form of uric acid is particularly advantageous for land vertebrates which lay shelled eggs. This is because shelled eggs of reptiles & birds possess many fine pores which are permeable to gases only.

It is formed mainly in liver from **ammonia and purine**. An enzyme **xanthine oxidase** is needed for its production.

If the embryo would have produced ammonia or urea inside the shelled egg, the soluble nitrogenous waste would have accumulated to toxic concentration levels. But because the wastes are in the form of uric acid which is thousand times less soluble than NH_3 or urea, this uric acid precipitates out of the solution and can be stored in the shell as a solid waste which is left behind when the animals hatches.

- In birds and reptiles urine is eliminated in a paste like form along with faeces.
- Tadpole and aquatic amphibians excrete ammonia, while their terrestrial adult forms excrete urea.
- Aquatic turtles excrete both urea & ammonia. Some tortoise can change their nitrogenous wastes when the environment is changed.
- Most terresterial reptiles excrete uric acid but crocodiles excrete ammonia in addition to uric acid.
- Uricotelics excrete uric acid as solid white crystal called **guano**.



SOME OTHER EXCRETORY PRODUCTS

Other wastes :

(i) Guanine - It is excretory waste of spider.
(ii) Ornithinic acid - It is excretory waste of birds.
(iii) Purine - It is excretory waste of butterfly.
(iv) Hippuric acid
(v) Creatine
(vi) Creatinine
— Excretory waste of mammals

(vii) Allantoin - It is excretory waste of foetus of **reptiles, aves** and **mammals**.

(viii) TMA (Trimethyl Amine oxide) - Marine Teleosts.

(ix) Amino acid - Some Molluscs **(*Pila, Unio*),** some Echinoderms **(Star fish, *Holothuria*)**.

CARBON DIOXIDE

It is formed during cellular respiration, upto annelida it is eliminated by general body surface through diffusion. In higher animals it is excreted by specialized respiratory organs.

MINERAL SALT

The excessive mineral salt like, potassium, calcium, magnesium, sodium are excreted in urine, sweat and faeces.

(i) Water

Excessive water is eliminated in faeces, urine, sweat and expired air.

(ii) Pigments

Pigments like bilirubin and biliverdin are eliminated in faeces, whereas, urochrome is eliminated in urine.

(iii) Drugs

Drugs are mainly removed through kidney.

Excretory organs of different organisms

S.No.	***Phylum***	***Excretory/osmoregulatory Organ/Organelle and principal N_2-waste***	***Function***	***Example***
I. Invertebrates				
(1)	Protozoa	Contractile vacuole Ammonia	Ammonotelic Osmoregulatory	Amoeba Paramecium
(2)	Porifera	General surface of body	Ammonotelic	Sycon, Leucon
(3)	Coelenterata	Ammonia, General surface of body	Ammonotelic	Hydra
(4)	Platyhelminthis	flame cells (=Solenocytes) form the protonephridial system	Ammonotelic	Taenia, fasciola
(5)	Nematoda	H-shaped excretory organ, Renette cells	Ammonotelic	Ascaris
(6)	Annelida	Nephridial system, (Metameric), various types	Ammonotelic	Pheretima
(7)	Arthropoda			
a.	Class-Insecta	Malpighian tubule (Uric acid)	Uricotelic	Periplaneta
b.	Class crustacea	Antennary (=green) gland Uric acid	Uricotelic	Palaemon
c.	Class Arachnida	Coxal glands Malpighian tubule Hepato pancreas Nephrocytes	Uricotelic	Spider
(8)	Mollusca	(a) Kidney (=organ of Bojanus) or Renal organ (b) Keber's organ Aquatic forms excrete Ammonia Terrestrial forms Excrete uric acid	 Ammonotelic Uricotelic	Pila Pulmonate Mollusc Limax
(9)	Echinodermata	Dermal branchiae (primitive gills) tube feet, body surface (Ammonia)	Ammonotelic	Cucumaria Asterias

HUMAN EXCRETORY SYSTEM

Excretory organ are also termed as organs of homeostasis.

The main excretory organ in humans is kidney.

Other excretory orgains are skin, liver, lungs & large intestine.

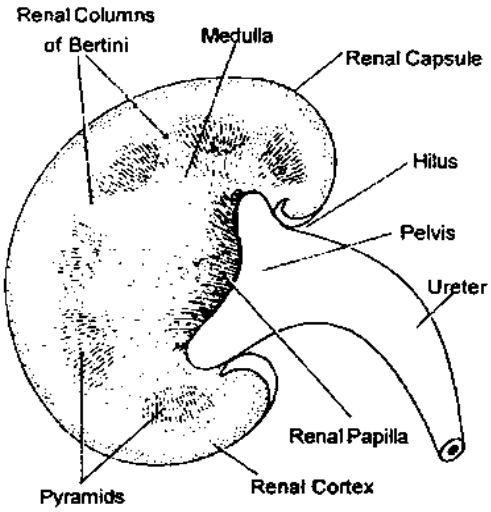
- Two kidney their blood supplies.
- A pair of ureters.
- urinary bladder
- Urethra

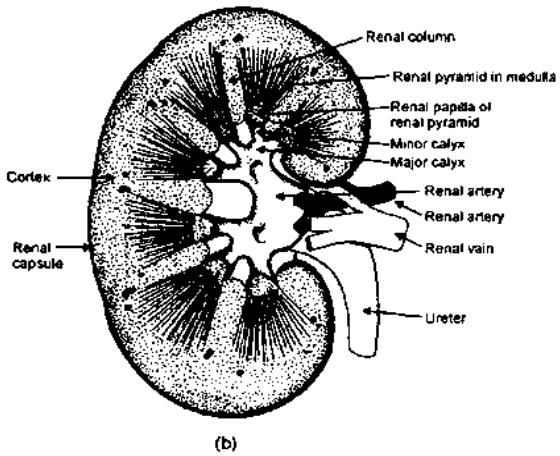
LOCATION AND STRUCTURE OF KIDNEYS

Each individual normally has two kidneys located lateraly on either side of vertebral column at the level to T_{12}, L_1 & L_2

Origin, location, form, size and external structure

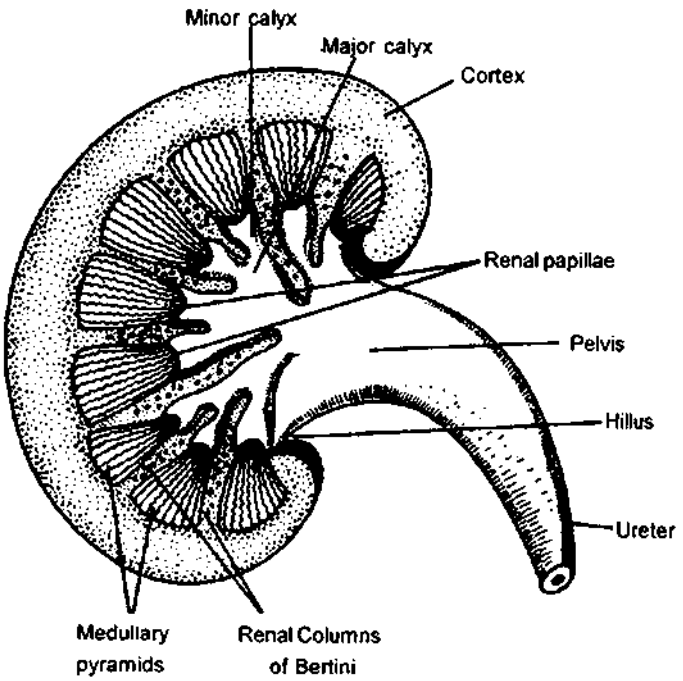
- Kidney is mesodermal in origin and retroperitoneal i.e. covered by peritoneum on ventral side.
- Kidney is found in pair. It is **bean shaped**, dark red, sized. (10 cm long × 5 cm broad × 4 cm thick)





HUMAN KIDNEY

- Both kidneys are situated in the anterior part of the abdominal cavity on either side of the median line (vertebral column). Last two pairs of ribs called floating ribs protect the kidney.
- In man the left kidney is slightly higher than the right kidney. In rabbit left kidney is slightly lower than right kidney.
- The concave side of each kidney faces inward whereas convex side faces outwards.
- Artery, vein, nerve and ureter enter or leave the kidney through the **hilus**.
- Externally kidney is covered by a layer of fibrous connective tissue called **renal capsule.**
- The structural & functional unit of kidneys is the Nephron.



These nephrons are arranged in a radiating fashion within the renal pyramids.

Urine produced by each nephron empties into **collecting duct.**

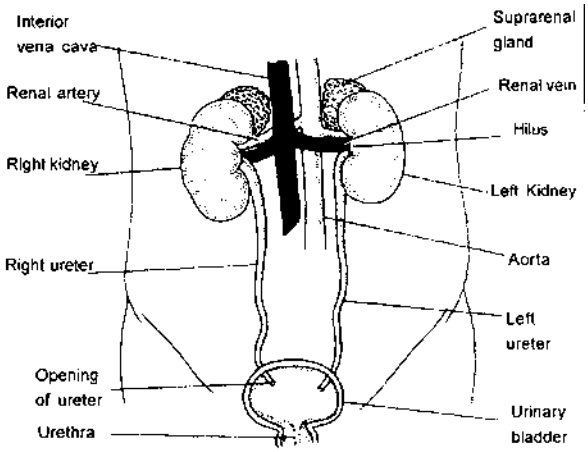
The collecting duct passes through a **papilla** into the **renal calyx** (Pleural-calyces).

The renal calyces drain urine in the central cavity of renal pelvis.

In rabbit, renal pelvis is unbranched, so the calyces and renal column of Bertini are absent.

Post Renal Urinary Tract

Urine passes from the pelvis into the **ureter**. Both the ureters open through separate oblique openings into **urinary bladder.** The obliquity of the openings prevent the backflow of urine. Externally, the bladder is lined by transitional epithelium or urothelium. This epithelium has great capacity to expand so that large volume of urine can be stored if required. Opening of urinary bladder is controlled by sphincters made of circular muscles. These normally remain contracted and during micturition these relax to release urine. (In rabbit a single sphincter is present while in human two sphincters, inner involuntary & outer voluntary, are present.)



External Structure of Urinary System

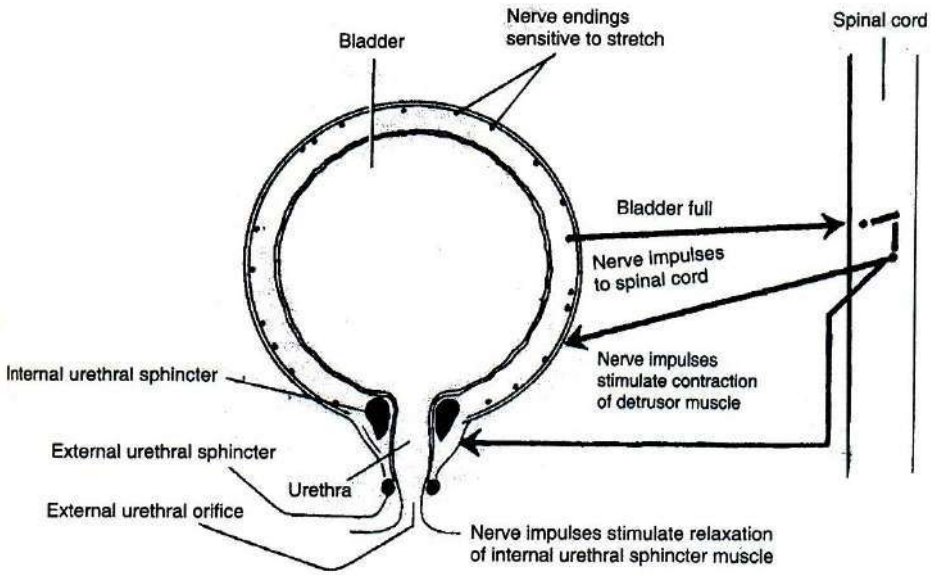
Passage of urine :

Nephron → Collecting duct → Papilla → Renal calyx → Penal pelvis → Ureters → Urinary bladder → Urethera

During act of micturition urine leaves the urinary bladder and enters the membranous duct called **Urethra.** The urethra leads to end of the penis in males and into the vulva in females. In males the urethra has three parts, prostatic, membranous & penile urethra prespectively. (Prostatic urethra & penile urethra are absent in females, therefore both sphincters are present in membranous urethra)

CONDUCTION OF URINE AND MICTURITION

(i) The urine produced in nephrone passed into the collecting tubules which opens in the **duct of Bellini**. Duct of Bellini converage towards hilium and pass through 15-16 conical renal pyramid which through minor and major calyxes pour their urine in renal pelvis of ureters. Both ureters carries the urine by peristalisis to urinary bladder.



(ii) The process of passing out urine is called micturition.

(iii) When urine get collected in urinary bladder muscular wall of urinary bladder get distended or expanded. Distension of wall of urinary bladder stimulates the sensory nerve endings in the bladder wall causing detrussor muscle to contract.

(iv) Micturition may voluntarily initiated or postponed. Urge for micturation starts when the bladder is little more than half full of urine.

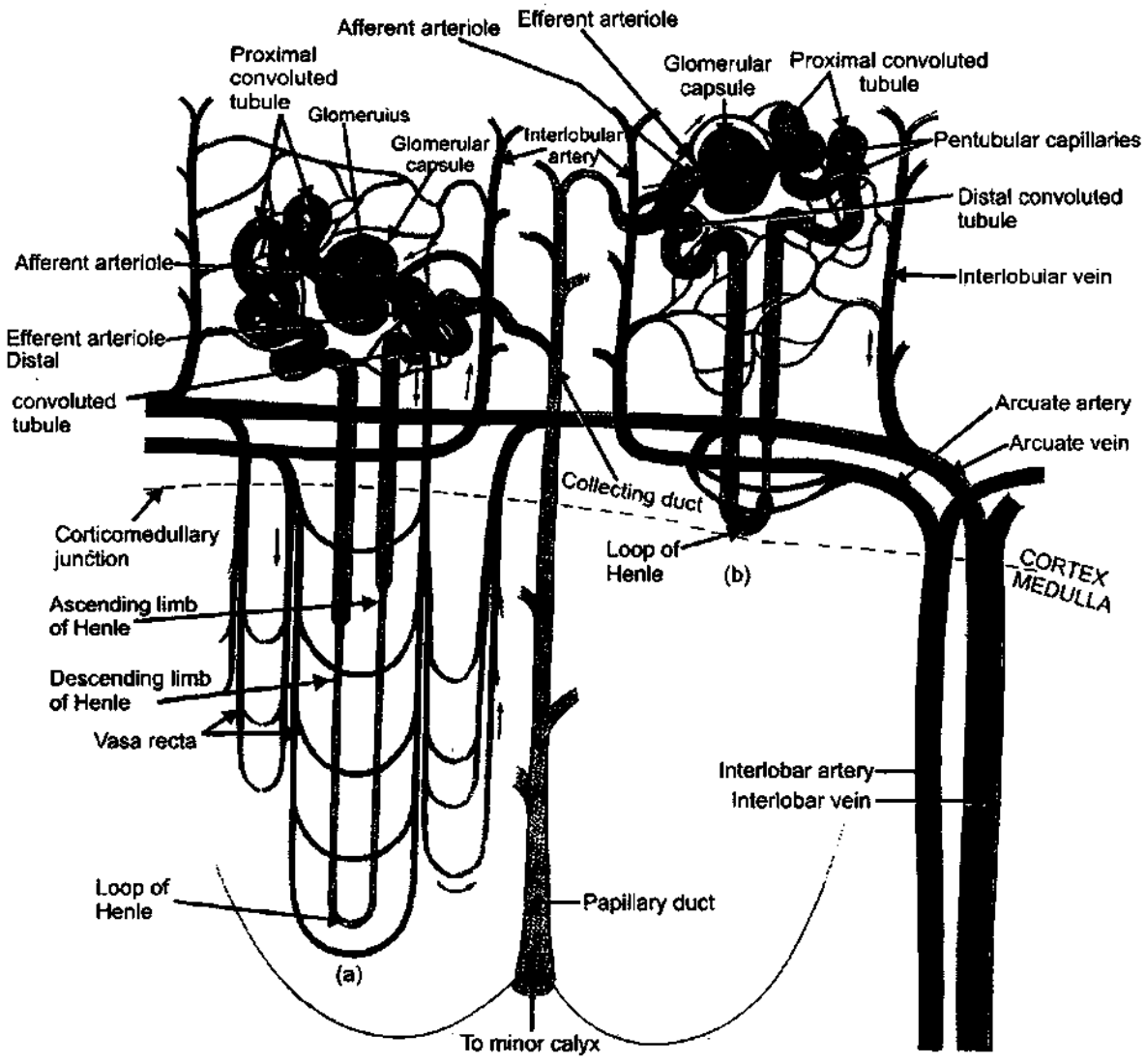
(v) A person feels desire of micturition when quantity of urine in the bladder is about 220 ml.

Note :

Sympathatic nerve fibre help in filling of bladder, whereas, parasympathatic helps in emptying of urinary bladder.

STRUCTURE OF NEPHRON

Nephron is the structural and functional unit of kidney. It is an epithelial tube which is about 3 cm long and 20-60 μm in diameter. (Each kidney has about one million nephrons in humans & 2 lakh in rabbit.



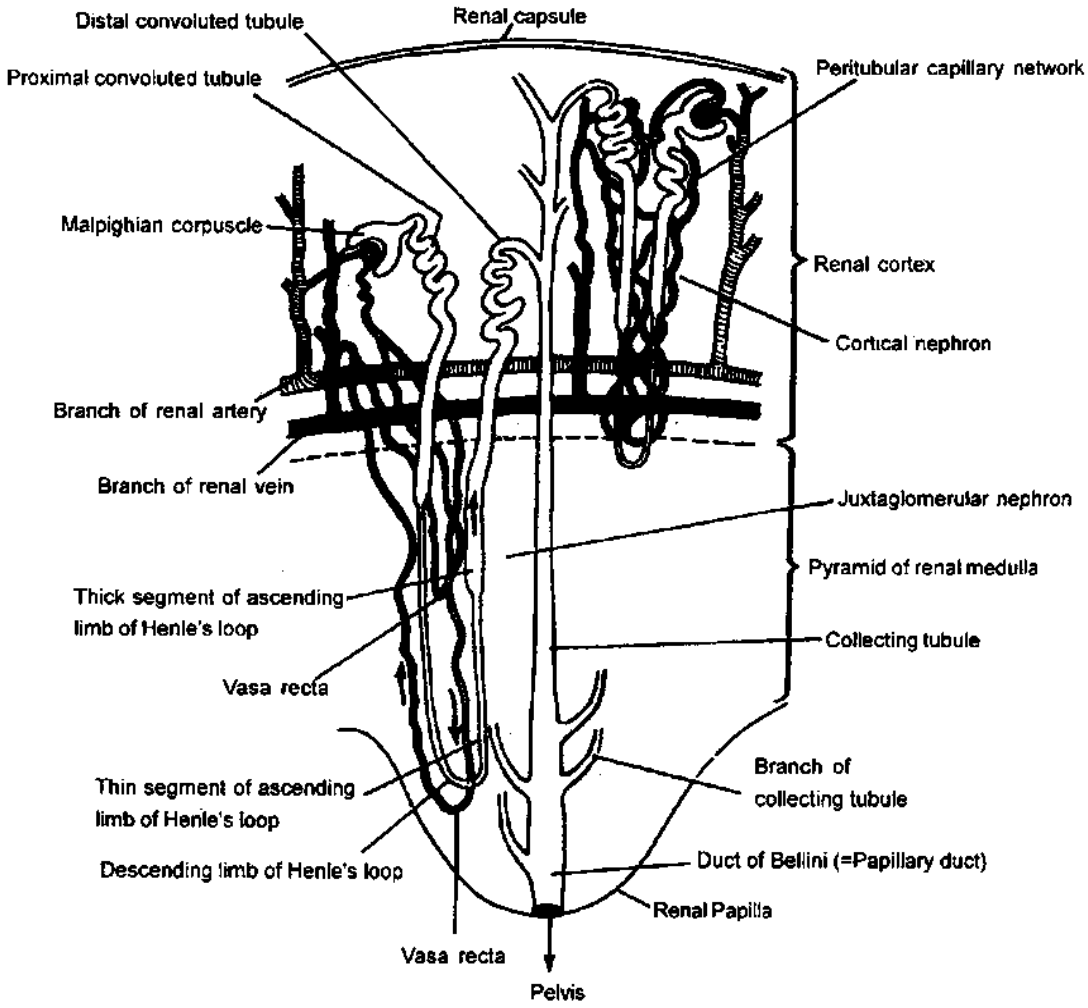
(a) Juxtamedullary nephron **(b) Cortical nephron**

A nephron can be divided into three regions :

(I) Proximal nephron (Bowman's capsule + Proximal convoluted tubule)

(II) Loop of Henle (Ascending + Descending limb)

(III) Distal nephron (Distal convoluted tubule which opens into collecting duct)



(I) Proximal nephron : Nephron tubule is closed at its proximal (starting) end but its distal end is open and continues into the loop of Henle. At the proximal or closed end the nephron is expanded and curved inwardly to form a double walled cup shaped **Bowman's capsule.** within bowman's capsule a network or tufts of capillaries is present, It is called **Glomerulus.** Diameter of afferent arteriole is greater than efferent arteriole.

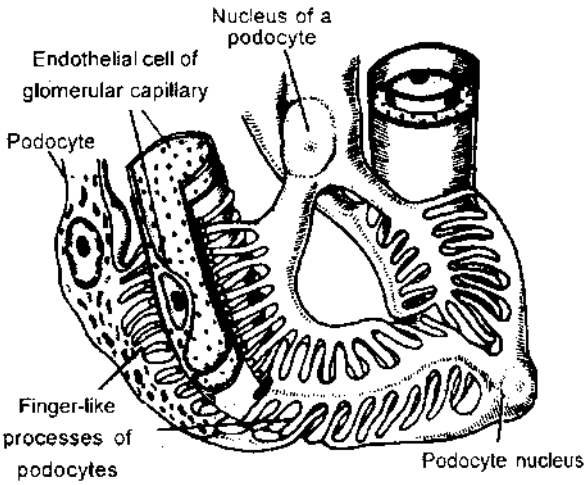
Malpighian corpuscles : Glomerulus and its surrounding Bowman's capsule together form this specialised structure.

The outer wall of Bowmans capsule is composed of flattened squamous cells.

The inner, invaginated wall that lines the concavity of bowmans capsule is composed of a special type of cells called **Podocytes.**

These cells bear finger like projections which are coiled around the capilaries of glomerulus.

The Bowmans capsule is followed by a short neck part lined by ciliated epithelium.



Proximal convoluted tubule : The epithelial cells of this region are specialised for transport of salts and other substances from the lumen to the interstitial fluid.

The membranes of these cells facing the tubule lumen has numerous microvilli (finger like projections

or Brush Borders) which increase the surface area. Near its basolateral surface, the mitochondria are concentrated, to allow of reabsorption of salts by active transport.

(II) Loop of Henle : It starts after the proximal convoluted tubule, It ends before the distal convoluted tubule. This hairpin like loop has a descending limb, followed by an ascending limb.

Descending limb : Its upper part - constitutes thick segment has the same diameter as PCT and is also lined by cuboidal epithelium.

Its lower part - constitutes thin segment and is lined by flat epithelial cells

Ascending limb : This part too has a **thin segment** first which widens abruptly at medullary zone to form **thick segment.** Lower thin segment is lined by simple squamous epithelium while upper thick segment is lined by cuboidal epithelium.

(**III) Distal nephron :** The ascending limb of henle's loop merges into **distal convoluted tubule.** This is lined by cuboidal epithelial cells with a few microvilli. Coils of both PCT & DCT are intermingled.

The distal convoluted tubules of a number of adjacent nephrons open into a common **collecting duct** or tubule.

Collecting ducts (present in medullary pyramids) are long tubules which travel through the medulla in the pyramids. In the papilla of the medulla (in rabbit) or papilla of the individual medullary pyramid (in human), Several adjacent collecting ducts converge to open into a common short and thick **duct or Bellini.** (present in papilla or medulla)

All ducts of Bellini then open at the tip of the papillae into the pelvis.

Renal cortex : The malpighian corpuscle, PCT & DCT of the nephrons are located here.

Renal medulla : Loop of henle, collecting duct and ducts of Bellini are found in this region.

TYPE OF NEPHRONS

According to their position, nephrons are of two types.

(i) Cortical nephrons :

- These consitute about 85% of total. (75-85%)
- Malpighian corpuscles of cortical nephrons are located close to the kidney surface.
- Their loops of Henle are small and a very small part of it runs in the medulla.
- Only peritubular capillary network is present & vasa recta is absent.

(ii) Juxtamedullary nephrons :

- About 15% of total. (15 - 25%)
- Malpighian corpuscles of these nephrons are located at the junction of cortex and medulla.
- The loop of Henle of these nephrons are long, dipping deep down into the medulla.
- Both, PTC network and vasa recta are present.

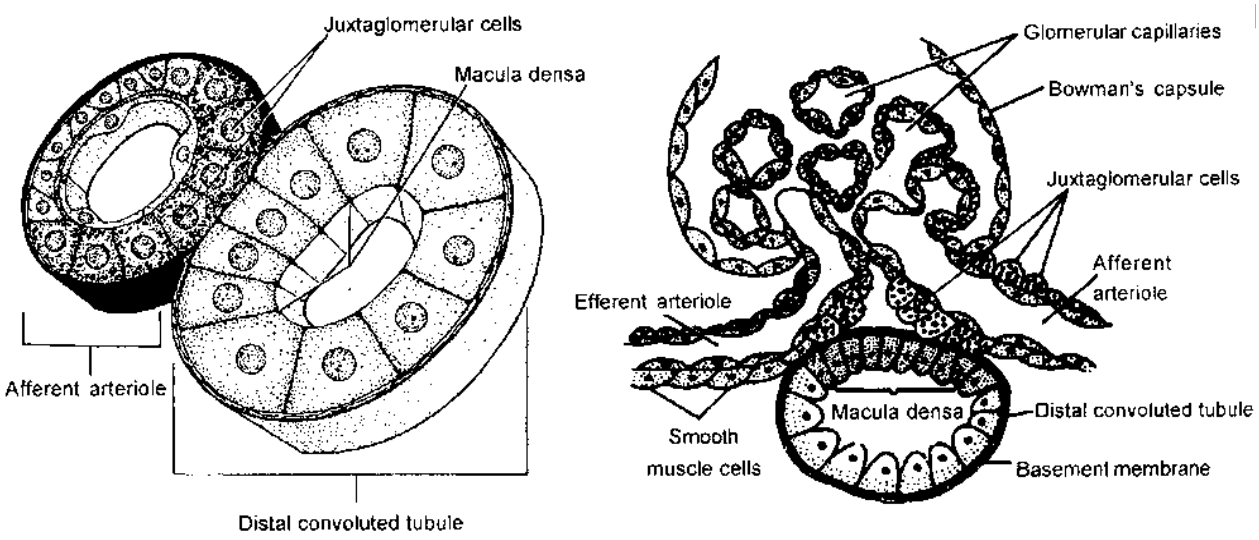
In these nephrons the initial part of the DCT is located close the mouth of Bowman's capsule, in contact with both afferent and efferent arterioles.

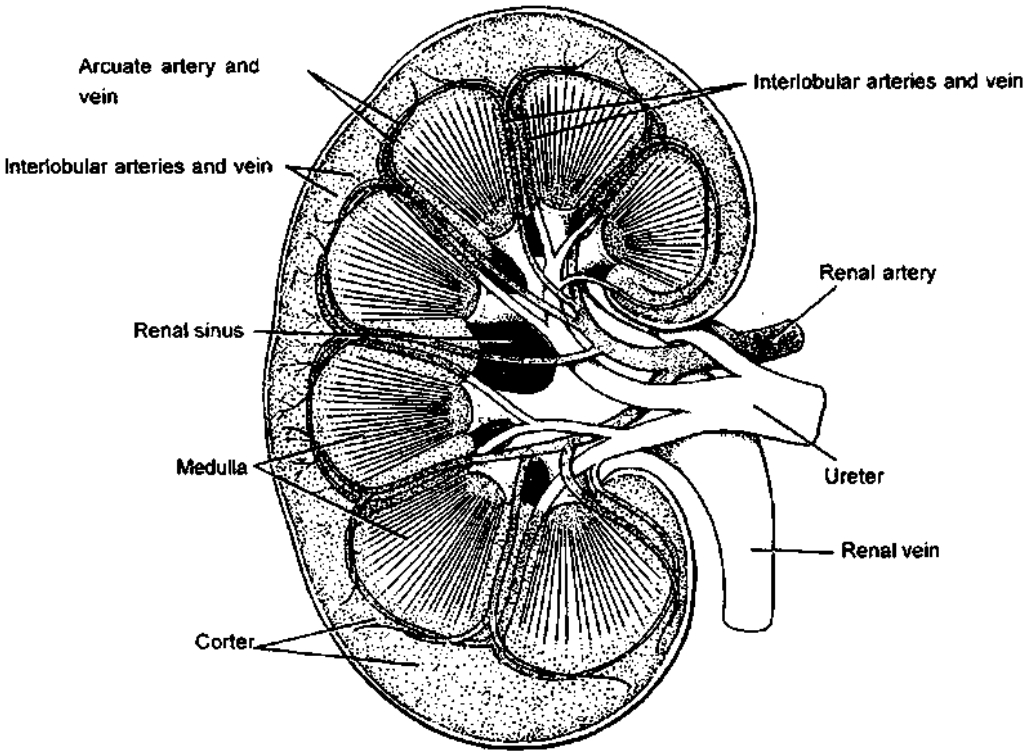
Juxtaglomerular apparatus : Juxtaglomerular cells + Macula densa.

Macula densa : The cells of DCT epithelium in contact with the arteriolar wall are denser than other epithelial cells. These are collectively called macula densa.

Juxtaglomerular cells : The smooth muscle cells of the wall of both arterioles in contact with DCT epithelium are swollen and contain dark granules of inactive renin. These are called juxtaglomerular cells.

Juxtaglomerular apparatus secretes **renin** and **erythropoitein**.





Blood Supply of the right kidney seen in coronal section

BLOOD VESSELS OF KIDNEY

Each kidney receives its blood supply by a single **renal artery** from dorsal aorta, and is drained off by a single **renal vein,** which opens in the inferior vena cava.

As the artery enters into the medulla after traversing through the hilum, it divides into a number of branches. These branches enter into renal cortex through the columns of Bertini and subdivide into **afferent arterioles** which form **glomerular capillaries.** These capillaries are drained, not by venules, but by **efferent arterioles. In Cortical nephrons :**

The efferent arterioles break up into dense **Pertitubular network of capillaries** around their tubules.

In Juxtamedullary nephrons :

The efferent arterioles break up into a network of thin capillaries which form hair pin like loops called vasa recta.

This vasa recta dips into the medulla or its pyramids along side the loops of Henle.

Both peritubular capillaries of cortical nephrons and vasa recta of juxtaglomerular nephrons lead into venules which join and rejoin to form small and large veins, all of which ultimately join to the form renal vein.

MECHANISM OF URINE FORMATION

The mechanism of urine formation involves three steps or processes :

(I) Ultrafiltration or Glomerular filtration

(II) Selective tubular reabsorption

(III) Tubular secretion

(I) Ultrafiltration or Glomerular filteration :

This process occurs in the Malpighian corpuscles of the nephrons. The glomerulus of a Malpighian corpuscle is a network of several (about fifty in man) parallel capillaries. From the blood flowing through glomerular capillaries, about 20% of plasma fluid filters out into the Bowman's capsule through a thin **glomerular-capsular membrane** due to a net or **effective filtration pressure (EFP)** of about 10 to 25 mm Hg.

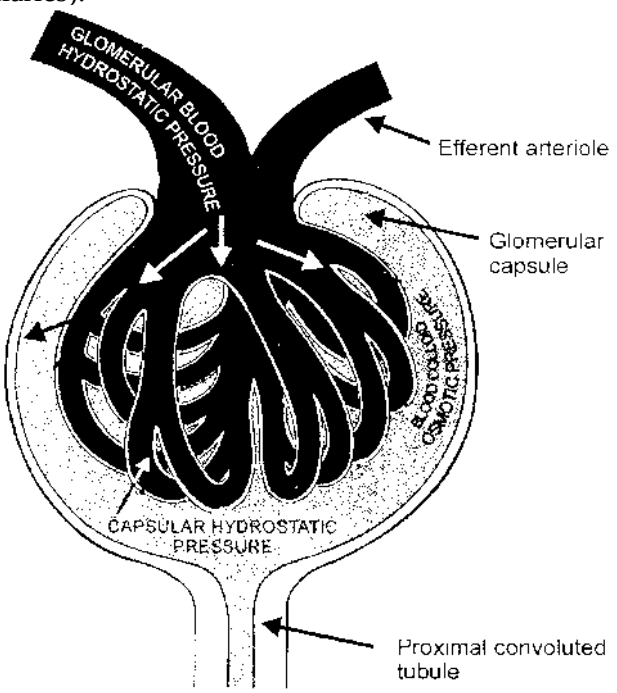
The glomerular-capsular membrane through which ultrafiltration occurs comprises three layer, **(I) endothelium, (2) basement membrane** of the wall of glomerular capillaries and **(3) squamous epithelial layer** of the finger-like processes ('foot processes' or pedicels) of podocyte cells of capsular wall entwining the walls of capillaries.

A special characteristic of glomerular-capsular membrane is that it is about 100 to 500 times more permeable than the walls of blood capillaries in other tissues of body. Such a tremendous permeability of this membrane is because of the presence of literally thousands of small pores, called **fenestrae,** in the walls of glomerular capillaries (fenestrated capillaries).

The effective filtration pressure that causes ultrafiltration is determined by three pressures : (1) glomerular hydrostatic pressure, (2) colloid osmotic pressure of blood and (3) capsular hydrostatic pressure.

The glomerular hydrostatic pressure is the blood pressure in glomerular capillaries. It is the chief determinant of effective filtration pressure, i.e. the main driving force to cause filtration. (it is 60 to 75 mm Hg)

The **colloid osmotic pressure** is the osmotic pressure created in the blood of glomerular capillaries due to plasma proteins. It resists the filtration of fluid from the capillaries. (it is 30 to 32 mm Hg)



The **capsular hydrostatic pressure** is the pressure caused by fluid (filtrate) that reaches into Bownman's capsule and resists filtration. (It is about 10 to 18 mm Hg)

Normally, the blood pressure in an arteriole that feeds a typical systemic capillary network is about 30 to 40 mm Hg. The pressure in afferent arteriole of glomerulus is about 60 to 75 mm Hg and since the efferent arteriole is thinner in diameter than afferent arteriole, this blood pressure (glomerular hydrostatic pressure) is maintained throughout the glomerulus. The colloid osmotic and capsular hydrostatic pressures, which resist ultrafiltration , are respectively about 30 to 32 mm and 10 to 18 mm Hg. Thus, the **net effective effective filtration pressure is about 10 i.e. (60) – (32 + 18) mm hg.** That is why, the glomerulus is called a '**high pressure capillary bed',**

EFP = GHP – [COP + CHP]

- **EFP ranges from 10 to 25 mm Hg.**

The plasma fluid that filters out from glomerular capillaries into Bowman's capsules of nephrons is called **glomerular filtrate.**

The quantity of glomerular filtrate, formed each minute in all the nephrons of both kidneys is called **Glomerular filtration rate (GFR).** In a normal adult human being, a glomerular filtration pressure of 1 mm Hg causes filtration of about 12.5 mL of plasma fluid from glomerular capillaries per minute. Thus the GFR in a normal adult person is 125 (12.5 × 10) mL of plasma fluid per minute. As already described in the chapter of circulatory system, an average adult person of about 70 kg possesses about five litres of blood all of which is pumped by the heart (cardiac output) into the arteries and received back through veins each minute. About 1250 mL (25% of total blood) of this blood circulated through kidneys each minute, and of this blood, about 650 mL is the blood plasma (52%). This 650 mL is called **renal plasma flow (RPF).** Obviously, 125/650 i.e. about one-fifth (20%) of the blood plasma, therefore, filters out into kidneys nephrons per minute. This is the ratio of GFR to RPF, and it is called **filtration fraction.**

With a glomerular filtration rate (GFR) of 125 mL per minute, about 180 litres of plasma fluid from about 1800 litres of blood circulating through both kidney of an average person each day filters out into kidneys nephrons. But only about 1.45 litres (about 0.8% part) of the total glomerular fitlrate is excreted out as **urine** per day, the rest is reabsorbed into the blood from the nephrons.

Due to continuous beating of the cilia of neck cells, the glomerular filtrate is continously made to flow behind from Bowman's capsules into the proximal convoluted tubules of the nephrons.

(II) Selective tubular reabsorption :

The glomerular filtrate is like blood plasma minus plasma proteins (colloids) in chemical composition. Thus, it is mostly water with all soluble and diffusible solutes of plasma which include nutrients (glucose, amino acids, etc,) electrolytes of salts (Na^+, K^+, Cl^-, HCO_3^-, H^+ etc) and waste products of protein metabolism (urea, uric acid, creatinine, etc). In contrast to glomerular filtrate, the urine which is ultimately extracted from the filtrate in nephrons, contains water, urea, uric acid, creatinine and useless elctrolytes in considerably higher concentrations, whereas nutrients are almost absent in it. This proves that, while the filtrate flows through a uriniferous tubule, not only its volume is reduced, but its composition is also considerably changed. These changes are obviosuly due to an exchange of materials between the filtrate and the blood of Peritubular capillaries.

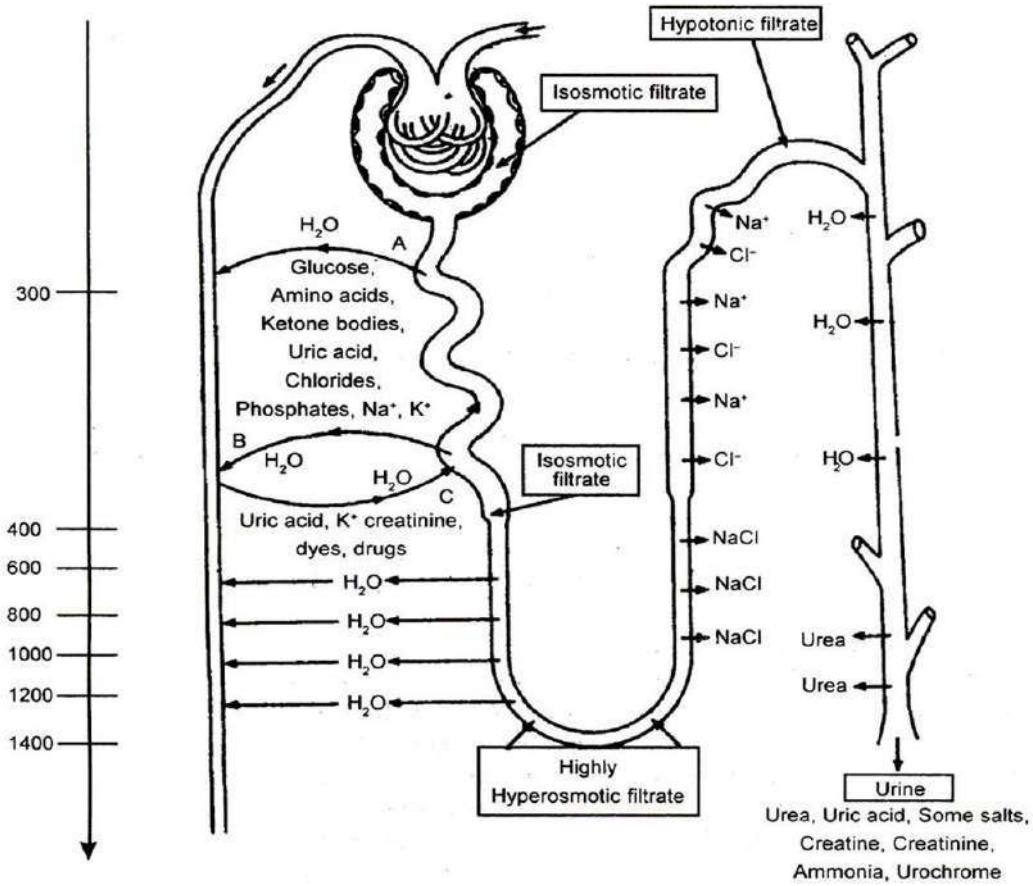
This exhange involves, (1) a **selective reabsorption** of useful materials into the blood form the filtrate and (2) Absorption of remaining unfiltered amount of excretory substance from blood flowing in the peritubular capillaries, by the cells of uriniferous tubules and then subsequent **secretion** of these substances into the filtrate. This selective reabsorption and secretion are finely tuned to maintain homeostatic balances in body fluids.

The blood flows rapidly in peritubular capillaries and with a very low pressure (only about 13 mm Hg). Due to this reason fluid can diffuse into these capillaries from surrouding tissue fluid, but cannot filter out of them. this reabsorption involves both active and passive processes.

(III) Tubular secretion :

In addition to its role in selective reabsorption of material from the glomerular filtrate back into the blood of peritubular capillaries via the renal interstitium, the distal part of proximal convoluted tubule also alters the composition of filtrate by a process of secretion. Epithelial cells in this part extract certain excretory substances from the blood of peritubular capillaries and secrete these into the filtrate. For example, uric acid filtered by glomerulus is almost completely reabsorbed in the first part of proximal tubule, but is later withdrown from blood and secreted into the filtrate in distal part of proximal tubule, Other secreted substances include H^+, K^+ , NH_4^+, creatinine, etc and certain dyes and drugs, like phenol red, penicillin, hippuric acid and its derivatives etc. Secretion of H^+ helps in controlling blood pH.

Permeability chart
PCT ⟶ Water, NaCl
Descending loop ⟶ Water only
Thin ascending loop ⟶ NaCl only and urea (inwards)
Thick ascending loop ⟶ Na^+, K^+ Pumps and Cl^- follows passively



Changes occurring stepwise in the filtrate while it flows through the tubules :

(1) Bownman's capsule : Since all plasma solutes, except proteins, freely enter into glomerular filtrate from blood, the total solute concentration (osmolality 300 milliosmoles per litre) of the filtrate is essentially the same as that of plasma. Here the filtrate is thus **isotonic** (isosmotic) to the plasma.

Concentration ↔ , Volume ↔

(2) Proximal convoluted tubule : The microvilli of the "brush-border" columnar cells of the epithelium of this tubule increase the internal surface of the epithelium about 20 times. Hence, this epithelium becomes most suitable for reabsorption . About 65 % to 80% of the filtrate is reabsorbed into the blood of peritubular capillaries through this epithelium and surrounding tissue fluid (renal interstitium). Most of the solutes like glucose, amino acids, vitamins, ketone bodies, acetoacetic acid, uric acid, chlorides, sodium. potassium, phosphates etc of the filtrate are reabsorbed into the blood by diffusion and active transport. Some urea is also reabsorbed. Sulphates, creatinine, inulin and PAH (para amino hippuric acid) are not reabsorbed. As most of the solutes are reabsorbed, water automatically goes back into the blood by osmosis leaving the osmotic pressure in the filtrate unchanged . Thus, the filtrate is reduced in volume, but it **still remains isotonic** to the plasma.

- Concentration ↔ , volume ↓

(3) Descending limb of henle's loop : The loop of Henle is divisible into four parts, namely Thick descending limb, the Thin descending limb, the Thin segment of ascending limb, and the Thick segment of ascending limb.

In mammalian kidneys, the osmolality of renal interstitium is different in renal cortex and medulla. Where as the cortical interstitium has the normal osmolality of 300 mL osmol/liter, the medullary interstitium has a gradient of increasing osmollity from the cortex upto the tips of the papillae. (300 to 1400 mL osmol/ liter).

The thin wall of descending limb of Henle's loop is *permeable to water, but not to the solutes.* As the isotonic tubular fluid flows down this limb, it gradually loses water by exosmosis due to increasing osmolality of medullary interstitium through which this limb extends. This leaves a small volume of concentrated (**hypertonic** to blood plasma)tubular fluid to enter into the ascending limb of Henle's loop.

- Concentration ↑ , Volume ↔

(4) Ascending limb of Henles loop : The thin segment of the ascending limb of henle's loop is structurally like the descending limb, but its permeability is different. It is *quite permeable to NaCl but not to water.* Due to decreasing osmolality of medullary interstitium towards cortex, the tubular fluid, therefore, loses Na^+ and Cl^- by diffusion, again becoming diluted and **isotonic** to plasma without changing in volume.

- Concentration ↑ , Volume ↔

The wall of the thick ascending limb of Henle's loop is virtually *impermeable to both water and solutes*, but the plasma membrane of its cells is very rich in $Na^+ - K^+$ *pumps*. These pumps pump out Na^+ by active transport, and Cl^- passively diffuse out following the outflux of Na^+ . Thus the process of dilution of the tubular fluid continues in this limb. Consequently, the tubular fluid becomes considerably **hypotonic** to blood plasma without a change in its volume.

- Concentration ↑ , Volume ↔

(5) Distal convoluted tubule (DCT) : In the distal convoluted tubule, active reabsorption of Na^+ and that of Cl^- continues by facilitated diffusion and hence the tubular fluid becomes still more diluted . It also helps to regulate blood pH by reabsorption of HCO_3^- which is an important buffer.

- In proximal DCT Concentration ↑ , Volume ↔ While in distal DCT Concentration ↑ , Volume ↓

(6) Collecting duct : From the distal convoluted tubule, the hypotonic tubular fluid flows into a collecting duct. This duct is *quite permeable to water but not to salt* (in presence of some ADH). Hence the tubular fluid loses considerble amount of water by exosmosis as the duct runs down through the hypertonic medullary interstitium to empty into the calyx. The distal part of collecting duct is permeable

to urea also. Hence same urea is also reabsorbed from tubular fluid and it adds to the hyperosmolality of medullary interstitium .

- Concentration ↑ , Volume ↔

After loosing considerable amount of water and some urea, while flowing through the collecting ducts, the filtrate ultimately becomes **urine.**

Chemical composition and physical characteristics of urine : Normal urine contains about 95% water 2% electrolytes (ions of salts, mainly chlorides, sulphates, phosphates and bicarbonates of sodium, potassium, ammonium, etc), 2.6% urea, 0.3% uric acid and traces of creatinine, ammonia, creatine etc. It is transparent but pale yellow due to the presence of a trace of urochrome pigment. Urochrome is a by product of haemoglogin degradation found in blood and filtered into glomerular filtrate Normal urine is slightly acidic with a pH of 6.00 (range is 4.5 to 8.2). Its specific gravity is 1.015 to 1.02. On standing, it becomes cloudy an acquires ammonia odour due to formation of ammonium carbonate.

OSMOREGULATION BY KIDNEYS

Kidneys also perform the important function of omoregulation (regulation of osmolality) by regulating the amount of water in body fluids. The normally functioning kidneys produce a large volume of dilute urine when more water is taken, and a small volume of concentrated urine when water intake by the body is poor or there is considerable loss of water from the body. This function of kidneys is regulated by the antidiuretic hormone **(ADH or Vasopressin)** secreted by the posterior lobe of pituitary gland. This hormone increases the water permeability of the last part of distal convoluted tubules and proximal part of the collecting ducts. In a absence of ADH, these parts are almost impermeable to water and therefore the urine is dilute. But in presence of ADH, these parts becomes quite permeable to water, so that much of the water present in tubular fluid is reabsorbed and the urine becomes concentrated. Besides ADH, the hormone **aldosterone**, secreted by adrenal glands, also plays important role in osmoregulatory function of kidneys by increasing Na^+, K^+ and Cl^- reabsorption from the filterate.

DILUTION MECHANISM (CORTICAL NEPHRONS)

The osmolality of body fluids normally remains about 300 mL osmol per litre of water. When amount of water increases, this osmolality decreases. This switches off the secretion of a ADH from pituitary gland, but stimulates secretion of aldosterone from adrenal glands. Absence of ADH makes the walls of distal convoluted tubules and collecting ducts almost completely impermeable to water. Contrarily, due to secretion of the aldosterone the walls of ascending limb of Henls's loop. distal convoluted tubule and collecting duct become quite permeable to sodium, postassium and chloride ions. As a result of this Na^+ and Cl^- ions are reabsorbed from the filtrate flowing up the ascending limb of Henle's loop and mostly water and waste products remain in the filtrate. By the time this filtrate reaches into the distal tubule, it becomes very hypo-osmotic with only about 100 mL osmol/litre osmolality. Then, as this diluted fluid passes through the distal tubule and collecting duct, some more of the remaining ions, especially of sodium (Na^+) are reabsorbed actively so that the osmolality of ultimate dilute urine is decreased to as low as about 65 to 70 mL osmol/litre. Dilution of urine mainly occurs in cortical nephrons.

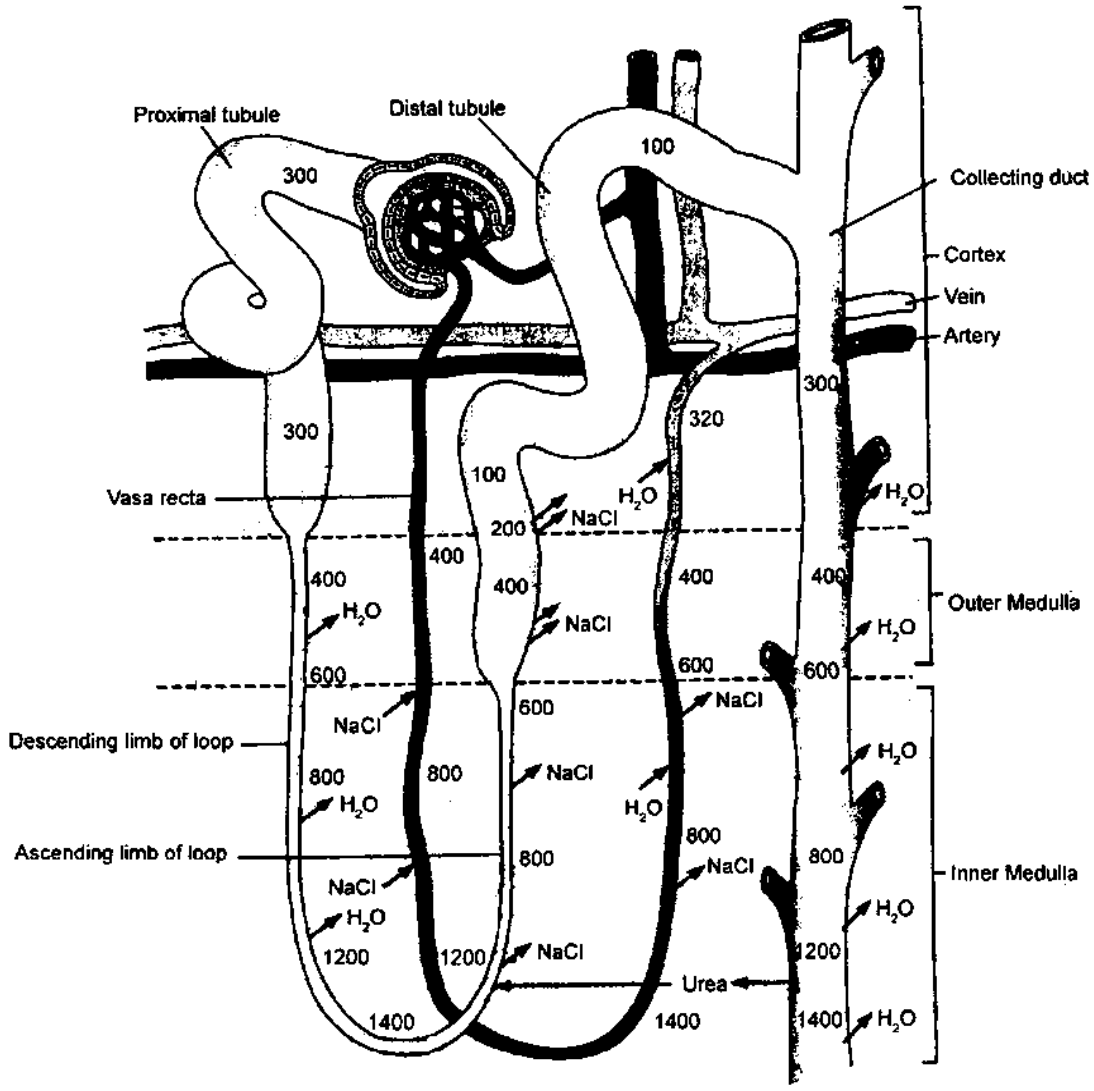
Diuresis and Hypertension : Normally, we excrete about 1.5 litres of urine per day. Diluted urine is excreted in larger volumes a condition called **diuresis.** When due to the inefficient regulation, the kidneys fail to adequatly dilute the uine, the body fluids are diluted and their increased volume cause hypertension (↑ BP).

Glucose, urea, mannitol and other diuretic substances are administered to such patients. The kidneys

excrete these substances and water is automatically excreted out with these. Caffeine of tea is also diuretic. That is why, urination becomes more frequent when more tea is taken . contrarily, if secretion of ADH is permanently hampered or blocked in a patient, the urine becomes very dilute and tasteless (insipid),. This condition is called **diabetes insipidus**. intermittent urination at short intervals and thirst are the only discomforts in this condition.

CONCENTRATION MECHANISM (JUXTAMEDULLARY NEPHRONS)

During times of low water intake or excessive water loss, for example, due to heavy perspiration , diarrhoea, vomiting, etc the kidneys must conserve water while still eliminating wastes and excess ions. The kidneys accomplish this by producing concentrated urine. It is primarily the long-looped juxtamedullary nephrons which establish the conditions for producing concentrated urine which may be four to five times more concentrated (1200 to 1400 osmol/litre) than plasma. concentrating the urine is under regulation of ADH and depends on presence of a steep gradient of increasing hyperosmolarity in the interstitial fluids of medullary pyramids.



Medullary heper osmolality : The osmolality of renal cortical interstitium is the same (300 mL osmol/ litre) as in other tissues, but that of the interstitium of renal medulla is hypertonic with a gradient of hyperosmolality from renal cortex to the tips of medullary papillae. Under the conditions in which a concentrated urine is to be produced the hyperosmolality of medullary interstitium near the tips of the papillae is as high as 1200 to 1400 mL osmol/litre.

Countercurrent mechanism to maintain medullary hyperosmolality : The gradient of increasing hypersomolality of medullary interstitium is maintained by a peculiar countercurrent mechanism operated by the Henle's loops of juxtamedullary nephrons and vasa recta. About 15% to 20% of the nephrons in mammalian kidney are situated at the level where cortex and medulla meet and, hence called **juxtamedullary nephrons.**

The Henle's loops of these nephrons are thin and long and extend almost upto the tips of medullary papillae. The peritubular capillaries associated with these Henle's loops are also very thin and in the form of thin loops extending almost upto the tips of medullary papillae. These capillary loops are called **vasa recta.** A counter current can be defined as the flow of a fluid in opposite directions in the two arms of a U-tube if the arms are rather very close together. Thus, the Henle's loops of juxtamedullary nephrons and vasa recta are anatomically ideal for the operation of countercurrent mechanism.There are two aspects of this mechanism, **(1) countercurrent multiplication** and **(2) countercurrent exchange.** The Henle's loops play the role of contercurrent multipliers. The vasa recta plays the role of countercurrent exchanger.

Since the concentration of tubular fluid in descending limb reflects the concentration of medullary interstitium, and since the concentration in the interstitium is raised by extrusion of salt from ascending limb, a positive feedback mechanism is created. *The more salt the ascending limb extrudes, the more concentrated will be the fluid that enters into it from descending limb.* Obviously, this feedback mechanism is the key point in the **countercurrent multiplier system.**

Countercurrent exchange : In order for the countercurrent multiplier system to be effective in creating the gradient of medullary hyposmolality, most of the salt extruded by the ascending limb of Henle's loop must remain in medullary interstitium, while most of the water coming out of the descending limb must be drained off into the blood. This is accomplished by the vasa recta by means of the mechanism known as countercurrent exchange. **Salt** is thus recirculated and trapped within the medullary interstitium, But contrarily, the **water** diffuses into the blood of ascending limb of vasa recta and is carried away into general blood circulation.

Significacne of urea :

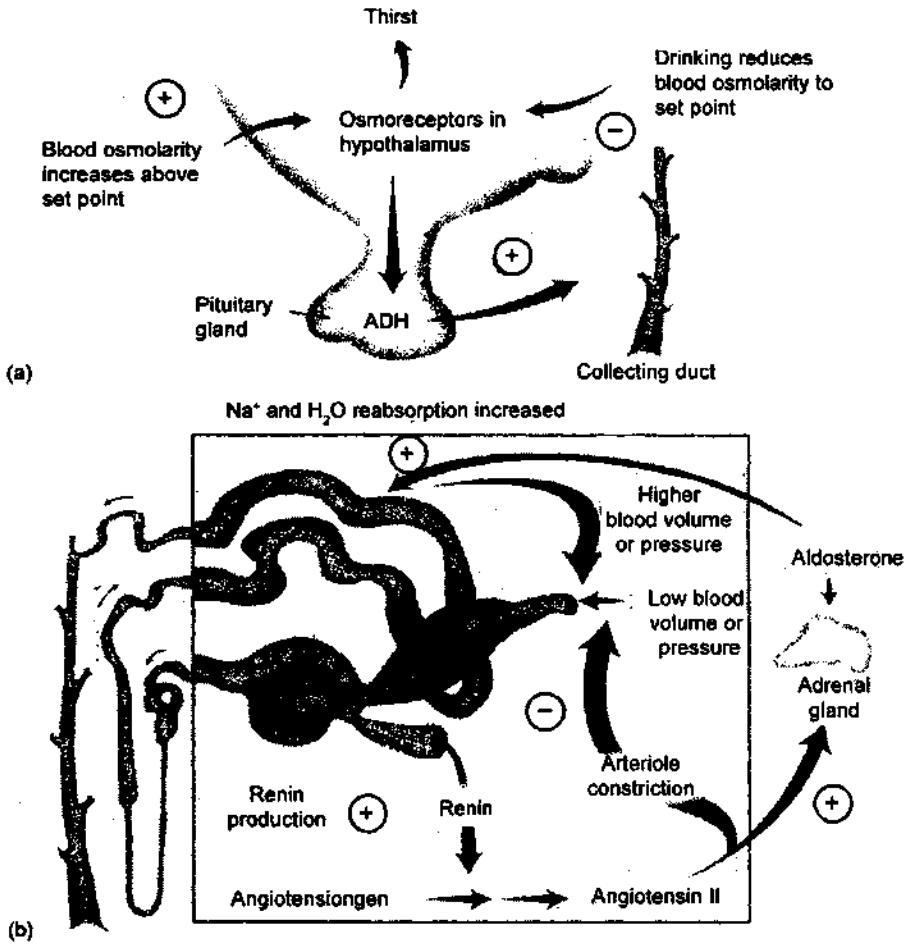
Permeability to urea is found only in the deeper parts of thin ascending limbs of Henle's loops and collecting ducts. urea diffuses out of the collecting ducts and enters into the thin assending limbs down its concentration gradients. A certain amount urea recycle in this way is trapped in medullary interstitium.

Role of distal convoluted tubule, collecting duct and ADH : As described above, the role of countercurrent mechanism is to proudce a small volume of highly hypotonic (osmolality only about 100 mL osmol/litre) tubular fluid which enters from the thick ascending limb of Henle's loop into the distal convoluted tubule and, thereafter into the collecting duct. To finally produce a very small volume of highly concentrated urine from this hypotonic tubular fluid is the role of distal convoluted tubule and collecting duct under the influence of the antidiuretic hormone (ADH). ADH triggers synthesis of a large number of molecules of a specific protein, named **aquaporin,** in the epithelial cells of distal convuled tubule and more particularly of collecting duct. Molecules of aquaporin become incorporated in the plasma membrane of these cells as integral proteins and act as water channels. Consequently some water is lost from hypotonic tubular fluid by exosmosis while it flows through the distal convoluted tubule, but most of the water of tubular fluid is lost across the wall of collecting duct via aquaporin as this duct traverses through the medullary interstitium to empty into a calyx, Due to this, the osmolality of the urine emptied into the calyx becomes 1200 to 1400 mL osmol/litre.

REGULATION KIDNEY FUNCTION BY FEEDBACK CIRCUITS

Two important hormonal controal of the kidney function by negative feedback circuits. These ara as follows :

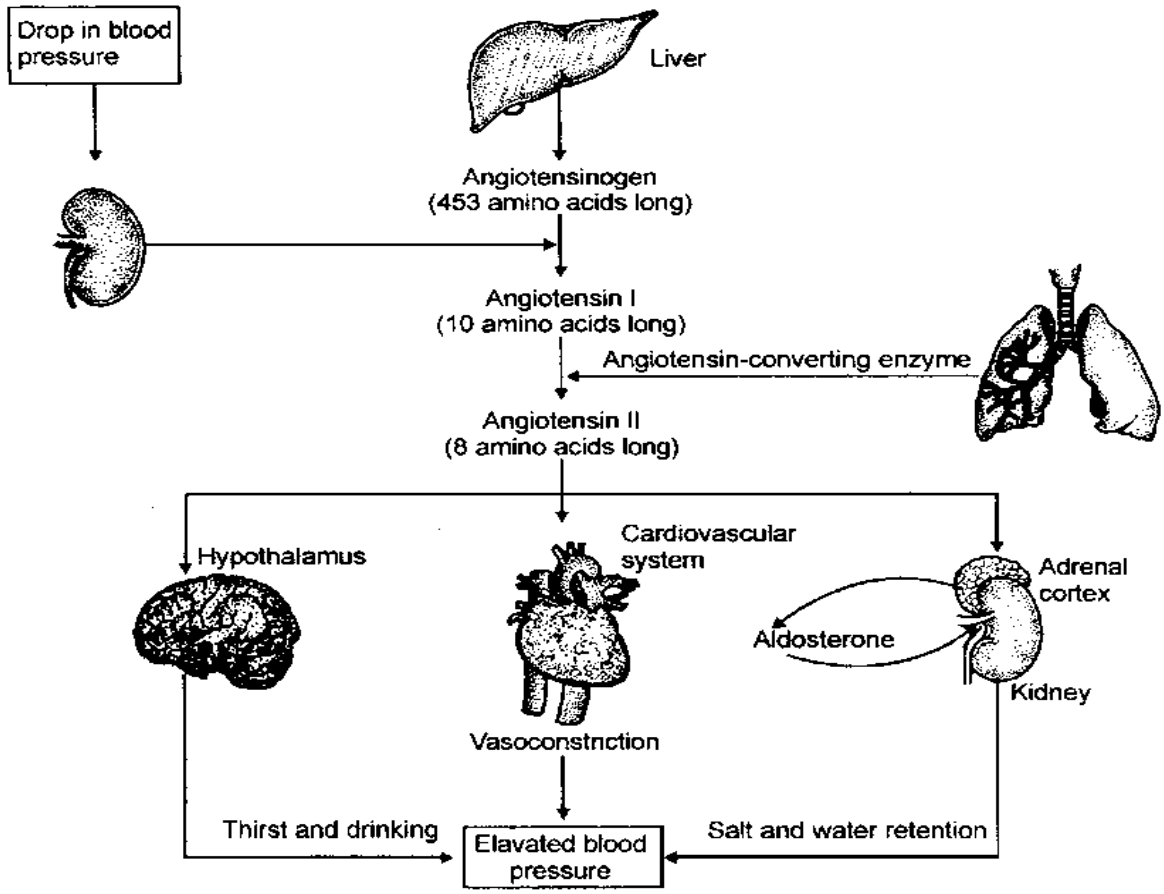
(i) Control by Antidiuretic Hormone (ADH) : ADH is produced in the hypothalamus from the pituitary glands. ADH enhances fluid retention by making the kidneys reabsorb more water. The release of ADH is triggered when osmorecepotors in the Hypothalamus detect an increase in the osmolaity of the blood above a set pont of 300 mosm L^{-1}. In this situation, the osmoreceptor cells also promote thirst. Drinking reduces the osmolarity of the blood, which inhibits the secretion of ADH, thereby completing the feedback circuit.



(ii) Control by Juxtaglomerular Aparatus (JGA) : JGA operates a multi-hormonal **Renin-Angiotensin-Aldosterone System** (RAAS). Whenever there is a fall in BP or blood volume, the JGA responds to this decrease in blood pressure or blood volume in the afferent arteriole of the glomerulus and releases an enzyme called **renin,** into the blood stream. In the blood, renin initiates chemical reactions that convert a plasma protein, called **angiotensinogen** to a peptide, called **angiotensin II**, which works as a hormone. Angiotensin II increases blood pressure by causing arterioles to constrict. It also increases blood volume in two ways.

(1) Firstly, by signaling the proximal convoluted tubules to reabsorb more NaCl and water.

(2) Secondly, by stimulating the adrenal gland to release **aldosterone,** a hormone that induces the distal convoluted tubule to reabsorb more Na^+ and water. This leads to an increase in blood volume and pressure, completing the feedback circuit by supporting the release of renin.



Still another hormone, a peptide called **Atrial Natriuretic Factor** (ANF), opposes the regulation by RAAS. Whenever there is rise in the BP or blood volume , the walls of the atrial of the heart release ANF in response to this increase in blood volume and pressure. ANF inhibits the release of renin from the JGA, and thereby, inhibits NaCl reabosorption by the collecting duct and reduces aldosterone release from adrenal gland. Thus ADH, the RAAS and ANF provid an elaborated system of checks and balance the regulate the kidney functioning, to control body fluid osmolarity, salt concentrations, blood pressure and blood volume.

Role of lungs in excretion :

Human lungs eliminate around 18 L of CO_2 per day and about 400 mL of water per day in normal resting condition. Water loss via the lungs is small in hot humid climate and large in cold dry climates. The rate of ventilation and ventilation pattern (ie.e. breathing through mouth or nose) also affect the water loss through the lungs. Different volatile materials are also readily eliminated throgh the lungs.

Role of skin in excretion :

Human possess two types of glands :

(1) **Sweat glands :** These excrete sweat, Sweat contain 99.5%, Water, NaCl, Lactic acid, Urea, Amino acid and glucose. Volume of sweat may vary from negligible to 14 litres a day.

(2) **Sebaceous glands :** These secrete sebum which conain waxes, sterols, other hydorcarbons and fatty acids.

Integument in many aquatic animals excretes ammonia in surrounding medium by diffusion.

Role of liver in excretion :

Liver is the main site for elimination of cholesterol, bile pigments (bilirubin & bilivirdin), inactivated products of steroid hormones, some vitamins and many drugs. Bile carries these materials to the intestine from where they are excreted with the faeces.

FUNCTIONS OF KIDNEY

- Regulation of water and electrolyte balance.
- Regulation of body fluid osmolality and elctrolyte concentration.
- Regulation of acid base balance.
- Regulation of arterial pressure.
- Excretion of metabolic waste and foreign chemicals
- Secretion of hormones like erythropoeitin and renin.
- Gluconeogenesis from amino acids.

DISORDERS OF KIDNEYS

(i) Artificial kidney : Artificial kidney, called haemodialyser, is a machine that is used to filter the blood of a person whose kidneys are damaged. The process is called haemodialysis. It may be defined as the separation of small molecules (crytalloids) from large molecules (colloids) in a solution by interposing a semipermeable membrane between the solution and water (dialyzing solution). It works on the principle of dialysis, i.e. diffusion of small solute molecules through a semipermeable membrane (G. dia = = through, lyo = separate). Haemodialyser is a cellophane tube suspended in a salt-water solution of the same composition as the normal blood plasma, except that no urea is present. Blood of the patient is pumped from one of the arteries into the cellophane tube after cooling it to 0oC and mixing with an anticoagulant (heparin). Pores of the cellophane tube allow urea, uric acid, creatinine, excess salts and excess H+ ions to diffuse from the blood into the surrounding solution. the blood, thus purified, is warmed to body temperature, checked to ensure that it is isotonic to the patient's blood, and mixed with an antiheparin to restore its normal clotting power. It is then pumped into a vein of the patient. Plasma proteins remain in the blood and the pores of cellophane are too small to permit the passage of their large molecules. The use of artificial kidney involves a good deal of discomfort and a risk of the formation of blood clots. It may cause fever, anaphylaxis, cardiovascular problems and haemorrhage. Kidney transplant is an alternative treatment.

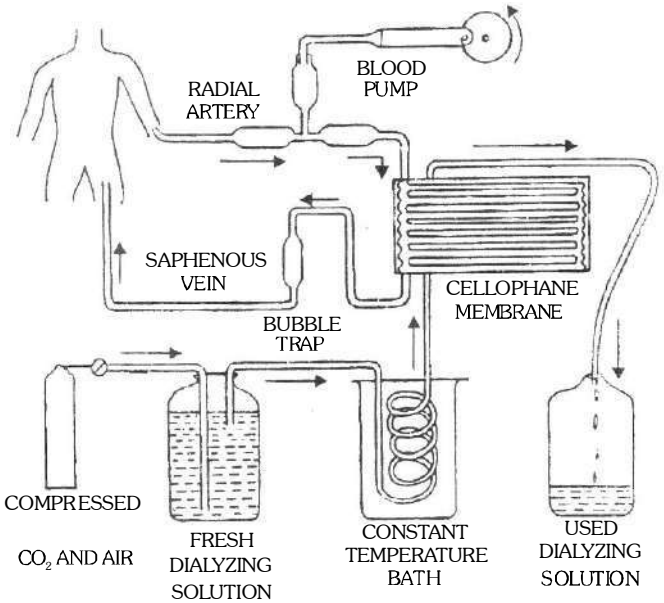


Fig. – Flow of blood through an artificial kidney for haemodialysis

C.A.P.D. : Continuous ambulatory peritoneal dialysis.

(ii) Kidney (Renal) Transplantation

Meaning : Grafting a kidney from a compatible donor to restore kidney functions in a recipient suffering from kidney failure is called renal transplantation.

History : First kidney transplant was performed between identical twins in 1954 by Dr. Charles Hufnagel, a Washington surgeon, India's first kidney transplant was done on December 1, 1971 at Christian Medical College, Vellore, TamilNadu. The recipient was a 35 years old person Shaninughan.

Eligibility : All patients with terminal renal failure are considered eligible for kidney transplantation, except those at risk from another life-threating disease.

Donors : A living donor can be used in a kidney transplant. It may be in identical twin, a sibling, or a close relative. If the living donors are not available, a cadaveric donor may be used (cadaver is a dead body). Over half of the kidney transplants are from cadavers.

Success rate : A kidney transplant from an identical twin, called isogeneic graft or isograft, is always successful. A renal transplant from a sibling or a close relative or a cadaver, termed allogeneic graft or homograft, is usually successful with the use of an immunosupressant that prevents graft rejection by body's immune response. Many renal transplant recipients are known to have retained functional grafts for over 20 years. Earlier, renal transplantation was limited to patients under 55 years. Now, however, with better techniques, kidney grafting has been done in selected patients in the 7th decade of life.

Pretransplant preparation : It includes haemodialysis to ensure a relatively normal metabolic state, and provision of functional, infection-free lower urinary tract.

Donor selection and kidney preservation : A kidney donor should be free of hypertension, diabetes, and malignancy. A living donor is also carefully evaluated for emotional stability, normal bilateral renal function, freedom from other systematic disease, and histocompatibility. Cadaveric kidney is obtained from previously healthy person who sustained brain death but maintained stable cardiovascular and renal function. Following brain death, kidneys are removed as early as possible, flushed with special cooling solutions, such as mannitol and stored in iced solution. Preserved kidneys usually function well if transplanted within 48 hours.

Recipient-Donor Matching : Recipient and donor are tested for 3 factors :

- **Blood groups :** Recipient's blood group should be compatible with donor's blood group.
- **Human leucocyte antigen (HLA) :** It is a genetic marker located on the surface of leucocytes. A person inherits a set of 3 antigens from the mother and three from the father. A higher number of matching antigens increases the chances that the kidney graft will last for a long time.
- **Antibodies :** Small samples of recipient's and donor's blood are mixed in a tube. If no reaction occurs, the patient will be able to accept the kidney.

Transplant procedure : Transplantation is done under general anaesthesia. Operation takes 3 or 4 hours. Cut is given in the lower abdomen. Donor's kidney is transplanted retroperitonealy in the iliac fossa. Artery and vein of new kidney are connected to the iliac artery and vein of the recipient. Ureter of the new kidney is connected to the urinary bladder of the recipient. Often the new kidney starts producing urine as soon as blood flows through it, but sometimes it may take a few weeks before it starts working. A week's stay in the hospital is necessary to recover from surgery, and longer if there are complications. The new kidney takes over the work of two failed kidneys. Unless they are causing infection or high blood pressure, the old kidneys are left in place.

Immunosupression : Immunosupression means to depress the immune response of the recipient to graft rejection. Prophylactic immunosuppressive therapy is started just before or at the time of renal transplantation. An ideal immunosuppressant suppress immunity against foreign tissue but maintains

immunity against infection and cancer. The drug, named cyclosporin, in such an immunosupressant. Use of antiserum to human lymphocytes is equally useful. It destroys T-cell mediated immune responses, but spares humoral antibody responses.

During embryonic development, nephrotome plate develops from mesoderm which is made up of fine tubules called **nephros.**

Nephrotome develops into kidney while neprons develops into Nephrons or Uriniferous tubules. On the basis of development, kidney are of 3 types.

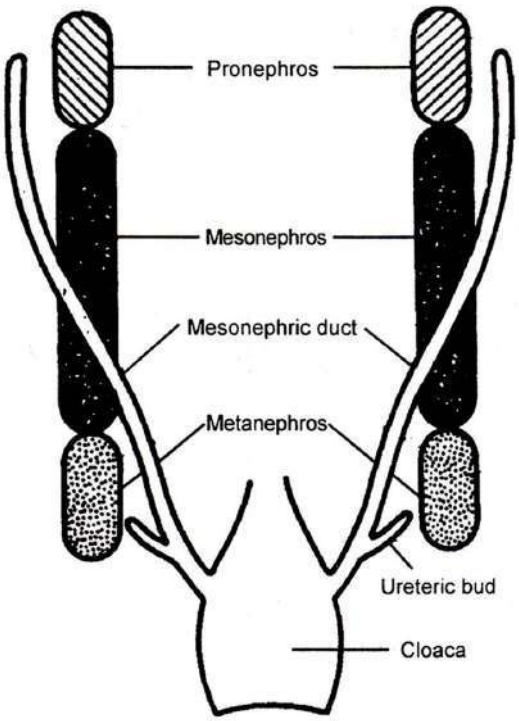
(1) Pronephric Kidney : Develop from anterior part (Pronephros) of Nephrotome plate, Its nephrons are in simple tubular shape. Nephrons are not differentiated Eg. Cyclostomates & Tadpole of frog.

(2) Mesonephric Kidney or opisthonephros : Develop from middle part (Mesonephros of) Nephrotome plate & remaining part of nephtotome is destroyed.Only Bowman's capsule is found in nephrons while remaining part is simple tubular.

Eg. Most of the fishes & adult Amphibians.

(3) Metanephric Kideny : Develops from posterior part (Metanephros) of nephrotome while remaining part is destoyed. Nephrons are will diffrentiated into Bowman's capusle PCT, DCT & loop of Henle's

Eg. Reptile, Aves, Mammals



Pronephros, Mesonephros & Metanephros

Henle's Loop :

- Less development in Reptiles
- Incompletely Developed in Aves
- Mammals have most developed Henles loops.

Autoregulation of GFR

Two important intrinsic mechanisms provide autoregulation of glomerular filtration rate :

(a) Myogenic mechanism : An increase in blood pressure will tend to stretch the afferent arteriole, which would be expected to increase the blood flow to the glomerulus. The wall of the afferent arteriole, however, responds to stretch by contraction, this reduces the diameter of the arteriole, and therefore causes increase in the resistance to flow. This myogenic mechanism, thus, reduces variations in flow to the glomerulus in case of fluctuations in blood pressure.

(b) Juxtaglomerular apparatus (JGA) : This specialised cellular apparatus is located where the distal convoluted tubule passes close to the Bowman's capsule between the afferent and efferent arterioles.JGA cells secrete enzymes like renin that modulate blood pressure, and thus renal blood flow and GFR are regulated. This discused earlier in the sheet.

Thus myogenic and Juxtaglomerular mechanisms work together to autoregulate the GFR Over a wide range of blood pressure.

REGULATION OF URINE FORMATION

HORMONAL REGULATION

1. Antidiuretic hormone or vasopressin

(i) It is secreted by posterior lobe of pituitary gland.

(ii) It inhances the reabsorption of water in the distal convoluted tubule and collecting duct.

2. Thyroxine

Deficiency of thyroxine leads to reduction in urine output.

3. Parathormone

It is secreted by parathyroid gland. It increase calcium reabsorption in renal tubule. It also reduces the reabsorption of phosphate in the renal tubules.

NERVOUS REGULATION

(i) Nerves arising from central nervous system are connected with both kidneys. The central nervous system sends impulse to the kidneys.

(ii) Nerve impulses regulates constriction and dilation of blood vessels of renal tubule. All these changes regulates urine formation.

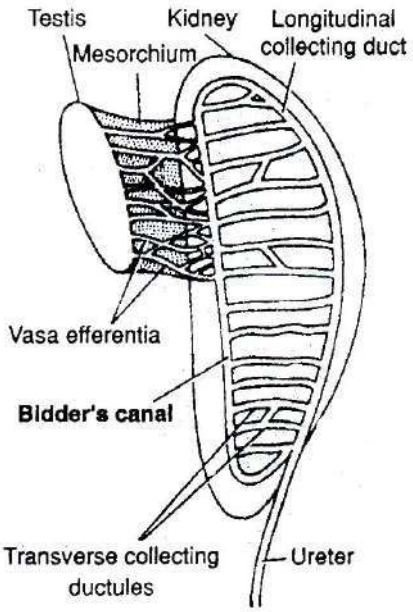


Diagram showing relationship of collecting ducts

IMPORTANT TIPS

Anuria - Failure of kidney to form urine.

Oligourea - is less urine output.

Cystitis - Inflammation of urinary bladder.

Filtration fraction - Ratio between GFR (glomerular filtration rate) and RPF (renal plasma flow).

Gout - Painful great toe (arthiritis) due to deposition of uric acid.

Haematuria - Presence of blood cells in urine.

Oedema - Increased volume of interstitial fluid.

Polynephritis - Inflammation of large number of nephrons.

Renal stone - Stone formation in the nephrons of kidney due to accumulation of mainly calcium oxalates some phosphates and uric acid.

Trimethylamine - Excretory product of marine teleosts (bony fishes).

Uraemia - High concentration of urea (about 10 times) in blood.

Chloragogen cells - Found in coelomic fluid of earthworm and are analogous (functionally similar) to human liver as are excretory in function.

Contractile vacuole - Osmoregulatory apparatus of fresh-water protozoans like Amoeba, Parmaecium etc. So contractile vacuole is functionally analogous to vertebrate kidney.

Glomerulonephritis - Chronic inflammation of glomeruli due to streptococcal infection.

Aminoaciduria - Urine with amino acids like cystine, glycine, etc.

Polyuria - Increased urine volume.

Allantoin and allantoic acid are nitrogenous excretory products formed during embryonic development of amniotes with shelled eggs. Allantoin is also called embryonic waste by allantoic acid is stored in allantois foetal membrane.

Chances of infection of urinary tract are more in women due to shroter urethra.

Urate cells - These are excretory cells of fat body of insects. These store excretory waste permanently called storage excretion.

Bright disease - Characterised by nephritis caused by streptococal infection.

Ptosis - Displacement of kidney.

Dysuria - Painful urination.

Certain animals are both ammonotelic and ureotelic e.g. Ascaris, earthworm, lung fish (African toad), etc.

Aminotelism - Expelling of amino acids as nitrogenous waste e.g. molluscs like Unio, Echinoder like Asterias, etc.

Chordate with flame cells is Branchiostoma (also called Amphioxus).

Nocturia - Increased volume of urine at night.

Abnormal constituent of urine - (i.e. Not present in normal condition)

1. **Protein -** If protein is present in urine it may be due to infection or injury in kidney. (Mainly albumin is filtered)
2. **Blood -** Due to infection and injury of kidney blood may appear in urine.
3. **Sugar -** In diabetes mellitus sugar appear in urine.
4. **Bile of bile pigment -** In jaundice bile pigment appear in urine.
5. **Ketone bodies -** In starvation and diabetes. Ketone bodies appear in urine.

Diabetes mellitus - Sugar appear in urine due to hyposecretion of insulin.

Diabetes incipidus - Tasteless more urine passing due to hyposecretion of A.D.H.

EXERCISE - 1

Q.1 The retroperitoneal kidney is -

(1) Kidney of fish

(2) Kidney covered by Peritonium on ventral side

(3) Kidney covered by Peritoneum on Dorsal side

(4) Kidney uncovered by Peritoneum on Dorsal Side.

Q.2 Difference between glomerular filtrate and plasma is of -

(1) Proteins

(2) Potassium

(3) First is white where as later is yellow

(4) First is yellow whereas later is white

Q.3 Excretory products of mammalian embryo are eliminated by -

(1) Placenta (2) Amniotic fluid

(3) Allantois (4) Ureters

Q.4 Workers in deep mines usually suffer from dehydration because -

(1) Water is lost due to evaporation

(2) Water is lost due to defeacation

(3) Water is lost in the form of urines

(4) Water is lost along with salts in the form of

Q.5 A condition of failure of kidney to form urine is called

(1) Diuresis (2) Hematuria

(3) Anuria (4) Ketonuria

Q.6 Diuresis is the condition in which -

(1) The excretory volume of urine increases

(2) The excretory volume of urine decreases

(3) The kidney fails to excrete urine

(4) The water balance of the body is disturbed

Q.7 Net filtration pressure in the glomerulus in kidney of man is about :–

(1) +75 mm Hg (2) +80 mm Hg

(3) +25 mm Hg (4) +50 mm Hg

Q.8 Loops of Henle occurs in -

(1) Cortex (2) Medulla

(3) Pelvis (4) Ureter

Q.9 Separation of amino and carboxylic groups from an amino acid is -

(1) Animation (2) Lysis

(3) Digestion (4) Deamination

Q.10 In frog nitrogenous waste Products are eliminated mainly as -

(1) Urea in tadpole & ammonia in adult frog

(2) Ammonia in tadpole and urea in adult frog

(3) Urea in both tadpole & adult frog.

(4) Urea in tadpole and uric acid in adult frog

Q.11 Which blood vessel contains the least amount of urea

(1) Hepatic Vein (2) Renal Vein

(3) Hepatic portal vein (4) Renal artery

Q.12 Ammonia is the main nitrogenous excretory material in -

(1) Amphibians (2) Turtles

(3) Tadpoles (4) Reptiles

Q.13 Presence of RBC in urine is called -

(1) Anuria (2) Haematuria

(3) Glycosuria (4) Ketonuria

Q.14 The blood vessel taking blood into Bowman's capsule is

(1) Afferent arteriole (2) Efferent arteriole

(3) Renal vein (4) Renel portal vein

Q.15 A man has taken large amount of protein in his diet. He will excrete more of

(1) Urea (2) Uric acid

(3) Sugar (4) Salts and water

Q.16 Ornithine cycle is related to -

(1) Respiration (2) Excretion

(3) Digestion (4) Nutrition

Q.17 In ornithine cycle, enzyme arginase breaks down arginine into -

(1) Citrulline and ammonia

(2) Ornithine and ammonia

(3) Ornithine and urea (4) Citrulline adnurea

Q.18 Cause of glomerular filtration is -
(1) Dialysis (2) Osmosis
(3) High hydrostatic pressure
(4) Diapedesis

Q.19 In glomerulus ultrafiltration occurs through
(1) Endothelial pores
(2) Basement membrane
(3) Podocytes.
(4) Inter podocytic spaces

Q.20 Trimethylamine is the excretory product in-
(1) Marine teleosts (2) Fresh water fishes
(3) Molluscs (4) Amphibians

Q.21 In mammals the urinary bladder opens into -
(1) Ureter (2) Urethra
(3) Vestibule (4) Uterus

Q.22. In rabbit and humans, the kidney is -
(1) Metanephric (2) Mesonephric
(3) Pronephric (4) Opisthonephric

Q.23 Urea is derived from
(1) Fats (2) Amino acids
(3) Carbohydrates (4) Uric acid

Q.24 Ammonia is excretory material in -
(1) Cartilaginous fishes (2) Fresh water fishes
(3) Whale (4) Camel

Q.25 Animals which excrete large amount of ammonia are
(1) Terrestrial (2) Amphibians
(3) Egg laying (4) Aquatic

Q.26 Ureotelic animals are those in which the main nitrogenous waste product is
(1) Amino acids (2) Urea
(3) Uric acid (4) Ammonia

Q.27 Excretory product of mammals is
(1) Salts (2) Glucose
(3) Urea (4) Ammonia

Q.28 Volume of urine is regulated by
(1) Aldosterone
(2) Aldosterone and ADH
(3) Aldosterone, ADH and testosterone
(4) ADH

Q.29 Urine of a human being suffering from diabities insipidus is
(1) Tasteless and thick (2) Sweet and thick
(3) Tasteless and watery
(4) Sweet and watery

Q.30 Malpighian corpuscles occur in -
(1) Medulla (2) Cortex
(3) Pelvis (4) Pyramid

Q.31 Reabsorption of glucose from glomerular filtrate occurs in
(1) Collecting tube
(2) Loop of Henle
(3) Proximal convoluted tubule
(4) Distal convoluted tubule

Q.32 Blood fraction remaining unchanged after circulation through kidney is
(1) Urea and uric acid
(2) Urea and Proteins
(3) Urea and glucose
(4) R.B.C. and proteins

Q.33 Which one is uricotelic
(1) Frog and toads
(2) Lizards and birds
(3) Cattle, money and man
(4) Molluscs and teleost fishes

Q.34 Which one is the most soluble in water
(1) Uric acid (2) Urea
(3) Fatty acids (4) Casein

Q.35 Brush border is characteristic of
(1) Neck of Nephron
(2) Collecting tube
(3) Proximal convoluted tubule
(4) All the above

Q.36 ADH controls water permeability of
(1) Collecting tube
(2) Proximal convoluted tuble
(3) Distal convoluted tuble
(4) Both 1 & 3

Q.37 What will happen if one kidney is removed from the body of a human being
(1) Death due to poisoning
(2) Ureamia and death
(3) Stoppage of urination
(4) Nothing the person will survive and remain normal

Q.38 Occurrence of excess urea in blood due to kidney failure is -
(1) Urochrome (2) Uraemia
(3) Uricotelism (4) Ureotelism

Q.39 What is true about distal convoluted tubule
(1) Na^+ reabsorption requires energy Na^+
(2) K^+ reabsorption does not require energy K^+
(3) Ammonia is excreted
(4) Water reabsorption requires energy

Q.40 Total filtrate formed in 24 hours in human kidney is
(1) 1.8 litres (2) 8.0 litres
(3) 18 litres (4) 180 litres

Q.41 In cockroach, the excretory product is
(1) Ammonia (2) Uric acid
(3) Urea (4) Both 1 and 3

Q.42 In kidney glomerulus is involved in
(1) Reabsorption of salts
(2) Urine collection
(3) Urine formation by blood filtration
(4) All the above

Q.43 The mechanism of urine formation in nephron involves
(1) Ultrafiltration (2) Secretion
(3) Diffusion (4) Osmosis

Q.44 Glomerular filtrate contains glucose in comparison to plasma
(1) More (2) Same
(3) Less (4) Nill

Q.45 In diabetes mellitus the patient drinks more water as there is urinary loss of
(1) Salt (2) Insulin
(3) Protein (4) Glucose

Q.46 The hormone that promotes reabosorption of water from glomerular filtrate is
(1) Oxytocin (2) Vasopressin
(3) Relaxin (4) Calcitonin

Q.47 Glucose is taken back from glomerular filtrate through
(1) Active transport (2) Passive transport
(3) Osmosis (4) Diffusion

Q.48 Which of the following is totally reabsorbed in renal tubules :-
(1) Na (2) K
(3) H_2O (4) $C_6H_{12}O_6$

Q.49 Part not belonging to uriniferous tubule is
(1) Glomerulus (2) Henle's loop
(3) Distal convoluted tuble
(4) Collecting duct

Q.50 Ornithine cycle operates in
(1) Stomach (2) Pancreas
(3) Liver (4) Oral cavity

Q.51 Reabsorption of chloride ions from glomerular filtrate in uriniferous tubule occurs by-
(1) Active transport (2) Diffusion
(3) Osmosis
(4) Brownian movement

Q.52 Main functions of kidney is
(1) Passive absorption
(2) Ultrafiltration
(3) Selective reabsorption
(4) Both 2 & 3

Q.53 Ornithine cycle performs
(1) ATP synthesis
(2) Urea formation in spleen
(3) Urea formation in liver
(4) Urine formation in liver

Q.54 If benzoic acid is present in the food of mammals, it is excreted out in the form of-
(1) Ornithuric acid (2) Aspartic acid
(3) Uric acid (4) Hippuric acid

Q.55 Person suffering from muscular dystrophy eliminate in urine a great amount of-

(1) Glucose (2) Sulphate

(3) Water (4) Creatinine

Q.56 Urea is formed in liver cells from

(1) Ammonia and Nitrogen

(2) Ammonia and carbon dioxide

(3) Ammonia carbon dioxide and aspartic acid

(4) Ammonia and carbon monoxide

Q.57 The stage of ornithine cycle at which arginase enzyme is used-

(1) Ornithine-citrulline

(2) Citrulline-arginosuccinic acid

(3) Arginine-ornithine

(4) Ornithine-urea

Q.58 In man the two kidneys lie-

(1) At the level of ovaries

(2) At the same level

(3) Left kidney at a higher level than the right one

(4) Right kidney at a higher level than the left one

Q.59 Which one is the diluting segment of uriniferous tubules

(1) Ascending loop of Henle

(2) Descending loop of Henle

(3) PCT

(4) DCT

Q.60 Vasa rectae are peritubular capillaries around

(1) Posterior part of alimentary canal

(2) PCT

(3) Loop of Henle

(4) DCT

Q.61 Micturition is

(1) Removal of urea from blood

(2) Removal of uric acid

(3) Passing out urine

(4) Removal of Fats

Q.62 Glomerular filtration rate would be decreased by-

(1) Constriction of the efferent arteriole

(2) An increase in afferent arteriolar pressure

(3) Compression of the renal capsule

(4) An increase in renal blood flow

Q.63 Diameter of the renal afferent vessel is

(1) Same as that of efferent

(2) Smaller than that of efferent

(3) Larger than that of efferent

(4) There is no efferent vessel

Q.64 The afferent and efferent vessels are

(1) Arterial in nature

(2) Venous in nature

(3) One is arterial and the other is venous

(4) None of the above

Q.65 Physiologically urea is produced by the action of an enzyme.

(1) Uricase (2) Urease

(3) Arginase (4) None

Q.66 A notch present on the medial side of kidney is known as

(1) Ureter (2) Pelvis

(3) Hilus (4) Pyramid

Q.67 The narrow apex of pyramid is called

(1) Column of bertini

(2) Calyx

(3) Papillary duct of Bellini

(4) Pelvis

Q.68 Bowman's capsule is lined by

(1) Ciliated cuboidal epithelium

(2) Squamous epithelium

(3) Nonciliated cuboidal epithelium

(4) Non ciliated columnar epithelium

Q.69 Functional & structural unit of kidney is

(1) Nephron (2) Seminiferous tubule

(3) Acini (4) None

Q.70 Nephron is also known as
(1) Juxto glomerular tubule
(2) Seminiferous tubule
(3) Uriniferous tubule (4) All

Q.71 Nephron is made up of
(1) Malpighian body (2) Tubule
(3) Both (4) None

Q.72 If we remove the pressure receptors from urinary bladder wall.
(1) There will be no micturition
(2) Micturition will continue
(3) Urine will collect in the bladder
(4) None

Q.73 Filtration fraction is the ratio of-
(1) GFR and RPF (2) Hb and HbO_2
(3) O_2 and CO_2 (4) HCO_3 and H_2CO_3

Q.74 Out of the following which is the abnormal condition of urine
(1) Diuretic (2) Alkaptonuria
(3) Haematomesis (4) None

Q.75 Urea is transported by
(1) Plasma (2) RBC
(3) WBC (4) All

Q.76 One is increased in blood of a person whose kidney is not working properly
(1) Urea (2) Ammonia
(3) Sodium chloride (4) None

Q.77 One is found in blood not in Nephric filtrate
(1) Urea (2) Glucose
(3) Amino acids (4) Globulin

Q.78 Uraemia is a disease when there is an excess of
(1) Cholesterol in the blood
(2) Glucose in the blood
(3) Urea in the blood (4) Urea in Urine

Q.79 Excretion in the form of uric acid and urates in birds is helpful in
(1) Conserving body heat
(2) Eliminating excess water
(3) Conserving body water
(4) Eliminating body water

Q.80 Maintenance of internal body tissue fluid is
(1) Excretion (2) Osmoregulation
(3) Homeostatis (4) None

Q.81 Urine is acidic due to presence of
(1) HNO_3 (2) HCI
(3) NaH_2PO_4 (4) H_2SO_4

Q.82 Discharge of bile pigments in urine indicates
(1) Anaemia (2) Diabetes
(3) Jaundice (4) Rickets

Q.83 Uric acid excretion is carried out by-
(1) Ultrafiltration
(2) Selective reabsorption
(3) Secretion (4) None

Q.84 One of the following in impermeable to H_2O
(1) PCT (2) DCT
(3) Descending limb (4) Ascending limb

Q.85 The snakes living in deserts are mainly
(1) Ammonotelic (2) Aminotelic
(3) Ureotelic (4) Uricotelic

Q.86 What is the pH value of human urine
(1) 2.00 (2) 6.00
(3) 7.5 (4) 8.00

Q.87 Which of the following is not a structure of kidney?
(1) Cortex (2) Medulla
(3) Calyx (4) Ureter

Q.88 Keto uria is
(1) Albumin in urine (2) Globulin in urine
(3) Ketone bodies in urine
(4) None of the above

Q.89 Glycosuria is the term used for-
(1) Loss of blood in urine
(2) Loss of glucose in urine
(3) Loss of salt in urine (4) None of these

Q.90 One is not the function of kidney
(1) Osmoregulation (2) Salt retention
(3) Excretion (4) Synthesis of urea

Q.91 The elimination of the insoluble $CaPO_4$ takes place by
(1) Kidney (2) Liver
(3) Large intestine (4) All

Q.92 The yellow colour of urine of vertebrates is due to-
(1) Cholestrol (2) Urochrome
(3) Urinod (4) None

Q.93 Which is the simplest excretory organs :-
(1) Alveoli (2) Flame Cells
(3) Nephridia (4) Kidney

Q.94 Characteristic smell of urine is due to
(1) Urea (2) Uric acid
(3) Urinod (4) None

Q.95 One of the following excrete urea
(1) Snakes (2) Birds
(3) Insects (4) None

Q.96 Uric acid excretion is an adaptation for
(1) Water conservation (2) Water removal
(3) Osmoregulation (4) None

Q.97 NH_3 is
(1) Less toxic (2) Toxic
(3) Highly toxic (4) None

Q.98 NH_3 change into urea in presence of
(1) Arginase enzyme (2) Urinase enzyme
(3) Xanthine oxidase (4) None

Q.99 In embryonic kidney 1st stage of development is
(1) Pronephric (2) Mesonephric
(3) Metanephric (4) None

Q.100 Loop of Henle is found in
(1) Pronephric kidney
(2) Meta nephric kidney
(3) Both (4) None

Q.101 Incomplete loop of Henle is found in
(1) Frog (2) Lizzard
(3) Bird (4) Mammal

Q.102 Complete loop of Henle is found in
(1) Amphibia (2) Reptilia
(3) Birds (4) Mammals

Q.103 Mammals are characterised by
(1) Metanephric kidney with loop of Henle
(2) Mesonephric kidney with out Henle loop
(3) Metanephric kidney with out Henle loop
(4) Proanephric without Henle loop

Q.104 Duct of Bellini concerned with
(1) Filtration of urine
(2) Purification of urine
(3) Conduction of urine
(4) All the above

Q.105 G.F. at the base of Henle's loop is
(1) Isotonic (2) Hypotonic
(3) Hypertonic (4) Insoluble

Q.106 Which vitamin is excreted out in high quantity through urine in man
(1) Vit C. (2) Vit D
(3) Vit E (4) Vit K

Q.107 Ornithine cycle discovered by
(1) Kreb and kornberg
(2) Hans kreb
(3) Kred and Henseleit
(4) Embden

Q.108 "Homeostasis" term proposed by
(1) Clude Bernard (2) Water cannon
(3) Marcello Malpighi (4) Henle

Q.109 Which part of Nephron composed of ciliated epithelium
(1) P.C.T. (2) D.C.T.
(3) Neck (4) 1 & 2 both

Q.110 Ureotelic kidney is found in
(1) Man (2) Frog
(3) Rabbit (4) All

Q.111 Contractile vacuole of Amoeba is equal to
(1) Kidney (2) Liver
(3) Intestine (4) Skin

Q.112 Urine contains How much water
(1) 96% (2) 90%
(3)70% (4) None

Q.113 Which secretes Renin
(1) Stomach
(2) Juxta glomerular body
(3) Juxta cortical cell
(4) Juxta medullary cell

Q.114 Podocytes are present in
(1) Afferent arteriole (2) Efferent arteriole
(3) Peritubular network
(4) Bowman's cup

Q.115 Which excretory material is least toxic
(1) Ammonia (2) Urea
(3) Uric acid
(4) Trimethylamine oxide

Q.116 Which is absent in Glomerular filtrate
(1) Blood corpuscles (2) Fats
(3) Proteins (4) All

Q.117 Inner wall of Urinary bladder composed of
(1) Unstriped muscles (2) Striped muscles
(3) Statified epithelium
(4) Transitional epithelium

Q.118 Changeable threshold material in Renal tubules
(1) Water and Glucose (2) Urea & Uric acid
(3) Glucose & Amino acids
(4) Water & salts

Q.119 Which material composed the "Gall stone from layered
(1) $CaCO_3$ (2) Oxalates
(3) Cholesterol (4) $CaSO_4$

Q.120 Excretory material are formed in
(1) Kidney (2) Rectum
(3) Liver (4) Everybody cell

Q.121 Sulphates phosphates and carbonates of calcium are excreted by
(1) Kidney (2) Liver
(3) Spleen (4) Colon

Q.122 Which regulates reabsorption of salts from Glomerular filtrate
(1) Oxytocin (2) Vassopressin
(3) Glucocorticoides (4) Mineralo corticoids

Q.123 Patients of diabeties have glucose in urine because
(1) Glucose is not absorbed from G.F.
(2) Glucose is absorbed from G.F.
(3) Glandular cells secreted glucose in G.F.
(4) Concentration of glucose is more in G.F. as compared to its normal amount

Q.124 Mesonephric kidney develops from
(1) Anterior part of nephrotome
(2) Middle part of Nephrotome
(3) Posterior part of nephrotome
(4) None

Q.125 Kidney is
(1) Ectodermal (2) Mesodermal
(3) Endodermal (4) None

Q.126 In male frog ureter transfer
(1) Urine (2) Sperms
(3) Both (4) None

Q.127 Pyramids in both kidneys of rabbit are
(1) 2 (2) 4
(3) 6 (4) 10

Q.128 Pyramids in kidney of man are
(1) 4 (2) 6
(3) 8 (4)12

Q.129 Na^+ and Cl^- both are removed by-
(1) Ascending limb of Henle's loop
(2) Proximal convoluted tubule
(3) Both (1) and (2)
(4) Descending limb of Henle's loop

Q.130 Trimethylamine oxide (TMO) is excreted by certain-
(1) Elasmobranches (2) Seashore birds
(3) Marine teleosts (4) Freshwater teleosts

ANSWER KEY

EXERCISE - 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	3	4	3	1	3	2	4	2	2	3	2	1	1	2	3	3	1	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	2	2	4	2	3	2	3	2	3	4	2	2	3	4	4	2	1	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	3	1	3	4	2	1	4	4	3	2	4	3	4	4	2	3	3	1	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	3	3	1	3	3	3	2	1	3	3	1	1	2	1	1	4	3	3	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	3	3	4	4	2	4	3	2	4	3	2	2	3	4	1	3	1	1	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	4	1	3	3	1	3	2	3	4	1	1	4	4	3	4	4	4	3	4
Ques.	121	122	123	124	125	126	127	128	129	130										
Ans.	4	4	4	2	2	3	1	4	3	3										

EXERCISE - 2

Q.1 Excretion involves process in which –
(1) Harmful substance are stored in cells before being eliminated
(2) Expulsion of urine from the urinary bladder and sweat from the skin
(3) Harmful substance in the body are chemically changed
(4) Substance of no further use or those present in excessive quantities are thrown out of the body

Q.2 In aquatic organisms the waste end product of nitrogen metabolism is –
(1) Urea (2) Ammonia
(3) Nitrogen (4) Allantois

Q.3 Ammonotelic animals are predominantly –
(1) Terrestrial (2) Parasitic
(3) Volant (4) Aquatic

Q.4 Which of the following is likely to accumulate in dangerous proportion in the blood of a person whose kidney is not working properly–
(1) Urea (2) Sodium chloride
(3) Ammonia (4) Lysine

Q.5 Urea is transported by –
(1) Blood plasma (2) Leucocytes
(3) RBCs (4) Haemoglobin

Q.6 Which of the following sets of animals are uricotelic –
(1) Fish, frog, lizard and fowl
(2) Fish, snake, fowl and man
(3) Camel, dog, monkey and man
(4) Crow, snake, cockroach and lizard

Q.7 Major nitrogenous waste product in ureotelic animals like rabbit and other mammals is –
(1) Ammonia (2) Amino acids
(3) Urea (4) Uric acid

Q.8 Which of the following sets of animals produce the same substance as their chief excretory product –
(1) Camel, housefly and snake
(2) Fish, pigeon and frog
(3) Amoeba, ant and antelope
(4) Frog, monkey and dog

Q.9 The blood which leaves the liver and moves to the heart has higher than the usual contents of–
(1) Oxygen (2) Urea
(3) Bile (4) Water

Q.10 Urea is a nitrogenous waste. Which of the following substance contribute to the nitrogen–
(1) Mineral salts (2) Amino acids
(3) Vitamins (4) Lipids

Q.11 A man, has taken a large amount of protein in his diet. He will excrete more of –
(1) Uric acid (2) Salt and water
(3) Urea (4) Sugar

Q.12 Most insects are –
(1) Uricotelic (2) Ammonotelic
(3) Aminotelic (4) Ureotelic

Q.13 Uric acid is chief excretory product in –
(1) Insects (2) Earthworms
(3) Amphibians (4) Mammals

Q.14 The snakes living in deserts are mainly –
(1) Ammonotelic (2) Aminotelic
(3) Uricotelic (4) Ureotelic

Q.15 The least toxic nitrogenous waste is –
(1) Ammonia + urea (2) Ammonia
(3) Uric acid (4) Urea

Q.16 In reptiles, uric acid is stored in –
(1) Anus (2) Cloaca
(3) Liver (4) Fat bodies

Q.17 If benzoic acid is present in the food of mammals, it is excreted out in the form of–
(1) Hippuric acid (2) Ornithinic acid
(3) Uric acid (4) Aspartic acid

Q.18 The excretory product of excess metabolism of creatine is
(1) Oxalic acid (2) Uric acid
(3) Creatinine (4) Urea

Q.19 Column of Bertini is found in –
(1) Liver (2) Kidney
(3) Ovaries (4) Testes

Q.20 Man is –
(1) Ammonotelic (2) Ureotelic
(3) Uricotelic (4) None of these

Q.21 The retroperitoneal kidney is –
(1) Kidney covered by peritoneum on ventral side
(2) Kidney of fish
(3) Kidney uncovered by peritoneum on dorsal side
(4) Kidney covered by peritoneum on dorsal side

Q.22 The position of kidney is –
(1) Inter peritoneal (2) Retroperitoneal
(3) Intraperitoneal (4) None of these

Q.23 The kidneys not only remove the waste products from the blood but also play a very important role in maintaining –
(1) Constant composition of the blood irrespective of the nature of the food or fluid intake
(2) Blood pressure constant
(3) Temperature of the body
(4) Equilibrium of the body

Q.24 The functional part of the kidney of adult reptiles, birds and mammals is –
(1) Holonephros (2) Pronephros
(3) Mesonephros (4) Metanephros

Q.25 Kidney is not distinguished into cortex and renal medulla in
(1) Frog (2) Man
(3) Rabbit (4) Camel

Q.26 The main function of pyramids of kidney is to-
(1) Direct the urine to flow in ureter
(2) Contain collecting tubules of kidney
(3) Store fats and protein
(4) Support the openings of collecting canals

Q.27 Which of the following influences the activity of kidney –
(1) Vasopressin and adrenalin
(2) Gonadotrophins
(3) Thyroxine (4) Vasopressin

Q.28 Which feature enables the mammalian kidney to concentrate urine in the medullary region –
(1) Rapid removal of sodium ions form the medullary tissues
(2) Maintaining a high osmotic pressure in the tissues between the tubules
(3) High oxidative metabolism of medullary cells
(4) Rapid flow of blood through the medulla

Q.29 In the kidney of the rabbit, the Loop of Henle is the part of –
(1) Collecting duct (2) Glomerulus
(3) Uriniferous tubule (4)Bowman's capsule

Q.30 Trimethylamine oxide (TMAO) is excreted by–
(1) Molluscs (2) Fresh water fishes
(3) Marine teleosts (4) Amphibians

Q.31 In the kidney, the formation of urine involve the following processes arranged as –
(1) Reabsorption, filtration and secretion
(2) Glomerular filtration, selective reabsorption and tubular secretion
(3) Filtration, secretion and reabsorption
(4) Secretion, absorption and filtration

Q.32 Which one is not the function of kidney –
(1) Acid-base balance (2) Osmoregulation
(3) Urea synthesis (4) Salt balance

Q.33 Kidney are not only the organs of excretion their work is supplemented by –
(1) Large intestine (2) Lungs
(3) Liver (4) Skin

Q.34 A severe fall in blood pressure disturbs the function of kidneys and reduces –
(1) Reabsorption of useful substances
(2) Glomerular filtration
(3) Secretion of nitrogenous waste
(4) Renal filtration

Q.35 The loop of Henle is most highly developed in-
(1) Mammals (2) Desert lizards
(3) Fresh water fishes (4) Salamanders

Q.36 The animal that excretes amino acids without deamination is –
(1) Spider (2) Unio
(3) Housefly (4) Frog

Q.37 Ammonia is the chief nitrogenous excretory material in –
(1) Cartilaginous fishes (2) Fowl
(3) Fresh water fishes (4) Mosquitoes

Q.38 A nephron does not have loop of Henle in –
(1) Rabbit (2) Dog
(3) Frog (4) Man

Q.39 In a glomerulus –
(1) Afferent capillaries are thicker than efferent capillaries
(2) Afferent arteriole is thicker than efferent arteriole
(3) Afferent arteriole is thinner than efferent arteriole
(4) Afferent capillaries are thinner than efferent capillaries

Q.40 Malpighian body is constituted by –
(1) Glomerulus, Bowman's capsule and efferent vessel
(2) Glomerulus and efferent vessel
(3) Glomerulus and Bowman's capsule
(4) Glomerulus only

Q.41 Which one of the following substance is completely reabsorbed from the filtrate in the renal tubule under normal condition –
(1) Urea (2) Uric acid
(3) Salt and water (4) Glucose

Q.42 High blood pressure is maintained in glomeruli than in other capillaries because –
(1) The variability of the diameters of arterioles causes higher resistance to blood flowing out of the glomeruli than to out of the capillaries
(2) Glomeruli has low hydrostatic pressure than capillary
(3) Capillary has less diameter than glomeruli
(4) All the above

Q.43 The afferent and efferent vessels are –
(1) Arterial in nature
(2) Venous in nature
(3) One is arterial and the other is venous
(4) None of the above

Q.44 Blood vessel leading to glomerulus is called
(1) Afferent arteriole (2) Renal artery
(3) efferent arteriole (4) Renal vein

Q.45 Juxtaglomerular cell of the kidney secrete –
(1) ADH (2) Aldosterone
(3) Renin (4) Angiotensin

Q.46 Ultrafilatration occurs in a glomerulus when-
(1) Osmotic pressure exceeds hydrostatic pressure
(2) Hydrostatic pressure exceeds osmotic pressure
(3) Colloidal osmotic pressure plus capsular pressure remain less than glomerular hydrostatic pressure
(4) Capsular hydrostatic pressure exceeds glomerular hydrostatic pressure

Q.47 Workers in deep mines usually suffer from dehydration because –
(1) Water is lost due to defecation
(2) Water is lost due to evaporation
(3) Water is lost along with salts in the form of sweat
(4) Water is lost in the form of urine

Q.48 If humidity is high in the presence of high temperature, we feel unpleasant due to –
(1) More sweating
(2) No sweating
(3) Less sweating
(4) Failure of sweat to evaporate due to excessive humidity

Q.49 The yellow colour of urine is due to –
(1) Urea (2) Melanin
(3) Uric acid (4) Urochrome

Q.50 Excretion is a continuous process but urine is not passed out continuously because of –

(1) Ureter (2) Rectum

(3) Urinary bladder (4) Cloaca

Q.51 The effect of antidiuretic hormone (ADH) on the kidney is to –

(1) Increase the excretion of Na^+

(2) Increase the excretion of water

(3) Increase the glomerular filtration rate

(4) Increase the permeability of the distal convoluted tubule of nephron to water

Q.52 ADH will be released from the posterior pituitary when there is a decrease in –

(1) Plasma potassium concentration

(2) Plasma pH

(3) Plasma sodium concentration

(4) Plasma volume

Q.53 If we remove the pressure receptors from the urinary bladder wall –

(1) Micturition will continue

(2) Their will be no micturition

(3) Urine will collect in the bladder

(4) There will be no collection of urine in bladder

Q.54 Mammalian kidney serve to excrete –

(1) Excess salts, urea and excess water

(2) Excess water, urea and amino acids

(3) Excess salts, urea and glucose

(4) Excess salts, excess water and excess amino acids

Q.55 Aquatic animals are mostly ammonotelic because –

(1) Excretion of ammonia requires large amount of water which is available to these animals

(2) Ammonia helps in checking inflow of water into body

(3) These get less light

(4) Water contains less nitrogen

Q.56 Aldosterone stimulates the reabsorption of–

(1) Keto acids (2) Glucose

(3) K^+ ions (4) Na^+ ions

Q.57 Percentage of which increases in blood if liver becomes functionless –

(1) Uric acid (2) Proteins

(3) Urea (4) Ammonia

Q.58 Which blood vessel carries least percentage of urea –

(1) Renal artery (2) Pulmonary vein

(3) Hepatic portal vein (4) Renal vein

Q.59 Glomerular filtration rate would be decreased by –

(1) an increase in renal blood flow

(2) Compression of the renal capsule

(3) An increase in afferent arteriolar pressure

(4) Constriction of the efferent arteriole

Q.60 One of the following substance is not found in mammalian urine –

(1) Ammonium salt (2) Sucrose

(3) Sodium chloride (4) Water

Q.61 In which part of excretory system of mammals can you first use the term 'urine' for contained fluid –

(1) Urinary bladder (2) Collecting tubule

(3) Bowman's capsule (4) Loop of Henle

Q.62 In public urinals, the urine on standing gives a pungent smell, due to –

(1) Conversion of uric acid into ammonia by ornithine cycle

(2) Conversion of both urea and uric acid into ammonia

(3) Conversion of urea into ammonia by bacteria

(4) None of these

Q.63 A person who is starving, that is not having food, water and beverages will have –

(1) Less urea in his urine

(2) Less fats in his urine

(3) More glucose in his blood

(4) More urea in his blood

Q.64 When certain marine organisms are placed in distilled water, they ultimately die. Which could be the most likely explanation –
(1) Excess of water in the tissues
(2) Loss of water from the tissue
(3) Loss of permeability of some membranes
(4) Loss of salts

Q.65 An advantage of excreting nitrogenous wastes in the form of uric acid is that –
(1) The formation of uric acid requires a great deal of energy
(2) Uric acid can be excreted in almost solid form
(3) Uric acid may be excreted through the lungs
(4) Uric acid is the first metabolic breakdown products of acids

Q.66 The amount of the original filtrate volume which is reabsorbed by the time the tubular fluid enters the Henle's loop is approximately–
(1) 75% (2) 95%
(3) 85% (4) 90%

Q.67 What is "renal threshold" –
(1) The highest concentration of substances upto which it is totally reabsorbed from glomerular filtrate
(2) At which all the substances are reabsorbed
(3) At which the filtration of a substance starts
(4) At which no substance is filtered in the glomerulus

Q.68 Which group of the following contains the final excretory product –
(1) Allantois, hippuric acid, ornithinic acid
(2) Ornithine, cytosin, citruline
(3) Trimethyl aminoxide, citruline, arginine
(4) Creatine, cretinine, citruline

Q.69 The glomerular filtrate contains –
(1) Blood minus cells
(2) Blood minus cell and proteins
(3) Plasma minus cells and proteins
(4) Blood minus proteins

Q.70 The vessel leading blood (containing nitrogenous waste) into the Bowman's capsule is known as –
(1) Afferent arteriole (2) Renal vein
(3) Efferent arteriole (4) Renal artery

Q.71 High threshold substances are the substances which can be –
(1) Excreted by the nephrons
(2) Ultrafiltered in the glomerulus
(3) Reabsorbed actively
(4) Secreted actively

Q.72 Which of the following is not an intermediate product in the biosynthesis of urea –
(1) Orinithine (2) Citrulline
(3) N-acetyl glutamate (4) Arginine

Q.73 Ornithine is converted into citrulline by an enzyme –
(1) Aspartic glutamic transaminase
(2) Glutamic dehydrogenase
(3) Ornithine carbamyl transferase
(4) Carbamyl phosphate synthetase

Q.74 Urea cycle in liver was discovered by –
(1) Bowman and Krebs
(2) Krebs and Henseleit
(3) Landsteiner and Weiner
(4) Bayliss and Sterling

Q.75 Which of the following terms refer to painful urination –
(1) Enuresis (2) Dysuria
(3) Anuria (4) Ketosis

Q.76 In diabetes mellitus, the patient drinks more water as there is urinary loss of –
(1) Protein (2) Salt
(3) Insulin (4) Glucose

Q.77 Presence of RBCs in urine is called –
(1) Glycosuria (2) Pyuria
(3) Albuminuria (4) Haematuria

Q.78 A patient who excretes large quantity of sodium in urine has –
(1) Diseased adrenal cortex
(2) Diseased adrenal medulla
(3) Diseased parathyroid
(4) Diseased thymus

Q.79. A kidney stone is –

(1) Deposition of sand in kidney

(2) Blockage by fats

(3) Blockage by proteins

(4) A salt such as oxalate crystallised in pelvis

Q.80 Glycosuria is the terms used for –

(1) Loss of glucose in urine

(2) Loss of blood in the urine

(3) Loss of salts in the urine

(4) None of these

ANSWER KEY

EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	2	4	1	1	4	3	4	2	2	3	1	1	3	3	2	1	3	2	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	2	2	4	1	2	1	2	3	3	2	3	4	2	1	2	3	3	2	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	1	1	1	3	3	3	4	4	3	4	4	2	1	1	4	4	4	2	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	3	1	1	2	1	1	1	2	1	3	3	3	2	2	4	4	1	4	1

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Part not belonging to uriniferous tubule is– **[AIPMT 94]**

(1) Glomerulus (2) Henle's

(3) Distal convoluted tuble

(4) Collecting duct

Q.2 Which pair is correct– **[AIPMT 2000]**

(1) Sweat = temperature regulation

(2) Saliva = sense of food taste

(3) Sebum = sexual attraction

(4) Humerus = Hind leg

Q.3 Malpighian corpuscles are present in– **[RPMT 2001]**

(1) Cortex (2) Medulla

(3) Germinal cells (4) None of them

Q.4 In rabbit and humans, the kidney is– **[BHU 82, CPMT 91]**

(1) Metanephric (2) Mesonephric

(3) Pronephric (4) Opisthonephric

Q.5 Brush border is characteristic of **[AIPMT 90]**

(1) Neck of nephron

(2) Collecting tube

(3) Proximal convoluted tuble

(4) All the above

Q.6 Which type of kidneys are found inamphibian– **[RPMT 2002]**

(1) Holonephric (2) Mesonephric

(3) Pronephric (4) Meta nephric

Q.7 Difference between glomerular filtrate and plasma is of– **[DPMT 85]**

(1) Proteins

(2) Potassium

(3) First is whit where as later is yellow

(4) First is yellow whereas later is white

Q.8 Effective filtration pressure in the glomerulus in kidney of man is about **[CPMT 90]**

(1) + 75 mm Hg (2) + 10 mm Hg

(3) + 35 mm Hg (4) + 50 mm Hg

Q.9 Nitrogenous waste products are eliminated mainly as– **[AIPMT 91]**

(1) Urea in tadpole & ammonia in adult frog

(2) Ammonia in tadpole and urea in adult frog

(3) Urea in both tadpole & adult frog

(4) Urea in tadpole and uric acid in adult frog

Q.10 Reabsorption of useful substances from glomerular filtrate occurs in **[AIPMT 89]**

(1) Collecting tube (2) Loop of henle

(3) Proximal convoluted tuble

(4) Distal convoluted tuble

Q.11 Blood fraction remaining unchanged after circulation through kidney is –**[MP PMT 88]**

(1) Urea and uric acid

(2) Urea and Proteins

(3) Urea and glucose

(4) Glucose and proteins

Q.12 Which one is the most soluble in water. **[MP PMT 90]**

(1) Uric acid (2) Urea

(3) Fatty acids (4) Casein

Q.13 ADH controls water permeability of– **[BHU 90]**

(1) Collecting tube (distal part)

(2) Proximal convoluted tuble

(3) Distal convoluted tuble (distal part)

(4) All the above

Q.14 What will happen if one kidney is removed from the body of a human being **[MP PMT 98]**

(1) Death due to poisoning

(2) Ureamia and death

(3) Stoppage of urination

(4) Nothing, the person will survive and remain normal kidney will become hypertrophied

Q.15 Occurance of excess urea in blood due to kidney failure is– **[CPMT 91]**

(1) Urochrome (2) Uraemia

(3) Uricotelism (4) Ureotelism

Q.16 What is true about distal convoluted tubule **[MP PMT 91]**

(1) Na^+ reaborption requires energy

(2) K^+ reabsorption does not require energy

(3) Ammonia is excreated

(4) Water reabsorption requires energy

Q.17 Total filtrate formed in 24 hours in human kidney is – **[BHU 92]**

(1) 1.8 litres (2) 8.0 litres

(3) 18 litres (4) 180 litres

Q.18 In kidney glomerulus is involved in – **[CPMT 92]**

(1) Reabsorption of salts

(2) Urine collection

(3) Urine formation by blood filtration

(4) All th above

Q.19 Glomerular filtrate contains glucose in comparison to plasma **[CPMT 92]**

(1) More (2) Same

(3) Less (4) Nill

Q.20 Which of the following is totally reabsorbed in renal tubes **[CPMT 93]**

(1) Na (2) K

(3) H_2O (4) $C_6H_{12}O_6$

Q.21 Ammonia is converted into urea in **[RPMT 95, Manipal 95]**

(1) Heart (2) Spleen

(3) Liver (4) Brain

Q.22 Which vitamin is excreted out in high quantity through urine in man– **[RPMT 2000]**

(1) Vit. C (2) Vit. B

(3) Vit. E (4) Vit. K

Q.23 If the afferent arteriole diameter is less than efferent arteriole than what happen **[Manipal CET 2000]**

(1) No effect

(2) Ultrafiltration reaction is slow

(3) Ultrafiltration is not possilbe.

(4) Ultrafiltration will stop & tubular secretion is start

Q.24 Concentration of urine depends upon which organ– **[AIPMT 2000]**

(1) Bowman's capsule

(2) Length of Henle's loop

(3) P.C.T.

(4) Network of capillaries arising from glomerulus

Q.25 Conversion of ammonia to urea is done by ..... **[AIPMT 2000]**

(1) Ornithine cycle (2) Arginine cycle

(3) Fumaric cycle (4) Citrulline cycle

Q.26 The movement of Ions against the concentration gradient will be–**[AIPMT 200]**

(1) Active transport (2) Osmosis

(3) Diffusion (4) All

Q.27 If henle's loop wer absent from mammalian nephron, which of the following is to be expected– **[AIPMT 2003]**

(1) There will be no urine formation

(2) There wil be hardly any change in the quality and quntity of urine formed

(3) The urine will be more concentrated

(4) The urine will be more dilute

Q.28 Correct order of excretory organs in Cockroach, Earthworm and Rabbit respectively– **[PRMT 2001]**

(1) Skin, malpighi tubules, kidney

(2) Malpighi tubules, kidney

(3) Nephridia, malpighi tubules, kidney

(4) Nephridia, kidney, green gland

Q.29 Which one does not filter out from blood to Bowmans capsule in glomerular ultrafiltration– **[RPMT 2001]**

(1) Amino acids (2) Polypeptide

(3) Glucose (4) Fatty acids

Q.30 Which one of the following body functions is not performed by kidneys **[RPMT 2002]**

(1) Excretion

(2) Osmoregulation

(3) Regulation of blood volume

(4) Detruction of dead blood copuscles

Q.31 Which of the following is excreted in mammals in the form of nitrogen– **[RPMT 2003]**

(1) Ammonium ion (2) Ammonia

(3) Uric acid (4) Urea

Q.32 The net pressure gradient that causes the fluid to filter out of the glomeruli into the glomeruli into the capsule is– **[AIPMT 2005]**

(1) 20 mm Hg (2) 50 mm Hg

(3) 75 mm Hg (4) 30 mm Hg

Q.33 Whic one of the following blood vessel in mammals contains least amound of urea– **[RPMT 2005]**

(1) Hepatic portal vein (2) Hepatic vein

(3) Dorsal aorta (4) Renal vein

Q.34 A person who is on a long hunger strike and is surviving only on water, will have : - **[AIPMT 2007]**

(1) Less urea in his urine

(2) More sodium in his urine

(3) Less amino acids in his urine

(4) More glucose in his blood

Q.35 Water reabsorption in the distal parts of kidney tubules is regulated by : **[CPMT 2002]**

(1) STH (2) TSH

(3) ADH (4) MSH

Q.36 Due to insufficient filtration in the Bowman's capsule, all are likely to happen except : **[AIIMS 1992]**

(1) Accumulation of fluid in the body

(2) Increase in blood pressure

(3) Incrase in blood urea level

(4) Loss of glucose through urine

Q.37 The appearance of albumin in the urine is most likely due to : **[AIIMS 1987]**

(1) Increase in the blood pressure

(2) Decrease in the blood osmotic pressure

(3) Damage to the Malpighian corpuscles

(4) Damage to the proximal convoluted tubules

Q.38 Urinary excretion of Na is regulated by : - **[AIIMS 1992]**

(1) Anterior pituitary (2) Posterior pitultary

(3) Anrenal cortex (4) Adrenal medulla

Q.39 Kidney crystals are solid clusters of : **[AIPMT 1990]**

(1) Calcium nitrate and uric acid

(2) Phosphate and uric acid

(3) Clacium carbonate and uric acid

(4) Calcium metabisulphite and uric acid

Q.40 The yellow colour of urine of vertebrates is due to : **[DELHI PMT 2004]**

(1) Cholesterol (2) Urochrome

(3) Uric acid (4) Melanin

Q.41 Which one of the four parts mentioned below does not constitute a part of a single uriniferous tubule: **[AIPMT 1994]**

(1) Bowman's capsule

(2) Distal convoluted tubule

(3) Loop of Henle (4) Collecting duct

Q.42 Diuresis s a specific pathological condition which lead to : **[MP PMT 2001]**

(1) Increased volume of urine excretion

(2) Decreased volume of urine excretion

(3) Increased glucose excretion

(4) Decreased electrolyte concentration

Q.43 Which one of the following pair of waste substances is removed from blood in ornithine cycle : **[BHU 2001]**

(1) CO_2 and urea
(2) Ammonia and urea
(3) CO_2 and ammonia
(4) Urea and sodium salt

Q.44 Maximum basorption of water in mammals is in : **[BHU 1996]**

(1) Lunge (2) Skin
(3) Kidneys (4) Small intestine

Q.45 The term haematuria is used to describe : **[DELHI PMT 2004]**

(1) Internal bleeding (2) Blood in urine
(3) Blood cancer (4) Blood poisoning

Q.46 Match the following : **[CPMT 1989]**

	'A'		**'B'**
I	Loop of Henle	1.	Carries blood the kidney
II	Renal artery	2.	Area where a considerable amount of reabsorption takes place
III	PCT	3.	Area of secretion
IV	Glomerulus	4.	Filtration of blood
V	DCT	5.	Plays a role in concentration of urine

(1) 5, 1, 2, 4, 3 (2) 5, 1, 2, 3, 4
(3) 1, 5, 3, 4, 2 (4) 2, 1, 3, 5, 4

Q.47 Which of the following is not a function of kidneys : **[Pune CET 2001]**

(1) Regulation of blood pressure
(2) Removal of urea
(3) Regulation of acidity of fluids
(4) Secretion of antibiotics

Q.48 In the kidney, the formation of urine involve the following processes arranged as **[NCERT 1979]**

(1) Glomerular filtration, reabsorption and tubular secretion
(2) Reabsoption, filtration and secretion
(3) Secretion, absorption and filtration
(4) Filtration, secretion and reabsorption

Q.49 The urine of man suffering from Diabetes insipidus is : **[CPMT 1988]**

(1) Sweaty and watery
(2) Sweaty and thick
(3) Tasteless and watery
(4) Tasteless and thick

Q.50 Anadvntage of excreting nitrogenous wastes in the form of uric acid is that : **[AIEEE 2003]**

(1) Uric acid can be excreted in almost solid form
(2) The formation of uric acid requires a great deal of energy
(3) Uric and is the first metabolic breakdown products of acids
(4) Uric acid may be excreted through the lungs

Q.51 Which of the following is correct : **[CPMT 1984]**

(1) Afferent arteriole is narrower than efferent arteriole
(2) Afferent venule is narrower than efferent venule
(3) Efferent arteriole is narrower than afferent arteriole
(4) Efferent venule is narrower than afferent venule

Q.52 What for the ascending limb of Loop of Henle is permeable? **[JIPMER [MED.] 2002]**

(1) Glucose (2) NH_3
(3) Na^+ (4) Water

Q.53 Why do we pass more urine in wet and cold season? **[MP PMT 1997]**

(1) Impairment of water absorption by nephrons
(2) Kidney becomes mor active
(3) Sweating is much reduced
(4) ADH seretion is increased

Q.54 Aquatic reptiles are– **[CPMT 2003]**

(1) Ammonotelic
(2) Ureotelic over land
(3) Ureotelic (4) Ureotelic in water

Q.55 If Henle's loop were absent from mammalian nephron. Which of the following is to be expected– **[AIPMT PMDT 2003]**

(1) The urine will be more in volume

(2) There will be no urine formation

(3) There will be hardly any change in the quality and quantity of urine formed

(4) The urine wll be more concentrated

Q.56 All Bowman's capsules of the kidney are found in – **[JIPMER [MED] 2001]**

(1) Cortex (2) Medulla

(3) Pelvis (4) None of these

Q.57 A conditon of failure of kidney to form urine to form urine is caled– **[AIPMT 1998]**

(1) Deamination (2) Entropy

(3) Anuria (4) None of these

Q.58 Two examples in which the nitrogenous wastes are excreted from body in the form of uric acid are– **[CPMT 2002]**

(1) Birds and lizards

(2) Mammals and mollusc

(3) Insects and bony fishes

(4) frogs and cartilaginous fishes

Q.59 In micturition– **[PB. PMT 1999]**

(1) Uretha relaxes (2) Ureter contracts

(3) Ureter relaxex (4) Urethra contracts

Q.60 What is the characteristic of metanephric kidney– **[MP PMT 2000]**

(1) Hypotonic urine production

(2) Excess secretion of uric acid

(3) Loop of Henle

(4) Hormone production

Q.61 The hormone sereted by kidney is– **[MP PMT 2001]**

(1) Gastrin (2) Secretin

(3) Erythropoietin (4) Aldosterone

Q.62 Which one do not filter out from blood to bowman's capsule in glomerular utrafiltration – **[RPMT 2001]**

(1) Amino acids (2) Polypeptide

(3) Glucose (4) Fatty acids

Q.63 Which type of kidney are found in amphibian– **[RPMT 2002]**

(1) Holonephric (2) Mesonephric

(3) Pronephric (4) Metanephric

Q.64 Which one of the following body functions is not performed by kidneys– **[RPMT 2002]**

(1) Excretion

(2) Osmoregulation

(3) Regulation of blood volume

(4) Destruction of dead blood corpuscles

Q.65 Which of the following are uricotelic animals– **[AIIMS 2002]**

(1) Rohu and frog (2) Lizard and crow

(3) Camel and frog

(4) Earthworm and eagle

Q.66 Marine teleosts, undergoing putrefaction, emit sharp characteristic foul odour, which is due to the production of– **[MP PMT 2002]**

(1) Trimethylamine

(2) Hydrogen sulphide

(3) Ammonia

(4) Lactic Acid

Q.67 Fresh water bony fishes maintain water balance by– **[BHU 2002]**

(1) Excreting a hypotonic urine

(2) Excreting salt across their gills

(3) Drinking small amount of water

(4) Excreting wastes in the form of uric acid

Q.68 Which is mismatched– **[Delhi PMT 2003]**

(1) Bowman's capsule-Glomerular filteration

(2) PCT-Absorption of Na^+ and K^+

(3) DCT-Absorption of glucose

(4) None of these

Q.69 Duct of Bellini opens on– **[BVP 2003]**

(1) Collecting duct (2) Ureter

(3) Renal papilla (4) DCT

Q.70 Uric acid is the main excretory product in – **[Bihar 2002]**

(1) Insects (2) Earthworm

(3) Amphibains (4) Mammals

Q.71 Main function of glomerulus is –**[Bihar 2004]**

(1) Filtration of blood

(2) Reabsorption of H_2O

(3) Reabsorption of Na^+

(4) Concentration of urine

Q.72 If ADH level of blood is less –**[Bihar 2005]**

(1) Volume of urine increases

(2) Volume of urine decreases

(3) Volume of urine is normal

(4) Volume of urine is unaffected

Q.73 Urea formation takes place through **[MP PMT 2003]**

(1) Nitrogen cycle (2) Ornithne cycle

(3) Cori cycle (4) Kreb's cycle

Q.74 Aquatic reptiles are : **[Jharkhand 2003]**

(1) Ammonotelic (2) Ureotelic

(3) Ureotelic in water

(4) Ureotelic over land

Q.75 Loop of Henle is associated with – **[Bihar 2002]**

(1) Uriniferous tubules

(2) Seminiferous tubules

(3) Neurons (4) Muscle fibres

Q.76 Loop of Henle is associated with : - **[Uttarancal PMT 2004]**

(1) Excretory system

(2) Respiratory system

(3) Reporducitve system

(4) Digestive system

Q.77 The complete reabsorption of glucose takes place in - **[MP PMT 2003]**

(1) Collecting tubule (2) Distal tubule

(3) Proximal convoluted tubule

(4) Henic loop

Q.78 Duct of Bellini opens on – **[Bihar 2004]**

(1) Ureter (2) Renal papilla

(3) Duodenum (4) DCT

Q.79 Which of the following is concerned formation of urea in rabbit – **[UP CPMT 2004]**

(1) Blood (2) Kidney

(3) Spleen (4) Liver

Q.80 Loop of Henle is found in – **[UP CPMT 2004]**

(1) Lung (2) Liver

(3) Neuron (4) Nephron

Q.81 Absorption of H_2O in DCT is controlled by - **[UP CPMT 2004]**

(1) ADH (2) ACTH

(3) LH (4) Oxytocin

Q.82 Which of the following is metabolic waste of protein metabolism : - **[MP PMT 2002]**

(1) NH_3, urea and CO_2

(2) Urea, oxygen and N_2

(3) Urea, ammonia and alanine

(4) Urea, ammonia and creatinine

Q.83 A condition in which body's internal environment remains relatively constant within limits is called **[UP CPMT 2004]**

(1) Homeostasis (2) Hemostasis

(3) Cematoma (4) Haemopoiesis

Q.84 The presence of arginase confirms that : **[UP CPMT 2004]**

(1) Urea cycle is operating

(2) Urea cycle may be operating

(3) Arginine is being converted into omithin

(4) Arginine is being converted into citruline

Q.85 The most abundant, harmfual and universal waste product of metabolism is : **[UP CPMT 2004]**

(1) CO_2 (2) Uric acid

(3) H_2O (4) C_2H_5OH

Q.86 Glomerular filtrate contains : - **[UP CPMT 2005]**

(1) Blood without blood cells and proteins

(2) Plasma without sugar

(3) Blood with proteins but without cells

(4) Blood without urea

Q.87 Urea is directly produced in mammals from : - **[UP CPMT 2005]**

(1) Ammonia released by oxidative deamination
(2) Oxidative deamination of purines
(3) Breakdown of ornithine
(4) Breakdown of arginine

Q.88 Glomerular hydrostatic pressure is present in- **[UP CPMT 2007]**

(1) Tubule of kidney
(2) Bowman's capsule
(3) Glomerulus or uriniferous tubule
(4) Malpighian tubule

Q.89 Diruresis is condition, which is characterized by **[MP PMT 2004]**

(1) Increase in urine volume
(2) Increased sugar excretion
(3) Decrease in urine volume
(4) Decrease in ionic balance

Q.90 Renin is released from :- **[MP PMT 2002]**

(1) Juxta glomerular apparatus
(2) Cortical nephron
(3) Collecting duct (4) Pelvis

Q.91 Liquid which collects in the cavity of Bowmans' Capsule is :- **[MP PMT 2004]**

(1) Blood plasma minus blood protiens
(2) Glycogen and water
(3) Urea, glycogen and water
(4) Urea

Q.92 The cavity of Bowman's caspule contain :- **[MP PMT 2001]**

(1) Urea, glycogen and water
(2) Urea and water
(3) Blood plasma except blood protein
(4) Concentrated blood

Q.93 Mammalain kidney resemble contractile vacuole of Amoeba in excretion of : - **[MP PMT 2006]**

(1) Glucose (2) Excess water
(3) Urea (4) Ammonia

Q.94 The hormone secreted by kidney is : - **[MP PMT 2001]**

(1) Gastrin (2) Secretin
(3) Erythropoietin (4) Aldosterone

Q.95 ADH acts on the : - **[MP PMT 2004]**

(1) Collecting tubule of kidney
(2) Loop of Henle
(3) Collecting ducts of tests
(4) None of the above

Q.96 Enzyme 'Renin' is secreted by : - **[MP PMT 2001]**

(1) Cells of stomach (2) Cells of intestine
(3) The cortical cells of kidney
(4) The cells of juxtaglomerular apparatus of kidney

Q.97 Absorption Na^+ and K^+ ions does not occur in : - **[MP PMT 2004]**

(1) Bowman's capsule
(2) Loop of henle
(3) Distal convoluted tubule
(4) Proximal convoluted tubule

Q.98 Loop of Henle is primarily meant for absorption of : - **[MP PMT 2002]**

(1) Potassium (2) Glucose
(3) Urea (4) Water

Q.99 Glomerular filtrate is : - **[UP CPMT 2004]**

(1) Blood minus blood corpusles and plasma protein
(2) Blood minus corpuscles
(3) Mixture of water, ammonia and corpuscles
(4) Urine

Q.100 Blood vessel leading into Bowman's capsule are called : - **[MP PMT 2001]**

(1) Renal vein (2) Renal artery
(3) Efferent arteriole (4) Afferent arteriole

Q.101 Urea synthesis takes place in :- **[MP PMT 2005]**

(1) Urinary bladder (2) Alimentary canal
(3) Liver (4) Kidney

Q.102 Human urine as compared to human blood is normaly : - **[Bihar 2004]**
(1) Hypotonic (2) Hypertonic
(3) Isotonic (4) All of these

Q.103 Kidney of frog is : - **[Bihar 2001]**
(1) Pronephric (2) Mesonephric
(3) Metanephric (4) None of these

Q.104 In the nephron of rabbit, reabsorption of glucose occcurs in : **[JKCMEE 2008]**
(1) distal convoluted tubule
(2) proximal convoluted tubule
(3) ascending limb of Henle's loop
(4) descending limb of Henle's loop

Q.105 Juxtaglomerular cells of renal cortex synthesises an enzyme called : **[Pb.PMT 2008]**
(1) ADH (2) Oxytoxin
(3) Renin (4) Urochrome

Q.106 Glycosuria is the condition, where a man : **[DUMET 2009, W.b. JEE 2010]**
(1) eats more sugar
(2) excretes sugar in urine
(3) sugar is excreted in faeces
(4) has low sugar level in blood

Q.107 Find the incorrect statement regarding mechanism of urine formation in man : **[Kerala PMT 2009]**
(1) Tubular secretion takes place in the PCT
(2) Aldosterone induces greater reabsorption of sodium
(3) The counter current systems contribute in diluting the urine
(4) The glomerular filtration rate is about 125mL per minute

Q.108 If one litre of water is introduced in human blood, then : **[DUMET 2009]**
(1) BMR increases
(2) BMR decreases
(3) RBC collapses and Urine production increases
(4) RBC collapses and Urine production decreases

Q.109 The size of filtration slits of glomerulus : **[W.B. JEE 2010]**
(1) 10 nm (2) 15 nm
(3) 20 nm (4) 25 nm

Q.110 This is not a nitrogenous waste :**[AMU 2010]**
(1) creatinine (2) purines
(3) allantoin (4) citrulline

Q.111 In which of the following organisms its excretory organs are correctly stated? **[CBSE 2010]**
(1) Human – Kideneys, Sebaceous glands and Tear glands
(2) Earthworm – Pharyngeal, Integumentary and Septal nephridia
(3) Cockroach – Malpighian tubules and Enteric caeca
(4) Frog – Kidneys, Skin and Buccal epithelium

Q.112 Urea synthesis takes place primarily in liver because : **[DUMET 2010]**
(1) Enzyme arginase is present in liver only.
(2) NH_3 and CO_2 are present in liver only.
(3) Hormone ADH is found in liver only.
(4) Kidney is smaller than liver.

Q.113 The average quantity of urea excreted in urine by man per day is : **[Kerala PMT 2010]**
(1) 1 – 5 gm (2) 25 – 30 gm
(3) 1 – 1.5 gm (4) 80 gm

Q.114 A large proportion of oxygen is left unused in then human blood even after its uptake by the body tissues. This O_2 : **[CPMT 2011]**
(1) acts as a reserve during muscular exercise
(2) raise the pCO_2 of blood to 75 mm of Hg.
(3) is enough to keep oxyhaemoglobin saturation at 96%.
(4) helps in releasing more O_2 to the epithelial tissues.

Q.115 Which one of the following correctly explains the function of a specific part of a human nephron? **[CPMT 2011]**
(1) Podocytes : create minute spaces (slite pores) for the filtration of blood into the Bowman's capsule.
(2) Henle's loop : most reabsorption of the major substances from the glomerular filtrate.
(3) Distal convoluted tubule : reabsorption of K^+ ions into the surrounding blood capillaries.
(4) Afferent arteriole : carries the blood away from the glomerular towards renal vein.

Q.116 Uricotelic mode of passing out nitrogenous wastes is found in : **[CPMT 2011]**

(1) Reptiles and Bird

(2) Birds and Annelids

(3) Amphibians and Reptiles

(4) Insects and Amphibians

Q.117 Ureters act as urogenital ducts in : **[CPMT 2011]**

(1) human males

(2) human females

(3) frog's both males and females

(4) frog's males

Q.118 The maximum amount of electrolytes and water (70-80 percent) from the glomerular filtrate is reabsorbed in which part of the nephron ? **[AIPMT Pre 2012]**

(1) Distal convoluted tubule

(2) Proximal convoluted tubule

(3) Descending limb of loop of Henle

(4) Ascending limb of loop of Henle

Q.119 Which one of the following options gives the correct categorisation of six animals according to the type of nitrogenous wastes (A, B, C) they give out ? **[AIPMT Mains 2012]**

	A AMMONO TELIC	**B UREOTELIC**	**C URICOTELIC**
(1)	Pigeon, Humans	Aquatic Amphibia, Lizards	Cockroach, Frog
(2)	Frog, Lizards	Aquatic Amphibia, Humans	Cockroach, Pigeon
(3)	Aquatic Amphibia	Frog, Humans	Pigeon, Lizards, Cockroach
(4)	Aquatic Amphibia	Cockroach, Humans	Frog, Pigeon, Lizards

Q.120 A fall in glomerular filtration rate (GFR) activates : **[AIPMT Mains 2012]**

(1) juxta glomerular cells to release renin

(2) adrenal cortex to release aldosterone

(3) adrenal medulla to release adrenaline

(4) posterior pituitary to release vasopressin

Q.121 Which one of the following characteristics is common both in humans and adult frogs? **[AIPMT Mains 2012]**

(1) Four - chambered heart

(2) Internal fertilisation

(3) Nucleated RBCs

(4) Ureotelic mode of excretion

ANSWER KEY

EXERCISE - 3

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	1	1	1	3	2	1	2	2	3	4	2	3	4	2	1	4	3	2	4
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	3	1	3	2	1	1	4	2	2	4	4	1	4	1	3	4	3	3	2	2
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	4	1	3	3	2	1	4	1	3	1	3	3	1	1	1	1	3	1	1	3
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	3	2	4	2	2	1	1	3	3	1	1	1	2	1	1	1	3	2	4	4
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	1	1	1	3	1	1	4	3	1	1	1	3	2	3	1	4	1	4	1	4
Ques.	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
Ans.	3	2	2	2	3	2	3	3	4	2	2	4	2	1	1	1	4	2	3	1
Ques.	**121**																			
Ans.	4																			

Q.1 **A :** When water has to be conserved in the body, ADH is secreted from the posterior pituitary.
R : ADH renders the walls of DCT, collecting duct and tubule impermeable to water.

Q.2 **A :** Renal threshold of glucose is said to be 180 mg per 100 ml.
R : Glucose starts appearing in the urine when its blood level exceed 180 mg per 100 ml of blood.

Q.3 **A :** Camels can go without water for long periods.
R : Camel stores water in the pouches of their rumen and fat in their hump.

Q.4 **A :** Tissue fluid contains much less protein than the blood plasma.
R : Blood capillary wall is impermeable to plasma proteins.

Q.5 **A :** Death ensues if waste products are not removed from the body.
R : Excretory system removes the nitrogenous waste products from the body.

Q.6 **A :** Earthworms excrete urea instead of ammonia in drier environments.
R : Synthesis of urea requires energy than the synthesis of ammonia.

Q.7 **A :** Kidneys of the vertebrates are retroperitoneal and extra-coelomic.
R : Structural and functional units of the kidneys are nephrons.

Q.8 **A :** Aquatic mammals like whales and seals are said to be ureotelic animals.
R : It is because of the fact that their main nitrogenous waste product is urea.

Q.9 **A :** Large cells performing excretory function in tapeworm, liver fluke and *Planaria* are named as flame cells.
R : Soluble waste products diffuse from neighboring cells into flame cells.

Q.10 **A :** In vertebrates, the liver is also referred as an accessory excretory organ.
R : Liver helps kidneys in the secretion of urine.

Q.11 **A :** Land snails excrete urea instead of uric acid as the major nitrogenous waste product.
R : Synthesis of uric acid involves for lower expenditure of energy than the synthesis of urea.

Q.12 **A :** Birds are obliged to be uricotelic.
R : Birds have very limited access to water.

Q.13 **A :** Urinary bladder and ureters are lined by transitional epithelium.
R : Ureters carry the urine to urinary bladder where it is stored temporally.

Q.14 **A :** The integument of land animals is far less permeable than that of aquatic animals.
R : This is because of the presence of sweat glands and sebaceous glands on the skin surface.

Q.15 **A :** Glucose and amino acids, unlike creatinine & ketone bodies, are rapidly absorbed by passive reabsorption from the tubules of nephrons in kidney.
R : Creatinine and amino acids are importance to the body.

Q.16 **A :** Secreting hypotonic urine is effective in reducing urinary loss of water.
R : Hypotonic urine is more concentrated and higher in osmotic pressure than the blood.

Q.17 **A :** The glomerular filtrate resembles the protein free plasma in composition and osmotic pressure.
R : The glomerular capillary wall and inner membrane of Bowman's capsule are impermeable to large molecules.

Q.18 **A :** During micturition, urine is prevented from flowing back into the ureters.
R : Urethral sphincters relax during micturition.

Q.19 **A :** Uric acid and creatinine can be detected in the normal urine of an adult man.
R : Uric acid and creatinine are the chief components of human urine.

Q.20 **A :** Kidneys maintain the osmotic concentration of the blood.
R : Kidneys eliminate either hypotonic or hypertonic urine according to the need of the body.

Q.21 **A :** Birds can considerably reduce water loss in the urine.

R : Birds store urine along with faces in the cloaca.

Q.22 **A :** The amount of lactic acid in sweat significantly increase after heavy or strenous work.

R : Body needs to excrete out extra lactic acid produced by glycolysis during heavy work.

Q.23 **A :** Some water is eliminated from the body.

R : Water elimination from body is only necessary to prevent the body from oedema.

Q.24 **A :** ADH reduces chloride loss in urine.

R : ADH decreases water absorption.

Q.25 **A :** Ammonia should be eliminated from the body as rapidly as it is formed.

R : Ammonia is insoluble in water.

Q.26 **A :** Excretion of urea is much helpful than ammonia.

R : The synthesis of urea requires energy.

Q.27 **A :** Earthworms excrete both ammonia and urea.

R : Excretion in earthworms depends on the environment.

Q.28 **A :** Birds drink very little water and insects never consume water.

R : Birds and insects are uricotelic with negligible water requirement to eliminate nitrogenous waste.

Q.29 **A :** Extracellular fluid serves as the 'sanitary drainage line' of the body.

R : Extracellular fluid collects excess water, CO_2, nitrogenous and other metabolic waste products from all tissues.

Q.30 **A :** Gout and kidney failure in man occurs due to excess uric acid.

R : Man is ureotelic.

Q.31 **A :** Invertebrates especially flatworms excrete through flame cells.

R : Flame cells have cilia.

Q.32 **A :** In birds and reptiles, main excretory product is the combined form of urine and faeces.

R : Birds and reptiles have no separate chamber of excretion of urine and faeces.

Q.33 **A :** Micturition is done by urinary bladder.

R : Urinary bladder stores urine.

Q.34 **A :** Liver has some role in excretion.

R : Liver excretes ammonia.

Q.35 **A :** If human urine is allowed to stand for some time, it smells strongly of ammonia.

R : Main constitutent of human urine is ammonia.

Q.36 **A :** Aquatic animals are generally ammonotelic in excretion.

R : Ammonia is highly toxic due to its high pH but is highly soluble in water.

Q.37 **A :** Excretory organs of annelids are protonephridia.

R : In annelids, protonephridia are mainly osmoregulatory and not excretory.

Q.38 **A :** Insects, birds and most reptiles are uricotelic in excretion.

R : In uricotelic animals, excretory organs are Malpighian tubules.

ANSWER KEY

EXERCISE - 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	3	1	2	3	2	1	2	3	4	1	2	3	4	4	1	2	3	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
Ans.	2	3	3	4	3	2	1	1	1	2	2	1	1	3	3	1	4	3		

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

ENDOCRINE SYSTEM

INTRODUCTION

- The branch of biology which deals with the study of endorcine system and its physiology is known as **''Endocrinology''**.
- **''Thomas Addision''** is known as father of Endocrinology.

Glands of body : A cell, a tissue or an organ which secretes certain useful chemical compounds is called a gland. Animals have three types of glands :

(i) **Exocrine gland (Gr., *ex* = out + *krinein* = to secrete) :** These glands have ducts for discharging their secretions. Therefore, they called duct glands. *ex* – Liver, Sweat gland, Sebaceous gland, Gastric glands and some intestinal glands.

(ii) **Endocrine glands (Gr., *endo* = within + *krinein* = to secrete)** : These glands lack ducts and pass secretions into the surrounding blood directly. Therefore they called ductless glands. *ex* – Thyroid, parathyroid, adrenal, pituitary, pineal body and thymus.

(iii) **Heterocrine glands :** These glands consist of both exocrine and endocrine tissue. The exocrine discharge its secretion by a duct and the endocrine tissue discharge its secretion into the blood. Pancreas and gonads are heterocrine glands. These are also called mixed glands.

- Co-ordination in the body of almost all the higher vertebrates is controlled by two systems **Nervous system** and **endocrine system.**
- Nervous system and endorcine system are called **Integrative system** of the body.
- Nervous system carries informations in the form of impulses to the different parts of body. High speed services are offered by this system.
- Where as, the work of co-ordination by endocrine system is slowly by secretion of some chemical substances.
- Substances secreted by these glands are known as hormones. The meaning of work 'hormone' in Greek is **''to excite'' = hormaein.**

Differences between Nervous and Endocrine Coordinations

	Nervous Co-ordination	Endocrine Co-ordination (Chemical Co-ordination)
1.	Information passes as electrical impulses along nerve fibres.	Information passes as a chemical substance through the blood and lymph.
2.	There is rapid transmission of information.	There is slow transmission of information.
3.	Response is immediate.	Response is usually slow.
4.	Response is very exact.	Response is usually widespread.
5.	Response is short lived.	Response is long-lasting

HORMONE

- The term hormone was coined by **Starling**.
- Hormones are also called "Primary messengers" or chemical messengers."
- First discovered hormone is **secretin.** It was discovered by **Bayliss & Starling in 1902.**

Source & Chemical Nature : - Hormones are chemical messengers which are secreted by one part of body and are poured directly into the blood stream, and they reach at their target place with the help of blood. A small amount of hormone affects some specific cells or physiology of cells of organ according to atmospheric conditions.

Chemical Nature of Hormone :

The animal hormones may be classfied into 6 categories :

1. **Amino acid derivatives :** The hormones epinephrine and norepinephrine from the adrenal medulla and thyroxine from the thyroid gland are derived from amino acid.
2. **Short peptides :** The hormones oxytocin and vasopression from the posterior lobe of the pitutary gland are short peptides of 9 amino acid. The melanocyte stimulating hormone (MSH) from the intermediate lobe of the pituitary gland is also short peptide of 13 amino acids.
3. **Long peptides :** The hormones insulin from the pancrease, adrenocortico tropin (ACTH) from the anterior lobe of the pituitary gland, calcitonin from the parathyroid gland consists of 84 amino acids.
4. **Protein :** The gonadotropic, thyrotropic and somatotropic hormones from the anterior lobe of pituitary are protein with high molecular weights.
5. **Steroids (Fat soluble) :** The hormones like cortisol and aldosterone from adrenal cortex, testosterone from interstitial cells of testes, estrogen and progesterone from Graaffian follicles of ovary and placenta are the examples of steroid hormones. The hormones contain cholesterol and bile salts.
6. **Fatty acid derivative : -** Prostaglandin

Physical & Chemical Specialities of Hormones : -

The moleucles of most of the hormones are small, and their molecular weight is low.

- Hormones are soluble in water and are easily diffusible in tissues.
- The secretion of hormone is always in very small quantity because these are most reactive substances
- Hormones are destroyed after use.
- Hormones can not be stored in the body except Thyroxine.
- Hormones are soluble in water and blood.
- Liver and kidneys separate them from blood and decompose them. The waste product formed after decomposition, hormones are excreted with urine. It can not be reutilized.
- Hormones are non-antigenic & non species specific substances.
- Usually, hormones do not participate in the metabolic activities of target cells but they affect and control the activity level of these target cells. Due to the effect of hormones, not only the rate of metabolic activites is effected but also the permeability of cell membrane is changed so the nature of reaction is also changed. so the nature of reaction is also changed.

Differences between Hormone & Enzyme

	Hormones	Enzymes
1.	They are produced at one site and are passed by blood to another site for action.	They may act at site where they are produced or carried to another site for action.
2.	They have low molecular weight.	They have very high molecular weight.
3.	Hormones may be steroids, proteins, Peptides or amino acid derivatives.	Enzymes are simple proteins.
4.	They are used up in their action	They are not used up in their action.
5.	They are effective in low concentration. Their excess or deficiency may cause disorders.	They also act in low concentration. However, the rate of enzyme catalyzed reactions steadily increase with an increase in their concentration
6.	They may act slowly or quickly.	They act slowly.
7.	They may accelerate or retard the specific recations.	They speed up the reactions.
8.	Hormone controlled reactions are not reversible.	Enzyme controlled reactions are reversible.

Differences between Hormone & Vitamins

	Hormones	Vitamins
1.	Hormones may be steroids, proteins, peptides or amino acid derivaties.	They are never proteins but simple organic compounds such as amines, esters, alcohol, aldehyde or organic acids.
2.	They are effective in low concentration. Their excess or deficiency may cause hormonal disorders.	They are needed in small quantity. Excess vitamins are excreted. Their deficiency causes malfunctioning called deficiency diseases or avitaminosis.
3.	They are secreted by the animal in its own body.	They are rarely synthesized in the body. They are moslty taken with food.
4.	Hormones influence the genes to produce Specific	They act as co-enzymes and help emzymes to perform their function.
5.	enzymes required during metabolism. They do not influence the working of those organs which have secreted them.	They are not produced by body organs (except vitamin D)

MECHANISM OF HORMONAL REACTIONS

- **MECHANISM OF HORMONE – Two types**

– Once hormone enter into blood stream it can reach almost to any cell in the body.

– However, each hormone effects only certain kind of cell which is called as **target organ.**

– All hormone do not act in the same way due to location of receptor.

- Hormones are two types :

(i) Water solbule hormone **(ii)** Lipid soluble hormone

- Water soluble hormones interact with a surface receptor, normally a ***glycoprotein*** and initiate a chain events within it where as lipid soluble hormone (Steroid hormones) readily pass through the plasma membrane to cytoplasm of the target cell. Molecular mechanism of hormones are of following types :
  (1) At Gene level
  (2) At Plasmalemma level

1. AT GENE LEVEL : -

In this type of mechanism steroid hormone and Thyroxine hormones are involved.

(a) Steroid hormones_: In this process steroid hormones enter into target cell where they combine with receptor protein, this Receptor protein conveys the hormone from cytoplasm to nucleus this hormone stimulates the DNA for synthesis of protein. Now DNA synthesises the m-RNA and this m-RNA goes into cytoplasm, where Ribosome synthesize the protein by translation. This new protein in an enzyme, which affects the vital activity of target cell.

(b) Thyroxine hormone_: The thyroid hormone thyroxine and tri-iodothyronine cause increase transcription by certain gene in nucleus. To accomplish this, These hormones first bind directly with receptor protein in nucleus. Receptor protein is located on chromosome. Advantage of intranuclear receptor the thyroxin hormone can continue they express their control function for weeks :

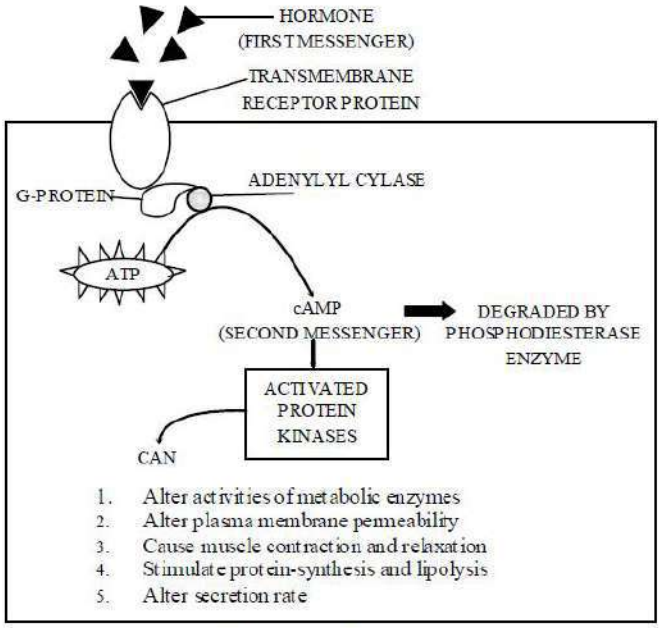


Fig. – Mechanism of Hormone action on cell surface

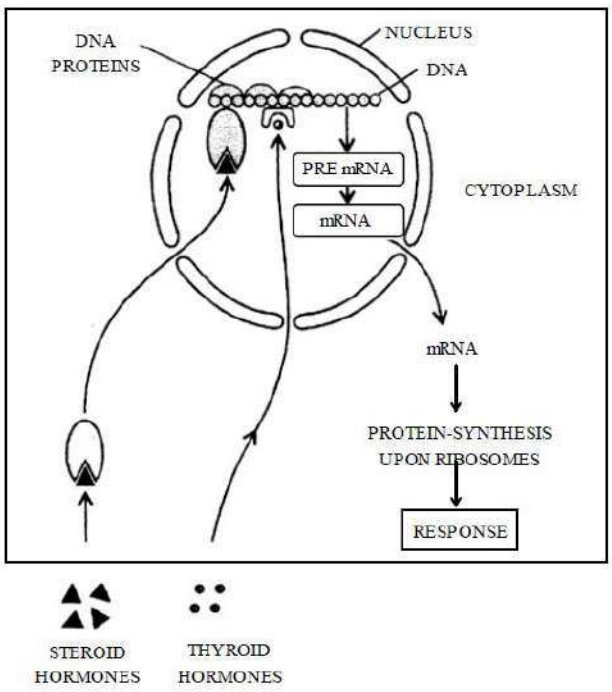
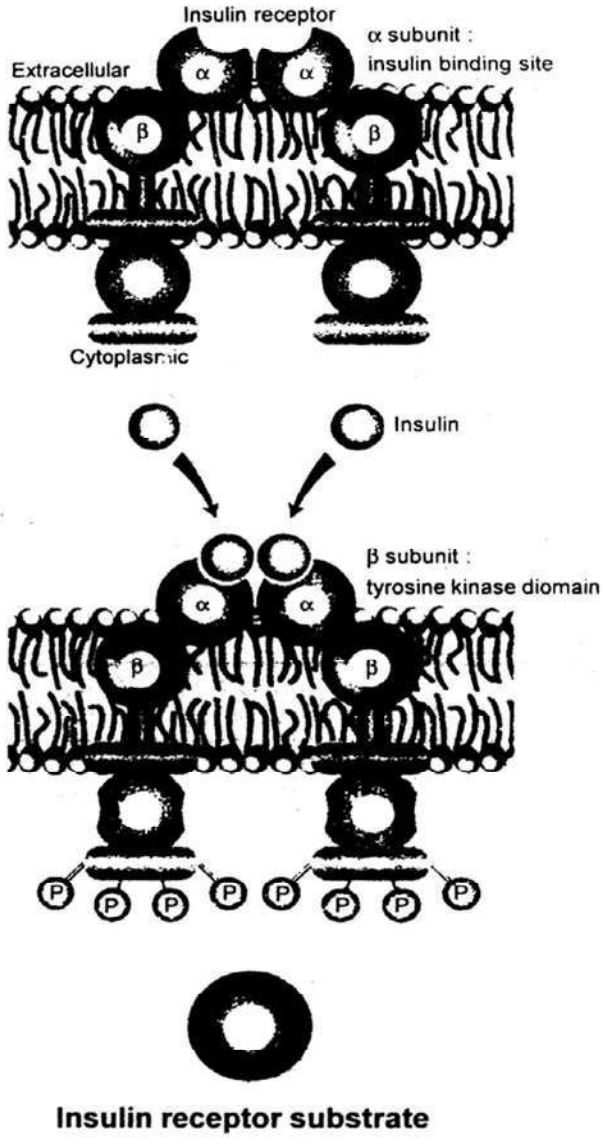


Fig. – Mechanism of cell surface within a cell

2. PLASMALEMMA LEVEL : - Following hormones an example of this mechanism :

(a) Tyrosine kinase mechanism : A good example of this is the effect of insulin. For transport of insulin hormone, **insulin** receptor is found in cell membrane, which is made up of 4 sub-unit. 2 sub-units (α-protein) are α-protein which are situated towards the outside of cell membrane this sub unit binds the insulin hormone, 2 sub-unit (β-Protein) protrude into the cytoplasm of the cell. The intra celluar portion of the β units has **tyrosine kinase activity**. These receptors are usually less than 100 in most of our body cells but may be more than 1,00,000 as in some liver cells.

Binding to the receptor – Binding of insulin to the outer 2α sub units of receptor triggers tyrosine kinase activity of the intra cellular portion of β-sub units. This causes a structural change in β-sub units. to become an activated tyrosine kinase. The activated tyrosine kinase produces autophosphorylation of the cytoplasmic receptor as well as phosphorylation of some cytoplasmic protein **(Insulin receptor subtrate, IRS)**.



Insulin receptor substrate

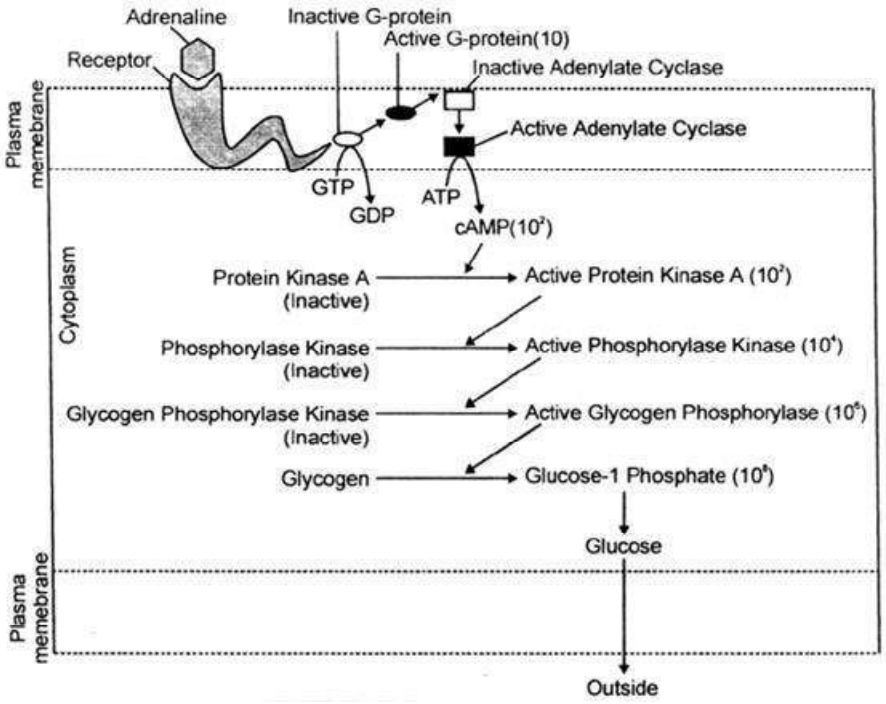
(b) C-AMP or Second messenger system : This C-AMP mechanism has been shown by following hromones :

- Adreno Corticotropin (ACTH)
- Thyroid stimulating hormone (TSH)
- Luteinizing hormone (LH)
- Follicle stimulating hormone (FSH)
- Parathyroid hormone (PTH)
- Secretin
- Catecholamines
- Most hypothalamic releasing hormone
- Vasopressin/ADH
- Glucagon

In this type of mechanism when adrenaline is attached to the surface receptor protein which found on the plasmalemma then first of all it forms a complex which is called as hormone receptor complex (HRC). A

transducer protein is found on inner surface of receptor protein which is called as G-Protein. This G-Protein consist of α, β, γ-sub unit. GTP is also found on G-Protein.

- After formation HRC than GTP change into GDP, in this process phosphate group is released which activates the G-Protein.
- After activation of G-Protein their sub units are divided into two group (i)-α-subunit and (ii)-β, γ-subunit (β, γ-subunit both are not separated with each other)
- Activated α-subunit of G-Protein activate adenylate cyclase.
- Activated adenylate cyclase change ATP to C-AMP on cell membrane.



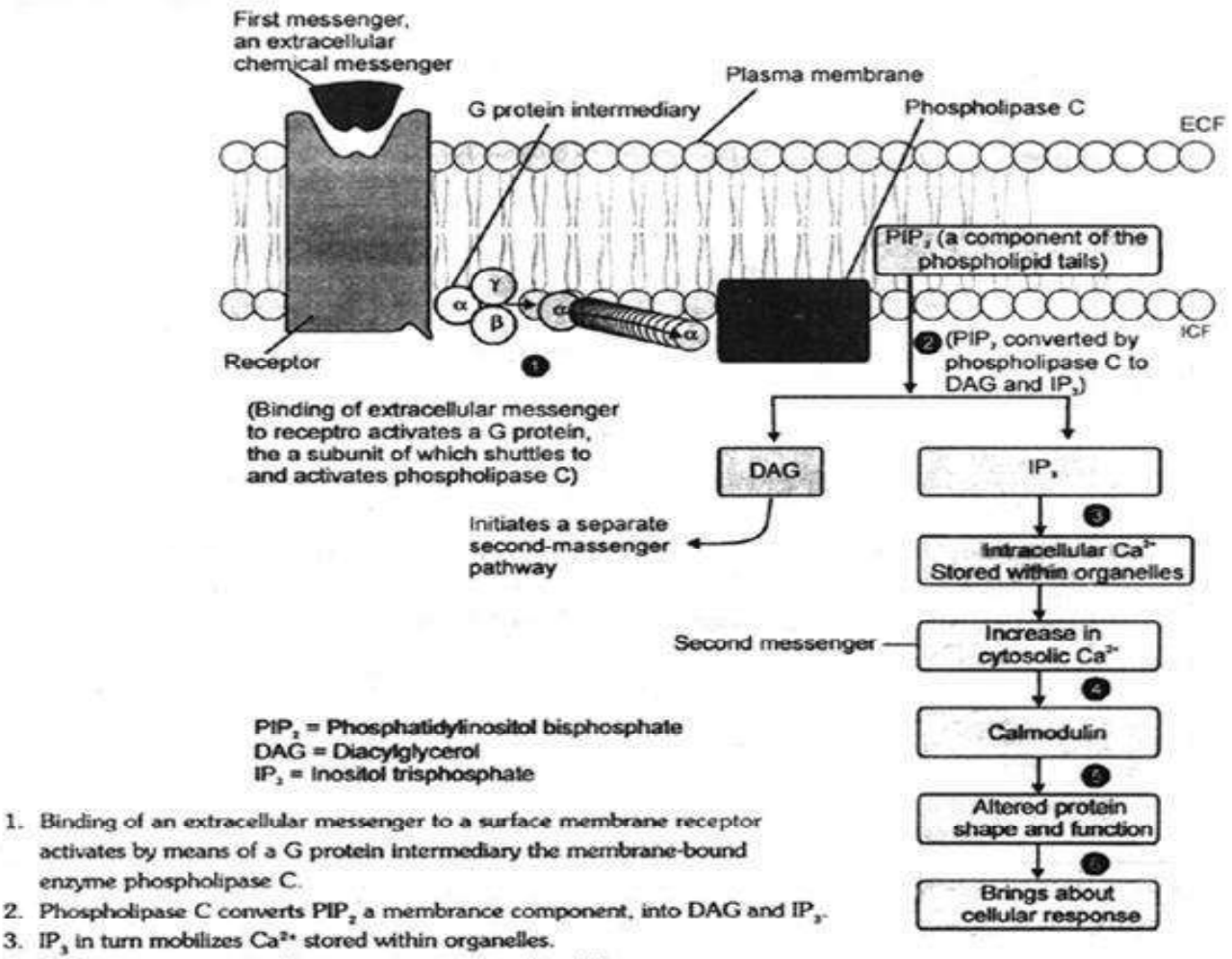
- This C-AMP goes into cytoplasm where it activates the inactive protein kinase-A to active protein kinase-A.
- This active protein kinase A changes inactive phosphorylase kinase into active phosphorylase kinase.
- This active phosphorylase kinase changes inactive Glycogen phosphorylase in to active glycogen phosphorylase.
- This active glycogen phosphorylase changes glycogen into Glucose-1-Phosphate.
- Each molecule of protein kinase-A activates about 100 molecule of enzyme phosphorylase kinase and so on.
- As a result a single molecule of adrenaline releases as many as 100 million molecules of glucose within only 1 minutes **(Amplification)**.

(c) IP_3 & DAG Mechanism : In this type of mechanism local hormones are involved such as prostaglandins, Acetylcholine, Somatostatin etc.

- Same CAMP mechanism transducer G-protein act.
- G-protein activates enzyme phosphodiesterase.
- Phosphodiesterase (Phospholipasec) Enzyme breaks phosphotidyl inositol biphosphate into inositol triphosphate (IP_3) and diacylglycerol (DAG).

- IP_3 is water soluble and diffuses into cytoplasm, IP_3 specialy mobelized Ca^{++} ion endoplasmic reticulam and the Ca^{++} ion promote smooth muscle contraction and changes in secretion by secretory cell and change in ciliary action.
- DG remain in the membrane where is activates an enzyme called protein kinase C, which in turn, activates many other enzyme, Activated protein kinase C plays an important role in cell division and cell proliferation.

The action of lipid soluble hormone are slower and last longer then the action of water soluble hormone.



1. Binding of an extracellular messenger to a surface membrane receptor activates by means of a G protein intermediary the membrane-bound enzyme phospholipase C.
2. Phospholipase C converts PIP_2 a membrance component, into DAG and IP_3.
3. IP_3 in turn mobilizes Ca^{2+} stored within organelles.
4. Ca^{2+}, acting as a second messenger, activates calmodulin.
5. Calmodulin induces a change in the shape and function of a particular intracellular protein. Many of the Ca^{++} dependent cellular events are triggered by activation of calmodulin.
6. The altered protein then prodeces the desired cellular response dictated by the extracellular messenger.

SPECIFIC TERMS

- **Chalones** → The hormones which are secreted from one endocrine gland to stimulate other endocrine gland is called as Chalones.
- **Autocoide** → The hormone which are secreted from one endocrine gland to target organ is called as Autocoide.

- **Diabetogenic** → The hormone which mainly affects or stimulates carbohydrate metabolism is called as diabetogenic.
- **Ketogenic** → The hormone, which mainly affect the fat metabolism.
- **Calorigenic** → The hormone, which mainly affects the basal metabolic rate (BMR) is called as calorigenic.

PITUITARY GLAND

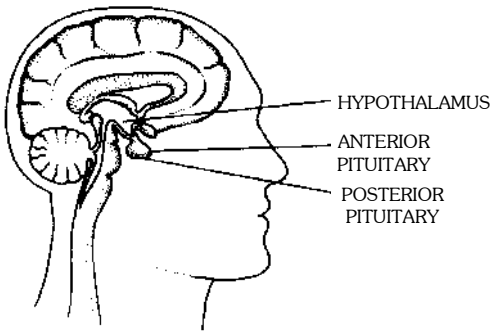


Fig. – Location of pituitary gland

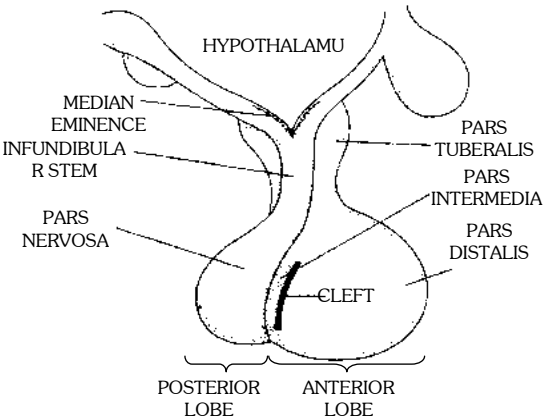
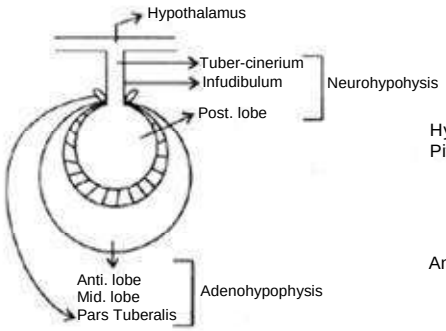
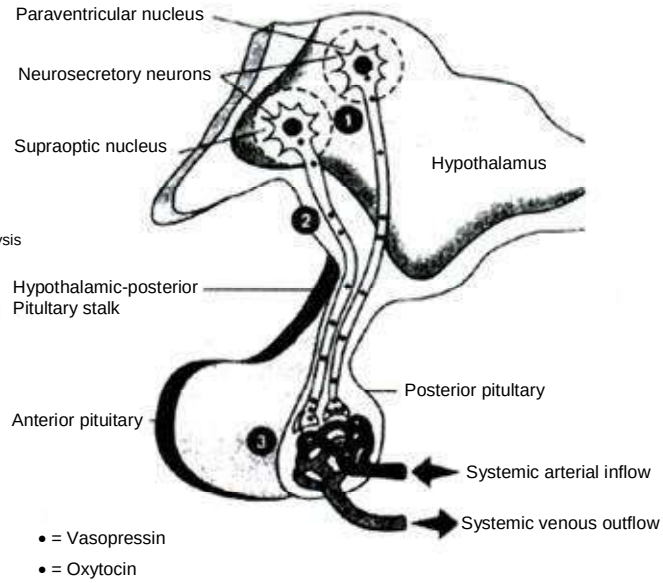


Fig. – Structure of pituitary gland





- On the basis of development pituitary gland is completely **Ectodermal**.
- It is situated in the **sella-turcica** of sphenoid bone.
- This gland is atached to the hypothalamus through a stalk which is called as **infundibulum**.
- The upper terminal end of infundibulum which is attached to the hypothalamus is called as **tubercinerium/Median eminence**.
- The lower terminal end of infundibulum is bulging type which is called **as posterior lobe or pars nervosa**.
- Tubercinerium, infundibulum & pars nervosa are collectively called as **Neurohypophysis**.
- A small & fine tube is developed in the foetus which is called as **gut**. This gut is developed into **alimentary** canal. Anterior part of gut is called as ***stomodaeum*** (developed from ectoderm).

- A small projection is developed from dorsal ***surface of stomodaeum*** (the anterior part of gut) this part is separated from stomodaeum and form ***Rathke's pouch***.
- Upper surface of Rathke's pouch is developed into **mid-lobe** which is also known as **pars intermedia**.
- The **upper margin** of **R.pouch**, which surrounds the infundibulum & forms a collar like structure called as **parstuberalis**.
- ***Remaining part*** of R.pouch. is developed into anterior lobe which is also called as pars distalis.
- **Pars distails, pars tuberalis** & **pars intermedia** are collectively called as **adenohypophysis**.
- Neurohypopohysis + Adenohypophysis is called as **hypophysis cerebri** or **pituitary body**.
- A remaining & vestigeal cavity of **R.pouch** is found in the anterior lobe which is called as **Hypophysis recess**.
- **Superior branch** of **hypophyseal artery** supplies blood to the **hypothalamus**.
- **Inferior branch** of **hypophyseal** artery supplies blood to the **pituitary gland**.
- Hypophysal portal vein collects the blood from hypothalamus and supplies to pituitary gland.
- Branches of hypophyseal artery & hypophyseal portal vein combined and form a network of blood capillaries which is called as **circle of Willis**.
- In human, mid lobe is ill developed or membrane like, while mid lobe is absent in elephant & Whale.
- Three types of glandular cells are found in Adenohypophysis.

1. **Basophils** → They are large cells & found in the peripheral part of gland. They are more in number.
2. **Acidophil** → They are small in size & found in the central part of pituitary gland.
3. **Neutrophils** → They are smallest in size and are found in scattered form. They are minimum in number.

- **STH & LTH** are secreted by acidophils.
- Remaining hormone of adenohypohysis are secreted by basophils.
- All hormone of pituitary gland are **protein Hormone**.

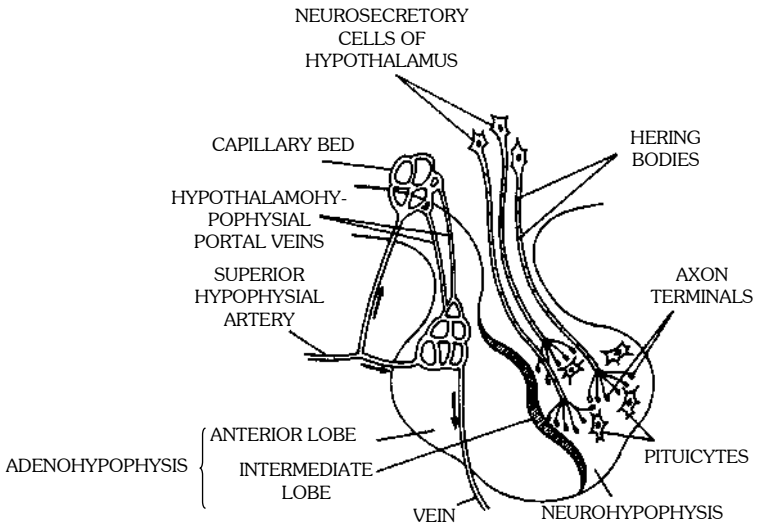


Fig. – Blood supply to pituitary

HORMONS SECRETED BY ADENOHYPOPHYSIS

All these hormones are of proteinaceous nature.

1. GROWTH HORMONE OR SOMATOTROPIC OR SOMATOTROPIN HORMONE

– [G.H. or S.T.H.] : -

By Somatotroph cells or α-acidophil cells

Function : Major effect
- On growth
- On metabolism

– Effect on Growth : -

(1) **On bone :** It increases length of bone.

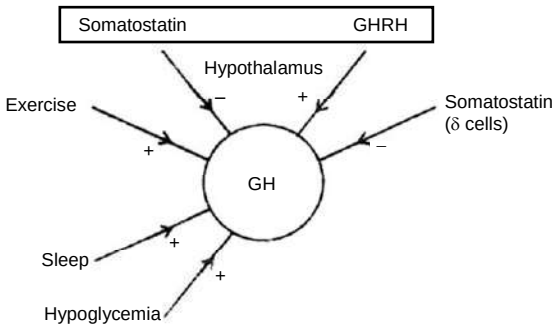
(2) **On soft tissue :**

(i) GH promotes mitosis & increases number of cells in many organs & tisue e.g. liver and muscles.

(ii) GH stimulates growth of muscle and cartilage due to increase synthesis of collagen, muscle grow in bulk.

– Effect on metabolism :

- **Fat :** Increases lipolysis so that free fatty acid level of plasma rises. Under the influence of growth hormone fat is used for energy in preference to carbohydrate and protein, due to this protein deposition is increases.
- **Carbohydrates :** Hyperglycermia develops due to decreased uptake of glucose in the cells, so it is also called diabetogenic hormone.
- **Protein :** GH increases amino acid uptake by the cells of the liver & muscles & helps in protein synthesis.
- In the presence of thyroxines and insulin, growth hormones become more active and stimulates the body growth. In this way this hormone is important for the growth of body.



– Diseases due to hyposecretion or hypersecretion of somatotropin hormone :

(a) Hyposecretion of STH : Due to deficiency of STH in childhood dwarfism is observed.

- Dwarfism due to the defect of pituitary is called Ateliosis. These dwarfs are called as midgets.
- This midget is physically & mentally normal while sexual maturation is delayed.

(b) Hypersecretion of STH : - Due to hypersecretion in childhood and adolescene, a higher quantity of amminoacids is supplied to the body cells.

(i) Epiphyseal cartilage present on the edges of bones does not convert into bone for a long time.

Thus the bones of legs & hands become very long and height of that person increases very much. Body becomes imbalanced. This disease is called **Gigantism**.

(ii) **Acromegaly : -** Due to hypersecretion of STH in adulthood, jaw bones of the affected person become long, cheek bones buldge out, broad hands, legs & fingers of person becomes gorilla like. These symptoms are observed as a result of acromegaly.

2. THYOTROPHIC OR THYROID STIMULATING HORMOONE [T.T.H. OR T.S.H.] :

- T.S.H. is secreted by **basophil cells. (Thyrotroph cell)**.
- It is glycorprotein in nature.
- T.S.H. stimulates thyroid gland to secrete thyroxine. TSH helps in almost all step of the thyroid hormones synthesis & it causes growth of throid gland.
- Secretion of **TSH** is stimulated by Thyrotrophin releasing factor & inhibited by somatostatin of hypothalamus.

3. ADRENO CORTICO TROPHIC HORMONE OR CORTICOTROPINE [ACTH] :

- ACTH is secreted by **basophil** (corticotroph) cells.
- In man, this ACTH is mainly made up of **valine** and **tyrosine** aminoacids,.
- It accelerates the cortex part of adrenal gland to secretes hormones.

4. FOLLICLE STIMULATING HORMONE [FSH] :

- It is also secreted by basophils. (Gonadotroph cell)
- It is glycoprotein in nature.
- This is secreted in male and female both.
- In males, it stimulates spermatogenesis and normal functioning of seminiferous tubules.
- In femables, it stimulates oogenesis and development of Graafian follicles of ovary.
- FSH is also known as **Gametokinetic factor**.
- Estrogen hormone that is secreted Graafian follicles is also affected by FSH.

5. LUTEINIZING HORMONE OR INTERSTITIAL CELL STIMULATING HORMONE – [LH OR ICSH]:

- It is also secreted by basophil (Gonadotroph) cells. It is also glycoprotein in nature.
- It stimulates **ovulation** in female as a result of this corpus luteum is formed.
- Hormone **progesterone** which is secreted by corpus luteum is also stimulated by L.H.
- In men **LH** is called **ICSH**. It affects the Leydig's cells or Interstitial cells of testes and stimulates the secretion of male hormone "**Testosterone**".
- L.H. is also called "**gamete releasing factor**".
- **FSH** and **LH** both are called **gonadotrophic hormone GTH**.
- FSH and LH act in combined form so these are called **synergesic** hormone.
- Gonadotrophic hormones (FSH & LH) are start secreting during puberty. Their secretion is regulated by hypothalamus.

6. LUTEOTROPHIC OR PROLACTIN OR LACTOGENIC OR MAMMOTROPHIN HORMONE (PRL) :

It is secreted by acidophil (Lactoroph) cells.

Function of prolactin hormone.

(1) Lactation (Galactopoiesis) : Prolactin is responsible for lactation in postpartum (after delivery) women.

- **Regulation of Prolactin secretion by Hypothalamus :** Hypothalamus mainly stimulate the production of all pituitary hormone, but it mainly inhibits prolactin production because normally hypothalamus prolactin inhibitory hormone (Dopamine) is greater than the releasing hormone.
- Breast is prepared for lactation by oestrogen (duct growth) and progesterone (lobule growth) but both of these hormone inhibit the actual secretion of milk.
- Dopamine is catecholamine (Biologically active amine) and neurotransmitter in the hypothalamus. It inhibits lactation.
- **During pregnancy :** Prolactin hormone steadly increase until term but due to high level of oestrogen and progesterone (secreated by placenta) lactation is inhibited.
- After expulsion of the placenta at parturition, there is an abrupt decline in circulating estrogen and progesterone.
- The drop in circulating estrogen initiate lactation.
- Nursing stimulates prolactin secretion.
- Prolactin inhibits the action of GnRH on the pituitary and antagonize the action of GnRH on the pituitary and antagonize the action of gonadotrophin on the ovaries. Ovulation is inhibited and the ovaries gets inactive.
- Nursing is important and effective method of birth control.

7. HORMONES SECRETED BY MIDDLE LOBE OF PITUITARY GLAND :

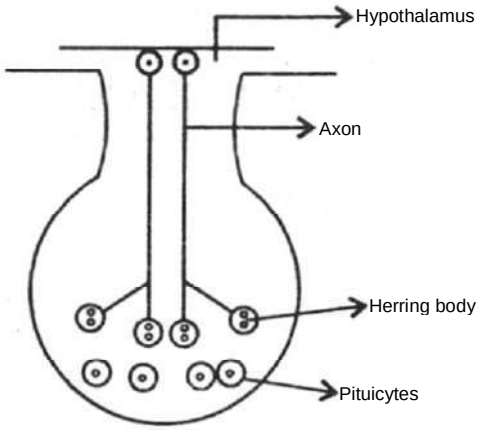
- The part of adenohypophysis of pituitary gland, which is very close to neurohypophysis is a very thin portion, it is called ***pars intermedia*** or ***middle lobe*** of pituitary gland.
- In man it is in the form of a thin membrane only. It is **inactive** in men.

MELANOCYTE STIMULATING HORMONE [MSH] :

- It is secreted by middle lobe. (By corticotroph cell).
- MSH is also called **intermedin**.
- In man, MSH is secreated by anterior lobe, because middle lobe is ill-developed.
- It stimulates the melanochytes to synthesize melanin in mammals.
- This hormone is related with change in the colour of skin in **Amphibian** and **Reptiles**. This phenomenon of colour changing is known as **metachrosis**.
- It darkens the complexion of skin by distributing **melanin** pigment evenly under the skin.
- Just oppsoite to it, **melatonin** secreted by **pineal body**, collects the melanin pigments at one place thus fairing the complexion of skin.
- MSH is found in all the vertebrates, but it is functional in poikilothermic animals e.g. fishes, amphibians, reptiles etc.
- The importance of MSH in man has not been evaluated.

POSTERIOR LOBE OR NEUROHYPOPHYSIS :

Posterior lobe of pituitary gland is $1/4^{th}$ part of total gland. It is just like nervous tissue, because in it, the termnial ends of the axons of neurosecretory cells of hypothalamus are swollen. These swolen ends are called **"Herring bodies"**. Hormones are released in these bodies.



- There are same large, branched fatty neurogilal supporting cells in between axons, that are called **"Pituicytes"**.

1. Posterior pituitary hormones are not synthesised in the gland itself but they are synthesized in the **supraoptic** nuclei and **paraventricular** nuclei of hypothalamus.

2. The hormone are then transported from their origin to posterior pituitary through axons of hypothalamohypo physeal tract and sotred in association with 2 protein i.e. Neurophysin-I, and Neurophysin-II.

(A) Vasopressin or Pitressin or Anti Diuretic Hormone [ADH] :

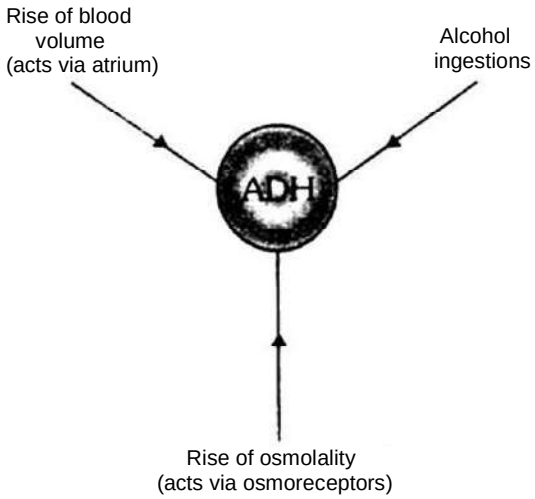
– **Main functions of ADH :**

Its main function is to increase the reabsorption of water in upper part of collecting duct and in distal convoluted part of uriniferous tubules. Due to this, amount of urine is reduced. So it is also called ADH.

- The hormone increases the blood pressure by constriction of blood vessels of tissues.
- Due to **hposecretion** of ADH or vasporessin, the amount of urine increases, this process is called **Diuresis**. Patient feels thristy, Dehydratinon starts in the body. This disease is called **Diabetes insipidus** (taste less urine, polyuria).
- Due to hyposecretion of ADH, deficiency of water starts in Extra cellular fluid (ECF). Blood pressure reduces, urine becomes dilute and blood becomes thick or concentrate.
- Intake of coffee, tea and excess alcohol etc decrease the secretion of ADH.
- Secretion of ADH is maximum in desert fauna (animals of xerophytic region) e.g. camel.
- Kangaroo – Rate (Dipodomys) also shows very high hypersecretion of ADH.

Kangaroo - Rat never drinks water in its life-time

- Hypersecretion of ADH causes dilution of blood and increases concentration of urine and thus blood pressure increases.



Control of ADH

(B) Oxytocin or Pitocin : It is the main **parturition hormone**. It stimulates the fast/rapid contractions and expansions of non-striated muscles of the uterine wall at the last moment of gestation operiod (pregnancy). Due to this uterine constrictions, **labour pains** start jsut before child birth.

- This hormone is secreted by pituitary glands of mother at the time of parturition.
- This hormone also initiates the contractions in uterine wall muscles during copulation/coitus as a result of that semen of man is sweeped out in the fallopian tubes of woman.
- After parturition, this hormone constricts the uterine wall and thus brings back to the normal position.
- Oxytocin hormone contracts the myoepithelial cells present at all the sides of alveoli of mammary glands. Thus it helps in milk ejection so it is also called **milk let down hormone**.
- In female, this hormone related with emotion.
- Even thought, cry or sound of baby can bring about release of this homone in lactating mother.
  This hormone helps during egg laying in birds.
  Injection of oxytocin are initates cows and buffaloes for instant milk release.
- Muller's organ and subneural glands of lower vertebrates are homologus to pituitary gland.

HYPOTHALAMUS

(i) **Position and Structure :** Hypothalamus is the floor of diencephalon. It is formed of masses of grey matter, called hypothalmic nuclei, containing neurosecretory cells. It is connected with anterior pituitary lobe by blood capillaries of hypophyseal portal system and with the posterior pituitary lobe by axons of its neurons, both passing through the pituitary stalk.

(ii) **Hormones of hypothalamus :** Neurosecretory cells of hypothalamus secrete neurohormones called releasing factors (RF) or inhibiting factors (IF). These neurohormones are carried by hypophyseal portal system to adenohypophysis (primary target organ) and stimulate or inhibit the release of trophic hormones from adenohypophysis. These neurohormones are proteinous in nature and formed of 3 – 20 amino acids.

Neurohormones of Adenohypophysis

Neurohormones	Physiological effects
(1) TSH-RF (Thyroid Stimulating Hormone – Releasing Factor)	Increased ACTH secretion from adenohypophysis.
(2) ACTH-RF (Adrenocorticotrophic Hormone-Releasing Factor)	Increased ACTH secretion from adenohypophysis.
(3) STH-RF (Somatotrophic Hormone-Releasing Factor)	Increased STH secretion from adenohypophysis
(4) SOMATOSTATIN (GROWTH INHIBITING HORMONE)	Decreased STH secretion from adenohypophysis.
(5) GTH-RF (Gonadotrophic Hormone-Releasing Factor) It is divided in two parts (i) FSH-RF (Follicular Stimulating Hormone-Releasing Factor) (ii) LH-RH (In female) (Luteinising Hormone – Releasing Factor) or ICSH-RF (In male) (Interstitial Cells stimulating Hormone-Releasing Factor)	Increased FSH secretion from adenohypophysis. Increased LH secretion from adenohypophysis.
(6) Prolactin-Releasing hormone (P-RH)	Increased secretion of prolactin or leutotrophic hormone.
(7) Prolactin-Inhibiting hormone (P-IH)	Increased secretion of prolactin or leutotrophic hormone.
(8) MSH-RF (Melanophore Stimulating Hormone-Releasing Factor)	Increased MSH secretion from intermediate pituitary lobe.
(9) MIF (Melanophore Inhibiting Factor)	Decreased MSH secretion from intermediate pituitary lobe.

(iii) **Hypothalamo – pituitary complex :** Pituitary gland is closely related with hypothalamus. Both together form hypothalamo-pituitary complex.

The hypothalmic-pituitary (hypothalamo-hypophyseal) system is a direct proof of coordination between the hormonal and nervous system. It regulates most of the physiological activities of body and maintains homeostasis inside the body. These neurosecretory cells are known to synthesize two more hormones : Oxytocin and Vasopressin, which are stored in their axons extending in the posterior lobe of pituitary gland.

THYROID GLAND

- It is the **largest endocrine gland in the body**.
- This is situated at the latero-ventral side of the joint of trachea and larynx in the neck region of man. The shape of this gland is like letter H or Butter fly. It is **bilobed** in birds and mammals, but it is single lobed in reptiles. Both of its lobes are connected by non-glandular band, formed of a connective tissue. This band is called **isthmus**. No hormone secreted by isthmus.

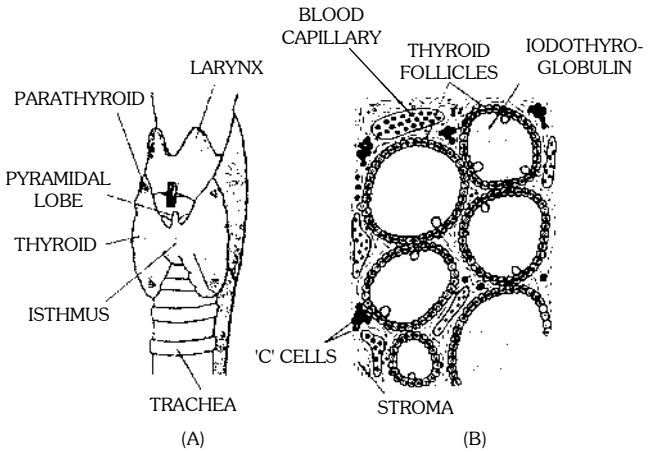
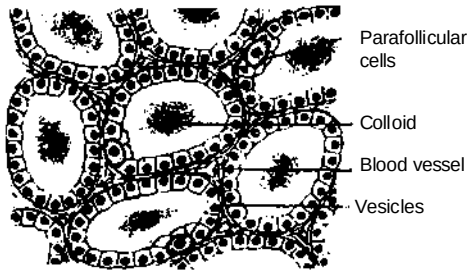
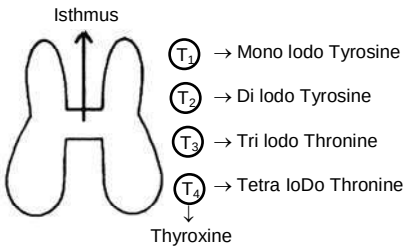


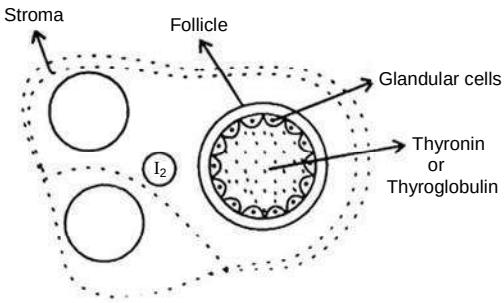
Fig. – (A) Thyroid gland, (B) Follicles suspended in stroma of a lobule



Thyroid Gland

- It is endodermal in origin.
- **Endostyle** of lower vertebrates like **Herdmania, Amphioxus** is homologous of thyroid gland.
- In human, this gland weight, about 25 gm to 35 gm approximately. (This is some what larger in women as compared to men).
- Each lobe of thyroid gland is made up of connective tissue. There are present so many folicles made up of glandular cells in connective tissue.





- These follicles are scattered in loose connective tissue, the stroma. A layer of cuboidal glandular cells is found in the wall of follicles. An iodised colloidal fluid substance **Thyroglobulin** is filled in the cavity of these follicles. **Thyroglobulin** is **glycoprotein** in nature. Parafollicular cells are occasionally found in between basement membrane of the follicle & these cells secrete thyro calcitonin.

  Thyroid is the only endocrine gland in the body which stores its hormone in its inactive state.

Production of Thyroxine :

Thyroxine contains two phenyl rings linked up by an ether bridge.

BIOSYNTHESIS

(1) Iodide trapping – when KI taken up by follicular cells.

(2) Oxidation of Iodide – KI $\rightarrow$ I_2.
The oxidation of iodine is promoted by the enzyme **peroxidase**.

(3) Organification – The binding of iodine with the thyroglobulin molecule is called organification of the thyroglobulin

Tyrosine + I_2 $\rightarrow$ MIT & DIT. (Monoiodotyrosine and Di-iodotyrosine)

(4) Coupling – MIT + DIT = T_3 (Tri-iodothyronine)

DIT + DIT = T_4 (Tetra-iodothyronine)

All of these step of thyroxine biosynthesis are stimulated by TSH hormone.

T_1 = Mono iodo tyrosine

T_2 = Di iodo tyrosine

T_3 = Tri iodo thyronine (20 %)

T_4 = Tetra iodo thyronine (80 %)

- Secretion of T_4 is compartively more than T_3, and T_3 hormone is four times more active than T_4 hormone. T_4 changes into T_3 on reaching in the tissues. After enter into tissue deiodination takes place in T = 4 = which , change into T_3.
- T_4 is called **thyroxine** in this T-chain of hormones.
- Thyroxine or Tetra-Iodo-Thyronine is a derivative of aminoacid.
- Each thryoglobin molecule contain an average of T_3 molecule for every 14 molecule of thyroxine (1 : 14 – T_3 : T_4).
- Thyroid hormones in the form of thyroglobulin are stored in the follicles in an amount sufficient to supply the body with its normal requirements of thyroid hormone for 3 months.

- **E.C. Kendal** first of all crystallised this thyroxine hormone.
- **Harrington and Barger** studied the molecular structure of thyroxine.
- Thyroid gland requires iondine "120 μg" every day for the production of thyroxine.
- Normal recommended minimum intake 200 μgm/day, if iondine in take < 50 μgm /day, then thyroid disorder develops.

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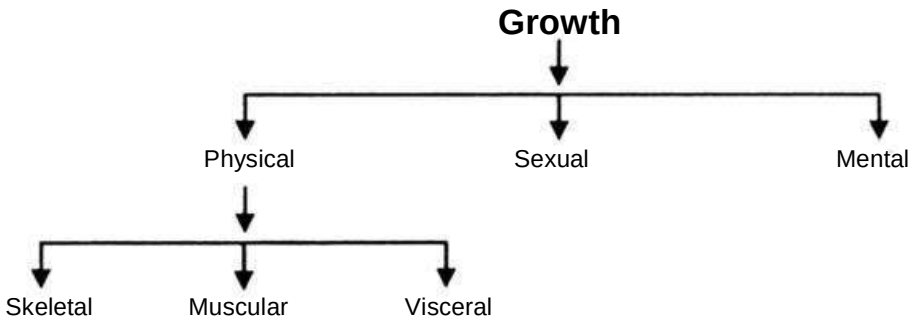
 If there is deficiency of iodine in food then thyroid try to absorbs more and more iodine from blood and increases its size it is called **simple goitre**.

- Goitre is found more abundently in the persons those live on mountain slopes, because iodine (at that place) flows along with water. When most of the people show the symptoms of this dissease then it is called **endemic goitre** and hill station called as "goitre zone"

- Persons who take sea foods, never show the symptoms of goitre.

1. Growth, Developemnt and Metamorphosis :



- Thyroxine stimulates the metamorphosis of tadpole larva in amphibians.
- Due to its deficiency, larva does not show metamorphosis to be an adult.
- Some amphibian larvae e.g. **Ambystoma** and **Necturus** (Water dog) do not undergo metamorphosis to an adult, and these larva stages start reproducing without gaining adulthood. This process is called as **Paedogenesis**.

2. METABOLISM :

General :

(i) Thyroxine regulates the **Basal Metabolic Rate (BMR)** in the body.

BMR : The rate of **calorie consumption** that is necessary for survive is called basal metabolic rate of body.

The hormone enhances the oxidative metabolism of body cells as a result of it energy production is also increased in the form of calories.

BMR increases $\rightarrow$ Body Temp. increase $\rightarrow$ loses weight.

Due to over production of heat it is called as calorigenic hormone.

(ii) Increase activity of $Na^+ - K^+$ AT Pase. It increases the number of mitochondria in all the cells of body i.e. increases metabolic rate of life. It increases the consumption of oxygen by the cells of body.

- Thyroxine play the both anabolic as well as catabolic role. At optimum concentration it play anabolic role but in oversecretion it play catabolic role.

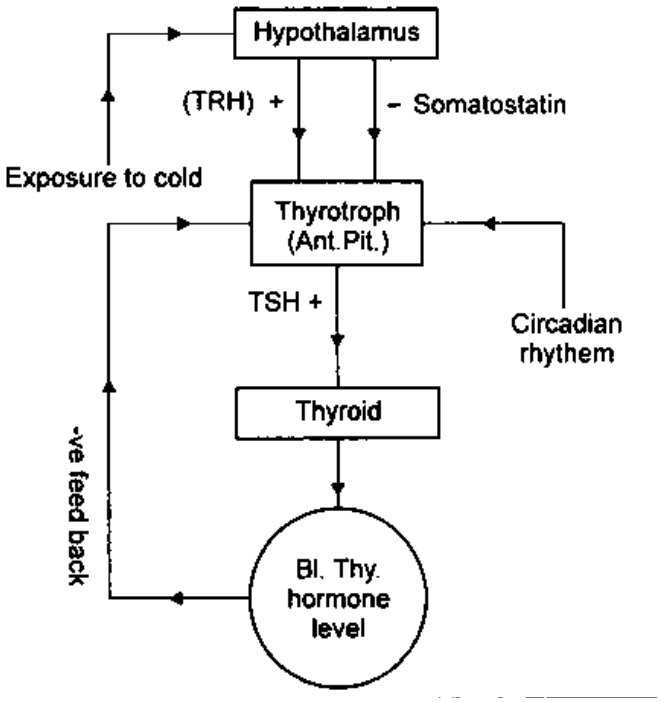
Fat Metabolism :

- Enhances enzyme activity both synthesis & predominantly catabolism of cholesterol.
- **Carbohydrate action** $\rightarrow$
- Blood sugar increase, act as a diabetogenic hormone.
- **Protein** $\rightarrow$ both catabolism & anabolism but at optimum concentration of thyroxine, **anabolism** is dominant.

3. ON INDIVIDUAL SYSTEM : Heart

- Thyroxine increases – Heart beat increases (Tachycardia) – Increases Cardiac output.
- Maintain the contraction of myocardium.
- It regulates the heart-beat because it acts directly on SA-Node.

- **CNS** – optimum conc. of thyroxine is required for developemnt of the nerve fibre & their myelination.
- **GIT** – thyroxine increase motility of GIT causes diarrhoea. Appetite also increase.
- **On blood** – Thyroxine stimulates. The formation and maturation of R.B.Cs

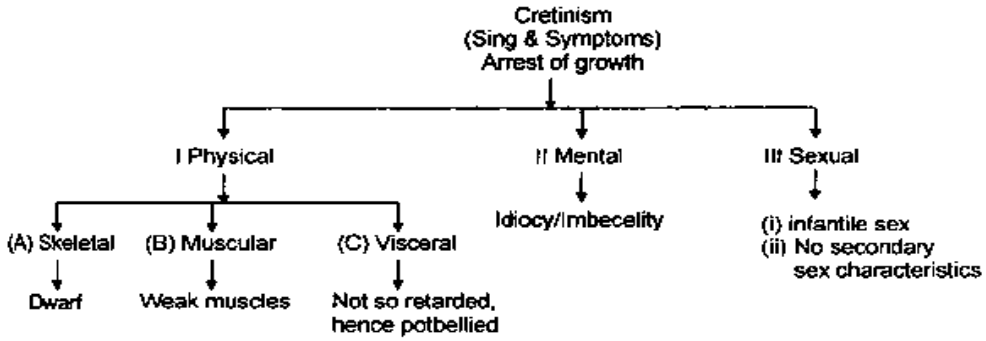


- The hypothalamus and anterior pituitary gland control rate of thyroid secretion.
- Anterior pituitary gland secretes TSH.
- The most important effect of TSH is **proteolysis of thyroglobulin** which causes release of thyroxine into the blood.
- Secretion of TSH is controlled by a hypothalamic hormone. Thyrotropin Releasing Hormone (TRH).
- Increase thyroid hormone in the body fluid decreases the secretion of TSH by anterior pituitary.

IRREGULARITIES OF THYROID GLAND AND IT'S DISEASES :

1. Hyposecretion of thyroid or Hypothyroidism :

- It may be a genetic disorder or due to deficiency of iodine in food or due to excess iondine excretion in urine.
- **In childhood**, hypothyroidism causes **Cretinism**, these children are called **cretin**, they may show such symptoms like : Thick lips, protruding tongue, pot belly, ill developed sex organs & retarded physical & mental growth. The children remain dwarf and become ugly. Their BMR, rate of heart beat and body temperature decreased. They are sterile.



- **In adults**, hypothyroidism causes **Myxoedema**. (Gull's disease) The symptoms of this disease are falling of hair, loose and swollen skin, deposition of adipose fat and mucous beneath the skin so body as a whole becomes obese, BMR and blood pressure are reduced. Patient becomes sensitive to cold and shows loss of sexual power. Mental slowing, **bradycardia**, weight gain occurs and lose of hair from head. Myxoedema is also called as Sporadiac goitre.
- **Simple goitre/Endemic goitre :** It is due to deficiency of iodine in food, and also known as **Colloid goitre**. Thyroid gland enlarges due to swelling. It is not a genetic disorder. The neck also swells up and looks like a collar. It is cured by extra intake of iodine in food or intake of sea food.
- **Hashimoto's disease :** In this disease, there is acute deficiency of thyroxine. Then the medicines given for the treatment of disease or even hormone thyroxine itself acts as antigen. In its reaction, body produes antibodies, which destroy the thyroid gland itself. It is known also as **suicide of thyroid or Autoimmune thyroiditis**.

2. Hypersecretion of thyroid or Hyperthyroidism :

The gland shows enlargement due to some microbial infections or genetic disorders, and this enlarged gland secretes thyroxine in excess amount. As a reuslt of it, BMR, heart beat rate, blood pressure, absorption of glucose in intestine and consumption of oxygen increase. Too much energy is produced in mitochondria, that it is not stored in the form of ATP but it is released in the form of heat in the body . Thus in place of growth unnecessary irritation, exhaustion are observed in the body of patient. Due to excess heat/calorie/energy formation, patient feels extreme hot.

Hyperthyroidism may cause following disorders in the body :

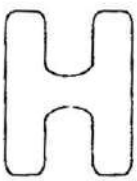
Expohthalmic Goitre or Grave's disease or Basedow's disease or thyrotoxicosis

In this disease, deposition of mucous beneath the eyeball takes place. As a result of that eyes look enlarged and buldging or protruding out side the eye socket, giving the patient a fearful look. In this disease whole gland shows enlargement in the neck region.

Plummer's disease : In this disease, thyroid gland does not show even growth but there become small tumours all over the thyroid just like buds, it is also called **Toxic adenoma**.

Thyroid gland shows enalrgement (swelling) at the time of hypersecretion.

Grave's Disease



Plummer's Disease

Parafollicular cells or C-cells :

Some large and clear cells are found in the stroma of thyroid gland & basal part of follice. These cells are endocrine nature. They are the remains of ultimobranchial bodies made up of fifth branchial pouches of embryo, i.e. para follicular cells are **endodermal** in origin.

These cells secrete **thyroclacitonin (Calcitonin) hormone** which lacks iodine. It is protein in nature.

Thyrocalcitonin reduces the destruction of bones and increases the rate of excretion of Ca^{++} in urin, thus reduces the number of Ca^{++} in extra cellular fluid.

- It enhances the deposition of Ca^{++} in bones thus making bones solid and strong.

- This hormone is antagonistic to **Collip hormone** or **parathormone**.

PARATHYROID GLAND

- These glands remain embedded in the dorsal surface of surface of thyroid gland. They are two pairs in number. They remain embedded in each lobe of thyroid completely or partially.
- It was discovered by **Raynard** and its detailed studied was given by **Sandrom**.
- Total weight about 140 mg and its size is 6 × 3 × 2 mm.

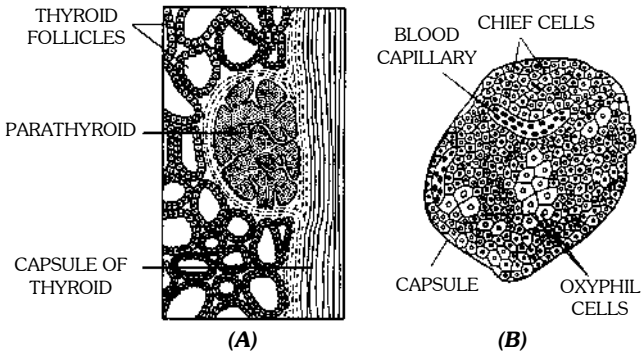


Fig. – (A) Parathyroid gland embedded in the surface of thyroid, (B) Ultrastructure of a parathyroid

- These glands are made by epithelium of third and fourth branchial pouches or pharyngeal puches slite of embryo i.e. these are also **endodermal** in origin.
- These glands secrete only one hormone – parathormone. It is also known as **Collip's hormone** or PTH. Its was obtained by **Collip** in its pure form.
- This hormone is proteinaceous in nature/Polypeptide hormnone.
- Parathormone is essential for survival because it significantly contributes to "homeostatis" by regulating the amount of calcium and phosphate ion in ECF.
- Calcium is key element in many physiological functions like proper permeability of cell membrances, muscular activities, nerve impulse conduction, heart beat, blood coagulation, bone formation, fertilization of ova.
- Calcium is most abundant of all minerals found in the body and about 99 % of calcium and phosphorus are contained in the bones.
- Maintenance of proper calcium level under "homeostatis" is in fact, a combined function of **parathormone, thyrocalcitotnin** and **vitatmin D_3 (cholecalciferol)**.
- Parathormone promotes absorption of calcium from food in the intestine and its reabsorption from nephron in the kidneys.
- Simultaneously, its accelerates elimination of phosphate in urine (phosphaturia action). Thus, calcium level tend to rise in the ECF due to effect of parathormone and phosphate level is decreased in ECF.
- This calcium is then utilized by bone-forming cells, (Osteoblast) in bone formation under the influence of vitamin D_3.
- Parathormone stimulates the osteoclast cells to feed upon bones, these cells remove unnecessary parts of bones by melting, thus change asymmetrical bone into symmetrical one. The remoulding of bone is done by these cells life long. As a result of this, amount of Ca^{+2} remains constant in blood in normal conditions.

Each 100 ml of blood contains 12 mg of Ca^{++}

About 1 kg of calcium is found in an adult man.

- Parathormone maintains the activity of muscles.
- Just opposite to it, **thyrocalcitonin** hormone works **antagonistically** to oppose the **parathormone** and **Vitamin D**. Thyroclacitonin reduces the amount of Ca^{++} in blood by increasing the excretion of Ca^{++} in urine and by reduing destruction of bone.

1. Hyposecretion :

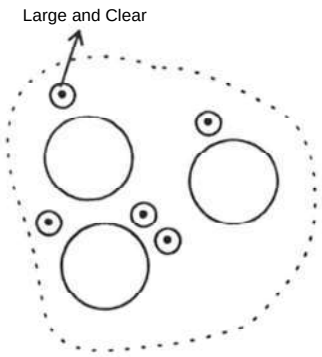
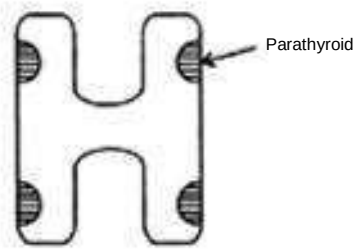
Due to hyposecretion of parathomone or PTH, the amount of Ca^{++} decreases in ECF (It is known as **hypocalcaemia**) and amount of PO_4^{-3} is increased.

- Due to the deficiency of Ca^{++} in blood, muscles and nerves get unnecessarily irritated and start convulsion and cramping. Sometimes voluntary muscles remain contracted for a long time, it is known as **tetany** disease.
- If this tetany appears in intercostal muscles and diaphragm, then animal dies due to **Asphyxia**.
- Removal of parathyroid gland causes quick death. It is the most fatal state/lethal condition.

2. Hypersecretion :

Due to hypersecretion of PTH. osteoclast cells feed excess amount of bone unnecessarily. As a result of this,bones become brittle and weak. This condition is called as **Osteoporosis**.

- When quantity of Ca^{++} is increase in ECF and level of PO_4^{-} is reduced, this condition is known as **hypercalcaemia** and **hypophosphatemia** respectively.
- Due to excess deposition of Ca^{++} in kidneys and gall bladder, **stones** are formed.

C-Cells/Para-follicular cells	Para Thyroid Gland
 It secretes Thyro calcitonin (TCT) hormone It decreases Ca^{+2} level in the blood	 It secretes the parathormone (PTH) hormone It increases Ca^{+2} level in the blood

ADRENAL OR SUPRA RENAL GLANDS

Position, Origin & structure :

- This gland was discovered by a scientist **Eustachius**.
- It is found on the head (anterior most part) of both the kidneys.
- Adrenal gland is **ecto mesodermal** in origin.
- It weights about **4 - 6** gm in man.

- Whole gland is surrounded by a fibrous capsule.

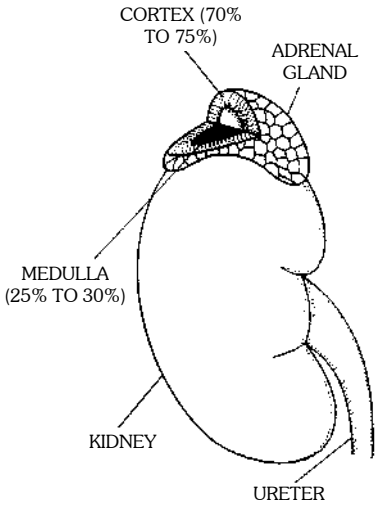


Fig. – Adrenal gland with a part cut to show cortex and medulla

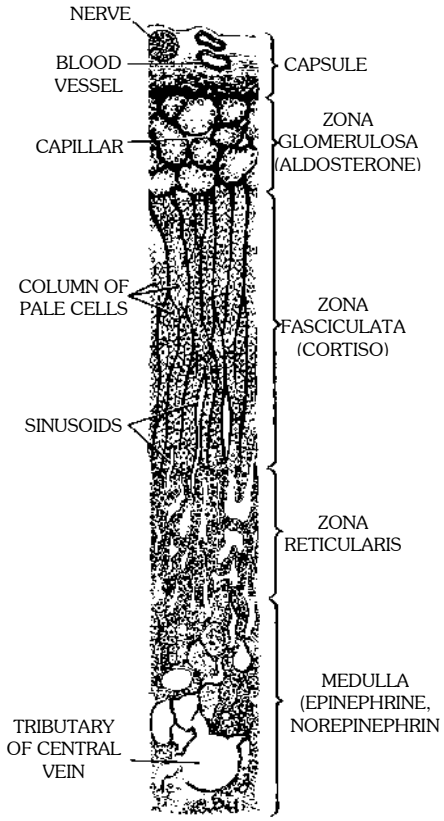


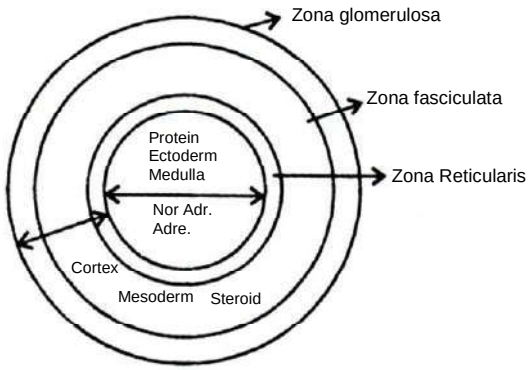
Fig. – Adrenal gland with a part cut to show cortex and medulla

- Each gland has two parts :
  Outer part of gland is called **cortex** and inner part is called **medulla**.
- Cortical portion is 80-90% and is develop from mesoderm of embryo.
- Medullar portion of this gland is mae up of neural-ectoderm of embryo. Only 10-20 % part is medullar part of gland.

Adrenal Cortex :

Most of the cells of this part are fatty. This portion is divided into three regions from periphery to centre.

1. **Outer zone or Zona glomerulosa :**
   Mineralocorticoid hormones are secreted by this zone.
2. **Middle zone or Zona fasciculata :**
   This zone secretes glucorticoid hormones. In this region polyangular cells are arranged in the layers.
3. **Inner zone or Zona reticularis :** Cells of this region are spread in the form of a network, these are arranged in layers. This zone secretes a small amount of sexhormones.



About 40-50 hormones are synthesized in adrenal cortex. All these hormones are of steriod nature. Their basic constituent is chloesterol, these are also called corticoids. Out of these 40-50 hormones, only 7-8 hormones are active.

1. Mineralocorticoids :

2 main hormones fall under this category.

(A) Aldosterone (B) Deoxycorticosterone

Aldosterone -

- These hormoens are related with distribution of water in tissues and balance of **electrolytes** in the body.
- These hormones maintain the ionic balances of Cl^-, K^+, Na^+ and water in the blood and ECF.
- Aldosterone hormone affects distal convoluted parts of uriniferous tubules & upper part of collecting duct.
- It basically activates the Na – K pump.
- It helps in reabosption of Na^+ & Cl^- ions and controls the excretion of K^+ ions.
- Aldosterone hormone is also known as **salt retaining** hormone it increases sodium concentration.
- An increase in Na^+ ion concentration (than normal) in ECF is called **Hypernatremia**.
- In hyposecretion of aldosterone hormone, there is a tremendous loss of ions of Na^+, Cl^- and HCO_3^- by urination and K^+ ions are increased in blood.

2. Glucocorticoids :

Mainly two hormons comes under this categories : - (A) Cortisol (B) Hydrocorticosterone

(A) **Cortisol :** It is an important hormone secreted by zona fasciulata. It is also known as **Hydrocorticosterone**. Cortisol has a small amount of mineralocorticoid activity.

Metabolic Effect :

On Carbohydrate metabolism :

- Increases sugar in blood causes Hyperglycemia. It stimulates the gluconeogenesis in the liver.

Protein metabolism :

Cortisol stimulates the protein break down in some organs like lymphoid tissues (thymus, lymph node etc), muscles, bones, skin etc.

Fat metabolism :

(i) Facilitates lipolysis.

(ii) Promotes deposition of fat, in subcutaneus tissue of the body.

On nucleic acid metabolism :

Cortisol inhibits the synthesis of nucleic acid in all other tissues except liver where (i.e., in the liver) RNA synthesis is increased.

- This hormone controls the activity of collagen fibre and controls the local inflammation or oedema.
- This hormone is "anti-inflammatory.
- Cortisol in used in arthritis/Rheumatism
- Cortisol checks the antigen antibody reaction and controls the local allergy so, it is also called as anti allergic hormone.
- This hormone increases the no. R.B.Cs and decreases the W.B.Cs in the blood so, This hormone is Immuni-suppressive.
- Now a days, contrisols are used in transplantation of organs.

3. Sex – Hormones/Sex corticoids/Gonadocorticoids :

- Sex hormones secreted by adrenals are called **gonadocorticoids**.
- They are secreted in very small amount by zona reticularis.
- Male hormones are called **androgens** and female hormones are called **oestrogens**.
- Both the hormones are secreted by men & women, but sex hormones are mainly secreted by gonads.
- The sex hormone of oppsoite sex secreted by adrenal gland.
- These hormones stimulate the muscles, external genitalia and sexual behaviour.
- Male hormone secreted by adrenal gland is mainly **dehydroepiandrosterone [DHEA]**.
- Female sex hormones progesterone and estrognes are secreted in minute quantities.

Adrenal medulla :

Origin : The adrenal medulla develops from the neuroectoderm of the embryo.

Structure : The adrenal medulla consists of rounded groups of relatively large and glandular cells. These cells are modified of sympathetic nervous system which have lost normal processes and have acquired a glandular function. These cells are called **chromaffin cells or phaeochromocytes**. These cells are connected with the preganglionic motor fibres of sympathetic nervous system, these are dicussed together **as sympatheticoadrenal system**.

Hormones of Adrenal medulla :

Two hormones are secreted by this part. They are collectively called as **catecholamine**.

These hormones are synthesized by chromaffin cells with Tyrosine amino acid.

$$\text{Tyrosine} \xrightarrow[\text{Decarboxylation}]{\text{Hydroxylation}} \text{Dopamine} \xrightarrow{\text{Hydroxylation}} \text{Norepinephrine} \xrightarrow{\text{Methylation}} \text{Epinephrine}$$

Adrenaline or Epinephrine :

- This hormone is 80 % part of the total hormones secreted by Adrenal medulla.
- It was termed as **Emergency hormone** by **Walter Cannon**, because this hormone prepares the body to face unavoidable emergency situations.

Functions of Adrenaline :

- It constricts the blood vessles of skin (Vaso contriction).
- The hormone enhances the flow of blood by vasodilation of blood vessels of brain, heart, liver and skeletal muscles.
- Increases the rate of heart beat, cardiac out put, so increases blood pressure.
- Adrenaline enhances the heart beat and thus increases cardiac output, due to this, circulation of blood becomes faster.
- The hormone stimulates the trachea and bronchi muscles to relax, as a result of it, rate of breathing is increased. So adrenaline hormone is used in asthma.
- It dialates the pupils of eyes. Goose flesh is observed due to its effect. It constricts the erecter pilli muscle of hair, and hair are raised.
- The hormone contraction in spleen, as result of it, spleen pours its stored blood into blood stream and controls the blood volume in body.
- It checks the secretion of saliva and reduces the peristaltic movements in alimentary canal.

- Due to the effect of this hormone, clotting period of blood is reduced, This hormone also stimulates the contraction of Uterus in female at the time of parturition.
- Adrenaline provides the body with an emergent chemical defence mechanism in stress conditions that threaten the physical integrity and chemical consistancy of the body e.g. accident, restlessness, fear, anger, mental tension, pain etc. It immediately prepares the body to face the emergency by a violent stress or alarm reaction.
- The **cortisol** hormones of adrenal cortex serves to maintain the body in living condition and recover it from the servere effects of stress reactions. Thus an increased output of cortisol is **"life saving"** in **"shock conditions"**. So it is also known as **life-saving hormone**.
- The hormones of **adrenal medulla** prepare the animal for fear, fight or flight in emergency conditions. (by excess secretion of these hormones) Adrenaline hormnoe is called **3F = FFF homone** and adrenal gland is called **"triple F gland"** (FFF gland)

Noradrenaline or Norepinephrine hormone :

- It is only 20% part of total hormones secreted by adrenal medulla.
- It acts as vasoconstrictor, thus increases the blood pressure. **Exception – It does not constrict coronary artery of heart**.

IRREGULAR SECRETION OF ADRENAL HORMONE

(i) Hyposecretion :

Addison's disease : Hypoadrenalism

- Caused due to hyposecretion of corticoid homrone of adrenal gland, following are some sympotms of addision's disease dehydration in the body, Blood pressure, BMR and body temperature are reduced, excretion of water and Na^+ increase. The skin of hands, neck and face turns to **bronze colour**.
- Hyposecretion of corticoids causes reduction in amount of glucose in blood, it is called **hypoglycemia**. In this disease, patient may die, so hormones of adrenal gland are called **life-saving hormones**.

(ii) Hypersecretion :

Cushing's syndrome (disease) :

- Due to hypersecretion of Gluco corticoids, body increases breadthwise or body becomes broad because excess deposition of fat under the skin (to cause moon face, fish mouth and buffalo hump). Protein catabolism increases in body. Irregular growth of skin and bones is observed. Hyperglycemia occurs. Amount of Na and water increase in ECF, which is called **oedema**. Due to this B.P. also increases.

Conn's Disease : (Primary aldosteronism)

- Due to excess of mineralocorticoids, an imbalance of Na^+, K^+ is observed. This disease is called **"Conn's disease"**. Due to this disease there occurs irregularity in nervous system, as result of that muscles get contracted, Muscle weakness, hypertension and hypokalemia are observed.

Adrenogenital Syndrome/Adrenal virilism/Pseudohermaphrodite :

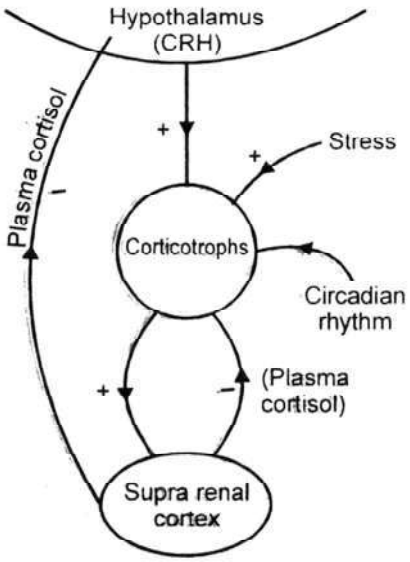
In this case, girls develop male characters, eg. menstrualion cycle is stopped, uterus and ovary are reduced or constricted and clitoris becomes enlarged. Somatic hairs are develops on body, development of Beard and moustache. Only hair symptoms are called as Hirsutism.

- In a man, female sex hormone is secreted by adrenal is in excess amount. he will show feminine characters i.e. development of mammary glands this disorder is called **gynaecomastia**.

- If in a male, androgens are present in excess **amount**, it developes extra enlargement of **penis**. This defect is called **macrogenitosomia** e.g. **manis, Armedillo**.
- Adrenal gland is also known as **4 – S gland**
- 4–S
  - S – Sugar metabolism
  - S – Slat retaining actions
  - S – Sex hormones
  - S – Stress reactions

Control of adrenal Secretion :

- Adrenocorticotropic hormone **[ACTH]** of anterior lobe of pituitary gland controls the hormones secreted by adrenal cortex.
- ACTH controls very little or even does not control the secretion of mineralocorticoids. These are controlled by **Renin hormone** secreted by kidneys.
- Pituitary gland does not control the secretion of adrenal medulla hormones, the adrenal medulla hormones secretion is controlled by nervous system.
- The amount of cortisol and ACTH in blood is maximum in the morning and minimum in early part of night.



Control of ACTH secretion

THYMUS GLAND

This is situated in the anterior part of heart called **mediastinal space**. It is a bilobed gland. It is originated by third branchial pouch of embryo, i.e. it is **endodermal** in origin.

- Thymus gland is well developed in a new born child, but it reduces continuously from adulthood to old age. It remains in the form of a string at last.
- Its structure is just like lymph gland. It is covered by connective tissue coat capsule and internally both the lobes are redividing in to small lobules.
- Each lobule has a dense, darkly staining peripheral **cortex** and a looser lightly staining central **medulla**.
- The cortex consists of densely packed lymphocytes.

- The medulla consists of reticular epithlial cell, a few lymphocytes and the "Corpuscles of Hasslls" thymic corpuscles.
- Thymus gland is related to immune system of body.

Hormones and functions of thymus gland :

- Thymus gland secretes thymosin or thymin hormone, that is proteinaceous in nature/Polypeptide.
- Main-immunity develop upto 9-10 year. If thymosine immunity power very high tymosin myasth gravis develop.

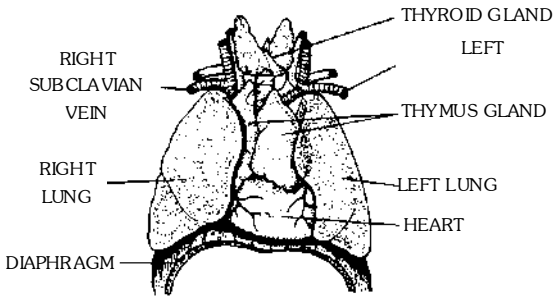
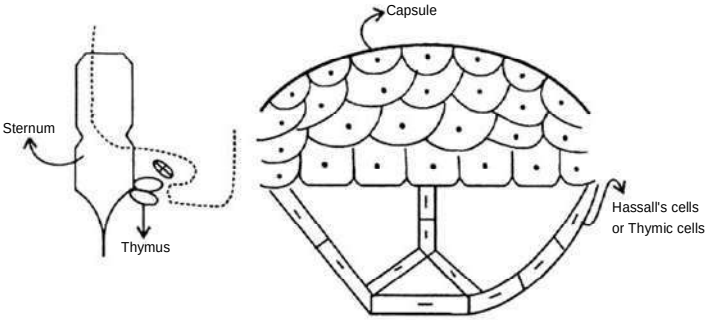


Fig. – Location of thymus gland



(1) This hormone helps in immune system of the body.

(2) **Hassall's corpuscles** are found in thymus gland, these are also called **thymic corpuscles or eopithelial cell or reticular cell**, they act as phagocytes.

(3) After the birth, **T-Cells** or **T-lymphocytes** are matured in thymus gland, then these lymphocytes are releases by thymus gland, reach to lymphatic organs like spleen, payer's patches and lymph nodes & deposited in it.

(4) Thymosin hormone stimulates the maturation of lymphocytes to destroy the antignes produced by bacteria or pathogen.

(5) According to one of the theories of Ageing the decline and disappearance of Thymus gland by middle age is the primary cause of **ageing**.

(6) Thymosin helps in the development of sex gland but inhibits sexual maturity in early young age.

(7) Thymus provide cell mediated immunity so thymus is also called **"Throne of immunity"** or **"Training school of T-lymphocytes"**.

- Secretion of thymin decreases the neuromuscular transmission, so hypersecretion of thymine may cuase **myasthenia gravis** (may be treated by corticoidesfor short time). It provides the antibody against receptor & block the Neuromuscular junction.

PINEAL BODY

Position :

- It is situated at the dorsal side of diencephalon of anterior part of brain i.e. prosencephalon. It is also known as **Epiphysis cerebri. Pineal** body is a part of brain. It is ectodermal in origin.
- There are found pinealocyte cells (formed by the modification of nerve cells) and supporting interstitial cells or neutroglial cells in pineal body.
- Pineal body called as **third eye in frog**.

Hormone & Functions :

- Pineal body secretes a hormone melatonin, which is an amino acid.
- Melatonin is functional in lower vertebrates only.
- In amphibians and reptiles, this hormone is related with metachrosis (change in the colour of skin). It affects the Melanophores of skin, thus acts antagonistically to the MSH of pituitary i.e. it fairs the complexion of skin.
- Central part of gland secretes antigonadial hormone.
- The hormone controls the sexual behaviour in mammals. It inhibits the sexual irritation, and also inhibits the development of genitalia and their functions.
- If pineal body is removed from rat, these will attain premature adolescence.
- The gland probably controls the sexual behaviour according to light differentiation, thus it acts as a **biological clock**.
- It is proved that the level of melatonin rises during periods of darkness and falls during periods of light.
- Children blind from birth attain puberty earlier than normal.
- Maximum developoment of pineal upto 7yr & then it undergoes involution & at the age of 14 yr interstitial tissue and crystals of $CaCO_3$ or Ca_3PO_4 are deposited in it, these are called **"Brain sand"** or **"Acervuli"**.

PANCREAS

- **Position :** Pancreas is a pink coloured mixed gland
- Endodermal in origin.
- 99% part is exocrine – Acini – Digestive enzymes.
- 1% part in endocrine – Islets of Langerhans – Different hormones.
- Each islet of Langerhans has 4 types of cells

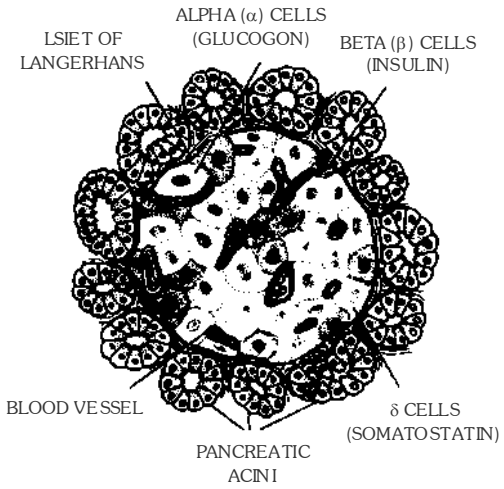


Fig. – T.S. of pancreas

(A) **Alfa cells (α-cells) :** These are the largest cells present in peripheral region these are approximately 25 % of the total cells. They secrete **glucagon** hormone.

(B) **Beta cells (β-cells) :** These are the small cells present in central region. These are about 60–65 % part of total cells. They secrete **Insulin** hormone.

(C) **Delta cells (δ-cells) OR Gamma cells (γ-cells) :**
These cells are found in middle region. These are about 10 % part of total cells. They secrete **somatostatin** hormone which regulates the activities of α-cells and β-cells.

(D) **F-cell or PP-cells :** Along with above mentioned cells, some other cells are also found in islet of Langerhans, these are called PP-cells which secrete pancreatic polypeptide hormone.

Insulin :

- It was first prepared/found by **Benting and Best**.
- Molecular structure of insulin was given by A.F. Sanger (with the help of cow's insulin)
- The term insulin was also given by **A.F. Sanger**.
- Insulin is the first protein that is artifically synthesized in lab and is crystallized.
- Human insulin was synthesized by **"Tsan"**.

- Functional human insulin is made up of 51-amino acids that has 2 chains.

(i) α-chain – It is made up **21** aminoacids

(ii) β-chain – It is made up 30 amino acids. Both chains are bind together with cross bonds of disulphide bonds.

- **"A.F. Sanger"** was awarded by **Noble Prize** for it.

Functions of Insulin hormone :

(I) **Actions on cell membrane permeability.**

(II) **Actions on metabolism of** : Carbohydrate, Protein, Fat, Nucleic acid, Minearl.

On cell membrane permeability : Exept brain cells, R.B.Cs. retina, insulin stimulates the permeability and consumption of glucose in all somatic cells.

Actions on Metabolism :

Carbohydrate :

(1) Insulin inhibits gluconeogenesis.

(2) Promotes glycogenesis. There are two major sites of glycogenesis, **Liver** and the **muscles**.

(3) Enhances peripheral utilization (oxidation) of glucose, causing the blood glucose level to fall.

(4) Inhibits glycogenolysis.

(5) Insulin reduces the glucose level in blood so, it is also called as Hypoglycemic factor.

(6) Insulin is anabolic hormone.

Fat :

(i) Insulin promotes lipogenesis and inhibits lipolysis.

(ii) Due to deficiency of Insulin incomplete oxidation of fats takes place which, is the main cause of ketoacidosis in blood.

Protein : Insulin promotes protein synthesis by promoting uptake of amino acid by liver and muscle cell.

Nucleic acid : Insulin promotes synthesis of DNA and RNA.

Hyposecretion of Insulin :

(1) Due to hyposecretion of insulin, permeability and consumption of glucose is decrease, Glycogenesis decrease in the liver so, glucose level in blood is increase and this disease is called **"Diabetes mellitus"** or sugar disease.

(2) World Diabetes Day – 14 November.

- Glucose is excreted throught urine, if amount of glucose is in excess in the blood, this is known as **"Glycosuria"**. In this stage, amount of glucose in blood increases upto > 180 mg./100 ml of blood plasma.
- The amount of water increased (in this stage) in the urine, so intervals of urination reduced, it is called **polyuria**.
- **Polydipsia -** Due to excess loss of water and minerals through urine. The patient feels thristy.
- **Polyphagia** - Due to deficiency of glucose and energy is somatic cell patient become excessive hunger.
- Due to incomplete oxidation of fats in fatty tissues, ketone and acetone bodies are formed. This ketoacidosin apply toxic effect on brain cells.
- The combined effect of ketoacidosis, dehydration and hyperglycemia may cause diabetic comma to the patient, patient becomes unconscious and even some time may be die.
- Insulin hormone is given to the patient by injection in this disease, Insulin given orally is not effective, because it digest in the alimentary canal like protein.
- Now a days, oral insulin is used in following states :

(A) IZS – Insulin Zinc Suspension. (B) PZI – Protamine Zinc Insulin

Hypersecretion of Insulin :

Or – Hyperinsulinism :

- Due to hypersecretion of insulin amount of glucose decreases in blood. It is called **hypoglycemia**.
- In hypoglycemia state, body cells take more and more glucose from blood So need of glucose for nervous system, retina of eye, genital epithelium is not fulfilled, as a result of that patient looses its reproductive power and sight. Due to excess irritation in brain cells, patient feels exhausted, unconsciousness, Cramps, and at last patient may die.
- **"Insulin shock"** – After physical exercise or fasting, if a diabetic patient takes an inlusin injection, sugar level in blood reduces quickly up to 40 mg/100 ml of blood. It is called insulin shock. The patient may be unconscious or even may die.

Disabetes mellitus are two type

(i) **Type - I Diabetes mellitus :** It is also called as juvenile diabetes or Insulin Dependent Diabetes mellitus (IDDM). It is usually develops before age 40 and it is characterised by loss of β-cells with eventually absence of insulin in the circulation. due deficiency of insulin fatal high level of ketone bodies. increase the blood. Insulin is the metabolic hormone which present ketonebody formation.

(ii) **Type - II Diabetes mellitus :** It is also known as matuarity onset diabests mellitus or Non-Insulin Dependent diabetes mellitus. It is usually develops after age 40 year and is not associatede with total loss of the ability of secrete insulin.

Difference between diabetes mellitus and diabetes insipedus

S.No.	Diabetes mellitus	Diabetes insipidus
1.	It is due to deficiency of insulin.	It is due to deficiency of ADH.
2.	The blood sugar becomes high and glucose appears in urine.	The blood glucose is normal and glucose does not appear in urine.
3.	There is high blood cholesterol and ketone body formation.	There is no such phenomenon.

(2) Glucagon :

- It is secreted by α-cells.
- It was discovered by **"Kimball** and **Murlin"**.
- Glucagon is a **hyperglycemic factor**.
- It is made up of 29 amino acids.
- It is antagonistic to insulin. It is secreted by the gland, when sugar level of blood reduces.
- Glucagon hormone increase the amount of glucose in blood.
- It stimulates gluconeogenesis in liver, as a result of that amount of glucose in the blood increased.
- It stimulates Lipolysis of fats in fatty tissues.
- The secretion of insulin and glucagon is controlled by a limit control feed back. When amount of glucose is increased in blood, then insulin is secreted by β-cells. As a result of it, when amount of glucose is reduced in blood, then glucagon is secreted by α-cells.

(3) Somatostain :

It regulates the secretion of insulin and glucagon.

(4) Pancreatic Polypeptide (PP) :

Its functions are known yet today perhaps it controls the absorptin of digested food in intestine.

OTHER ORGANS WHICH SCRETE HORMONES

(A) Kidney : - Main function of kidney is excretion, but it secretes some hormones also. These are as follows :

1. **Renin :** - It converts a plasma protein is secreted by Juxtaglomerular complex of kidney. Renin hormone acts as an enzyme. It changes the Angiotensinogen into Angiotensin I.

$$\text{Angiotensinogen} \xrightarrow{\text{Renin hormone}} \text{Angiotensin I.}$$

- Renin hormone increase reabsorption of water and Na^+ ions in uriniferous tubules.
- It stimulates the secretion of aldosterone hormone from adrenal cortex.

2. **Erythrogenin :** The hormone reacts with plasmaprotein (Globulin) and forms a new hormone erythropoietin.

- Erythropoietin stimulates bone marrow to form RBCs.

3. **Renomedullary prostaglandins :** It is the most active renal hornone. It makes relaxation in unstriated muscles of blood vessels of kidneys. It enhances the excretion of Na ions by urine (diuretic effect), renal vasodilation & decreases tubular reabsorption.

(B) Skin : Due to the effect of ultraviolet rays of sunlight steroids like Argosterol and cholesterol are changed into Argocalciferol and cholecalciferol vitamin D respectively in the skin, it reaches to its target organ by blood stream.

- **Vit. D is supposed to be a hormone**. It acts as a co-hormone with parathormone.
  It helps in bone formation and teeth formation. It increases the absorption of calcium and phosphorus by intestine.
- 'Rickets' disease is observed in children due to the deficiency of vit. 'D' as a result of which bones become weak and thin.
- In adulthood, its deficiency causes **Osteomalacia**. Bones become weak and brittle.

(C) Gonads : -

(i) Testes (Male gonad) :

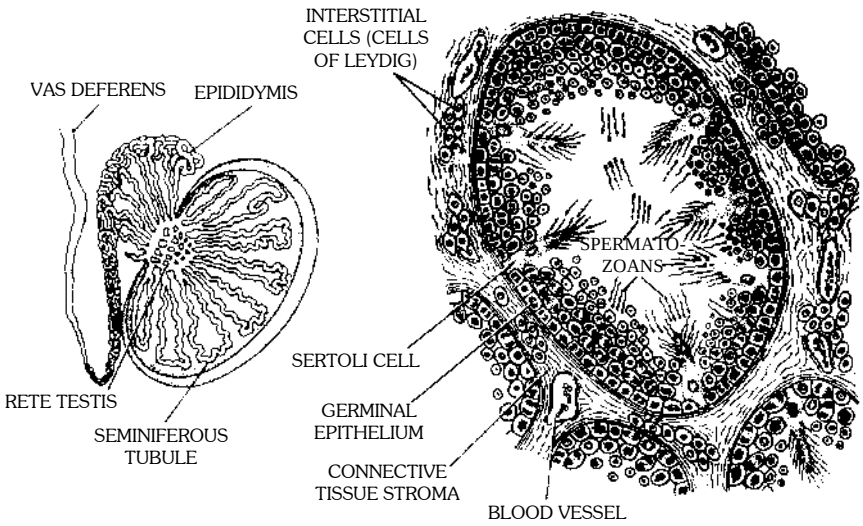


Fig. – Ultrastructure of testes

- Leydig's cells or Interstitial cells of connective tissue of seminiferous tubules of testes secrete male hormones androgens.

- Main androgens are testosterone and androsterone.
- These are steroid in nature.
- Testes also secrete inhibin/activin

WORKS OF TESTOSTERONE

- It increase the diameter of pectoral bone.
- It stimulates the haemopoiesis in bones.
- It increases the cholesterol level in blood.
- Testosterone is the main androgen (30 to 100 ng/ml).
- It changes the sexual behaviour in male eg. deveop the sexual attraction towards the female.
- This Hormone stimulates the development of secondary sex organ. Such as epididymis, vas deferens, seminal vesicle.
- This hormone developes the low pitch of voice which is known as musculizatin of voice.
- This Hormone stimulates the number of sebaceous gland on the face which causes the Acne & pimples.
- It increases the developemnt of beard & moustache.
- It develops the musculization power in muscle.
- It also stimulates the growth of hair on the upper limb, lower limb, thoracic, abdominal part, armpits & near to the external genital organ.
- It stimulates the skeletal growth.
- It also help in the organisation of Ca^{+2} in bones.

(ii) Ovary (Female gonad) :

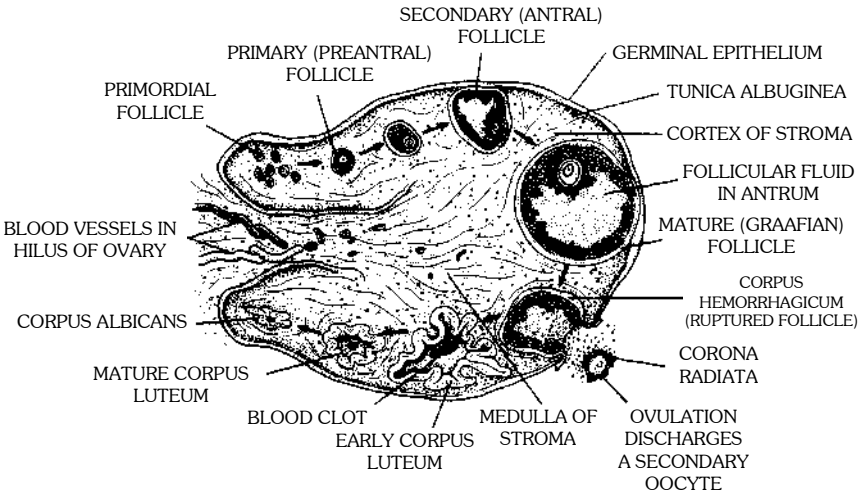


Fig. – V.L.S. of ovary

- **Estrogen/Oestrogen :** The hormone is is secreted by the inner layer – theca interna of graafian follicles.
- Estrogen includes estradiol, estrone and estriol.
- Estrogen is steroid in nature.
- This Hormone stimulates the development of secondary sex organ such as fallopian tube, uterus, vagina.
- Promotes the development of mammary gland. It stimulates the tubular growth.
- It devlops the high pitch of voice which is also called as Feminine of voice.

- This Hormone removes the hair from face, upper & lower limb, thorax & abdominal part. But stimulates growth of hair near the external genital organ & armpits.
- It makes the muscle soften.
- It also develops the growth of skeletal muscle & bone. It help in the organisation of Ca^{+2} in the bone.
- It increase the diameter of pelvic bone.
- It stimulates the blood formation but decreaes the cholesterol level in the blood.
- It stimulates the rate of growth of hair of head.
- It also changes the sexual behaviour, means attraction towards the male.

Corpus Luteum : (Temporary endocrine gland).

After ovulation Graafian follicle changed into a yellow gland in the ovary, it is called **corpus luteum**. Regulation and control of its production is done by L.H. Corpus luteum is an endocrine gland. Following are the hormones secreted by this gland.

(1) Progesterone :

- The hormone stimulates the developemntal characters of pregnancy.
- Due to the effect of this hormone, uterine wall endometrium become thick and blood circulation is increased in it. Fats and glycogen are deposited in its cells.
- This stimulates the alveolar growth of mammary glands become highly developed, as a result of this breasts become enlarged.
- It helps in implantation of embryo in the uterine wall.
- The hormone maintains pregnancy, so it is also called **"Pregnancy hormone"** Progesterone inhibits the contractions in uterine wall muscles, so it is also called **"anti abortion hormone"**.

(2) Relaxin :

Perhaps corpus luteum also secretes it, but it is secreted at the end of pregnancy/gestation period.

(3) Estrogen

(4) Inhibin

(D) Placenta : (Temporary endocrine gland).

Placenta connects the embryo and uterus of mother at the time of embryo development. It secretes some hormones –

(i) **Chorionic gonadotropic hormone (CGH) = Human chorionic gonadotropic (HCG)**

It is a protein hormone. It helps to maintain the pregnancy and controls the secretory action of corpus luteum.

- At the initial stage of pregnancy CGH or HCG is secreted in excess amount by placenta and it is excreted by urine. At this stage pressence of CGH of HCGH in the urine is tested by urin test.
- It is a positive test for pregnancy. It also called Gravidex test.
- HCG or CGH is tested in urine test for pregnancy test.

(ii) **Placental lactogen or human chorionic somatomammotropin :**

It is also a protein hormone, and stimulates the mammary glands for milk production.

(iii) **Estrogen :** It is a steroid. It controls extradevelopment of breast during pregnancy.

(iv) **Progesterone :** It is also a steroid. It controls the slow action of slowly abolishing corpus luteum and maintains the pregnanacy.

(v) **Relaxin :** It is a protein hormone. At the time of parturition, it helps to expand the pubic symphysis of pelvic girdle to facilitate the child birth in females.

Hormones which always remains in tissue fluid :

There are some hormones which never reach upto blood stream but always remains in ECF.

These are as follows :

(1) Neurohormone : These are secreted in the nodes of axons of nerve cells. Acetylcholine and Norepinephrine are the main neurohormones.

(2) Prostaglandin : These are fatty acids. These are most active substances among all the known substances.

- Prostagladin are of so many types. Kidneys, gonads, seminal vesicles, thymus, brain etc. Due to vasodialator this hormone decreases the blood pressure.
- These prostaglandins are first of all observed in semen of man. These stimulate contraction of unstriated muscles.
- These prostaglandins are secreted by seminal vesicles and reach upto vagina of female thorugh semen of male, and then these activate the muscles of uterus of female.

(3) Kinins : These are chemicals which are secreted by any organ of body at the time of chemical change in ECF, and reduce the B.P. by expanding blood vessels. These also reduce th time of blood clotting.

Kinins are also called as **"Firstaid hormone"**.

(4) Pheromones or Ectohormones :

- The term "Pheromone" was coined by **Karlison** and **Butenandt**.
- These are secreted by exocrine glands. These are also called **"Semio-chemical"**. They travell from one place to other place by air.
- These chemicals are secreted by animals and effect the other animal's behaviour and mode of life of the same species.
- Just like hormones, their target place is far from place of origin.
- First of all, pheromone Bombykol was studied. It is pheromone of silk moth. Pheromones are volatile in nature, and travel through air from palce to place.

Pheromones are of 3 types :

(1) Sex – Pheromone :

These attract male and female animals for reproduction. Female silk moth secretes **Bombycol** or **Gyplure** from its body which attracts male for mating.

(a) **Muskone :** It is secreted by **Musk deers**.

(b) **Civetone :** It is secreted by **cats**.

(2) Aggregation pheromone :

This pheromone is secreted by one member of social insects and pheromone sends mesages to other members of that society. Thus helps in aggregation. e.g. : **Geradiol** pheromone in **honey bee**.

(3) Alarm pheromones :

These pheromones are secreted by one members of the insect species and alarm the other members of the same species. e.g. : Secretion of **formic acid** in ants insects etc.

Types of pheromones

Type	Example
(1) Sex pheromones	Bombycol – sillkmoth Queen substance – Honey bee Civetone – Cat Muskone – Muskdeer
(2) Aggregation pheromones	Geradiol – Honey bee
(3) Alarm pheromones	Danger signals
(4) Marking pheromones	Mark the territory in wild animals

SPECIAL POINT

- **Heterocrine gland :** These are those endocrine glands which are involved in hormone secretion as well as some other function eg. pancreas, gonads, placenta, GI mucosa and kidneys.
- In females protactin induce maternalism i.e. strong emotional attachment.
- In male prolactin promotes paternalism i.e. protective attitudes towards family members and intensive food gathering for the family.
- Sporadic cases of simple goitre (sporadic goitre) in a population are normally due to genetic defect.
- **Tropic hormone :** A hormone which stimulates another endocrine gland to secrete its hormone is called trophic hormone.
- **Simmond's diseases :** This condition is due to atrophy of the anterior lobe of pituitary gland.
- **Pheaochromocytoma :** It is due to hypersecretion of adrenaline causes, high blood pressure, high level of sugar in blood and urine, high metabolic rate, nervousness and sweating.
- **True sexual precocity :** True sexual precocity is early maturation of ovaries and testes with production, of ova before the age of 9 years in girls, or sperm before 10 years in boys, occurs without evident cause.
- **Sexual pseudoprecocity** results from adrenal cortex, testes, ovary or from other sources, including extragonadial tumours.
- **Eunuchoidism :** Failure of testoterone secretion in male causes eunuchoidism. (A) eunuch has a undeveloped secondary sex organs like prostrate, seminal vesicle and penis (B) lacks external sex character such as beard, moustache and low pitch of voice and (C) does not produce sperm.
- **Growth hormone :** Stimulate the liver to form **"Somatomedins"** (Insulin like growth factors"). This somatomedins potent effect to bone growth.
- In heart CGMP has antagonistic effect to CAMP, CAMP mediate muscle contractin in response to adrenaline, while CGMP slow down muscle contractin is response to acetycholie (NCERT).
- CGMP used in second messanger in atrial natriuretic peptide and Bronchodilation use as medicine (life saving drug) vasodilation in genital organ nitric oxide.

List of hormones their chemical nature and functions

Name of endocrine gland	Name of hormone and its chemical nature	Functions
(1) Neurosecretory cells of Hypothalamus (Supraoptic Nucleus and Paraventricular Nucleus)	(1) Oxytocin and vasopressin nanopeptide.	(i) Milk ejection and parturition (oxytocic effect). (ii) Vasoconstriction and antidiuretic (vasotocin) effects.
	(2) Gonadotropin releasing hormones	Stimulates FSH and LH sysnthesis.
	(3) Other releasing hormones *e.g.* TSHRH, MSHRH, ACTHRH, GHRH etc. Proteinaceous	Stimulate TSH, MSH, ACTH GH secretions from pituitary.
(2) Pituitary (a) Neurohypophysis (Pass Nervosa) (b) Adenohypehypsis (contains diverse cell types)	Store and release Oxytocin and Vasopressin. Proteincaceous or glycoprotein	Hormone release is related to physiological state and requirements. Affect growth, development differential pubertal changes and other metabolic mechanism.
(3) Pineal	Melatonin-derived from the amino acid tyrosine	(1) Antagonist to FSH / LH (2) Regulates biological / circadian rhythms.
(4) Thyroid gland (amine hormone) having – NH_2 group)	(a) Thyroxine, iodinated amino acid called tyrosine (T_2, T_3, T_4). (b) Thyrocalcitonin (Peptide)	(a) Controls basal metabolic rate (BMR). All organ / system of body responds to thyroxine. (b) Facilitates Ca^{+2} absorption
(5) Parathyroid gland	Parathormane, Peptide	Ca^{+2} and PO^{-}_4 metabolism.
(6) Thymus	Thymosine (polypeptide)	Anti-FSH and LH; delays puberty
(7) Islets of lengerhans (= Endocrine pancrease) (i) α-cells (ii) β-cells (iii) δ-cells	Glucagon Isolated by Insulin Banting Secretin Polypeptide	(i) Gluconeogenesis / Glycogenolys (ii) Glycogenesis (iii) Gastric functions
(8) Adrenal gland (a) Adrenal medulla (Amine hormone have – NH_2) (b) Adrenal cortex	(a) Catecholamines (epinephrine = adrenaline, and norepinephrine = noradrenaline (derived from tyrosine) (b) Mineralcorticoids and glucocorticoids and traces of androgen and estrogen steroids derived from cholesterol	(a) Stresses = emergency = Fright, Fight and Flight Hormone (3F) acclerates cardiac functions muscle activity etc. (b) Electrolyte and carbohydrate metabolism.

(9) Ovary (a) Ganulosa cells steroid, fat soluble have sterol group derived from cholesterol	Estrogen (Steroid) Estrone, estradiol	Secondary sex character primary action on uterine endometrium mitogenic.
(b) Corpus luteum	Estrogen and Progesterone (Steroid)	Secreted during luetal phase of menstrual cycle in human female and oestrous cycle of other mammals. Prepares uterine endometrium for receiving blastocytes for implantation. Progesterone is also called pregnancy hormone and is anti-FSH and anti-LH/anti-LTH.
(c) Placenta temporary endocrine gland formed during pregnancy	(a) Steroid secreted are estrogen and progesterone (b) Relaxin-Polypeptide	(a) Maintenance of pregnant state, prevents lactogenesis folliculogenesis, and Ovulation. (b) Act on pubic symphysis and enlarges the birth canal to facilitate birth. Acts synergestically with oxytocin during this process (parturition)
(10) Testis (i) Sertoli cells (= sustentacular cells) (ii) Leydig cells (= Interstitial cells)	(i) Inhibin – Polypeptide (ii) Estradiol-Steroid Androgens (*e.g.* Testosterone) Steroid and rostenedione)	Inhibits FHS action and attenuates spermatogenesis decrementally –do– (i) Pubertal changes in male (ii) Secy. sex characters in male (iii) Sex drives (iv) Spermatogenesis
(11) Gastro-intestinal hormones (secreted by cells of mucosa of stomach and intestine) also called hormones		Stimulates gastric juices secretion from gastric gland, movement of sphincters of stomach and increased movement of stomach
(a) Pyloric stomach (Argentophil cells) Intestine	Gastrin (i) Secreten (ii) Cholecystokinin (CCK) (iii) Enterogastrone (iv) Duedocrinin (v) Enterokinin (vi) Villikrinin	(i) Stimulates secretion of succus entericus (ii) Bile released from gall bladder (iii) Inhibits gastric secretin (iv) Stimulates secretion of mucous from Brunner's gland (v) Stimulate intestinal gland (vi) Stimulate villi movement

Disease caused by hormonal irregularities

Disease	Hormone	Quantity	Gland
Dwarfism	GH	Deficiency	Pituitary
Gigantism	GH	Excess	Pituitary
Acromegaly	GH	Excess	Pituitary
Simmond's disease	GH	Deficiency	Pituitary
Diabetes incipedus	ADH	Deficiency	Pituitary
Cretinism	Thyroxine	Deficiency	Thyroid
Simple goitre	Thyroxine	Deficiency	Thyroid
Myxaedema	Thyroxine	Deficiency	Thyroid
Exophthalamic goitre	Thyroxine	Excess	Thyroid
Tetani	Parathyroid	Deficiency	Parathyroid
Plummer's disease	Thyroxine	Excess	Thyroid
Addison's disease	Mineralocorticoids	Deficiency	Adrenal cortex
Conn's disease	Mineralocorticoids	Excess	Adrenal cortex
Cushing's disease	Corticosteroid	Excess	Adrenal cortex
Diabetes mellitus	Insulin	Deficiency	Pancrease
Myasthenia gravis	Thymosine	Excess	Thymus

(iii) **Insect endocrine glands :** The endocrine system of cockroach comprises intercerebral gland cells, corpora cardiaca, corpora allata, and prothoracic glands.

(1) **Intercerebral gland cells :** These cells lie in the brain between the two cerebral ganglia. They secrete a hormone called the brain hormone. This hormone activates the prothoracic glands to secrete their hormone.

(2) **Corpora cardiaca :** These are a pair of rod-like bodies situated on the sides of the oesophagus just behind the brain. They secrete a growth hormone.

(3) **Corpora Allata :** These are a pair of small, rounded bodies lying close behibnd the corpora cardiaca. They secrete a juvenile

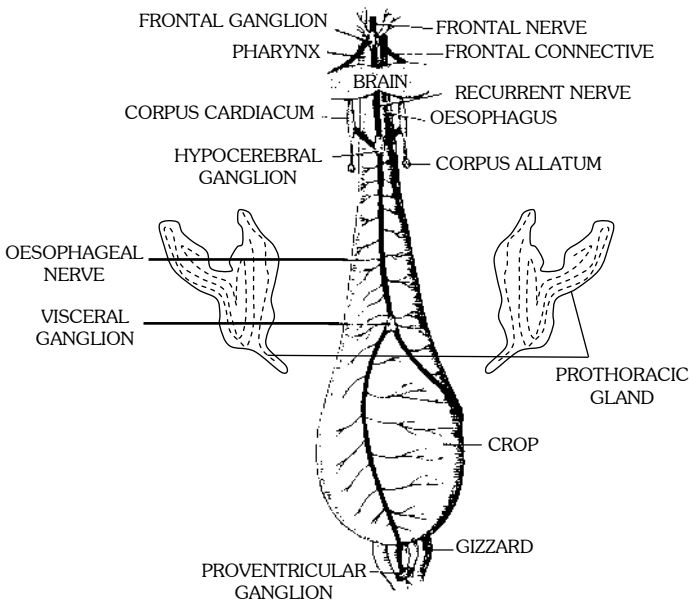


Fig. – Endocrine glands of cockroach

hormone in the nymphal stages. This hormone causes retention of the nymphal characters and checks the appearance of adult characters. In other words, it keep the insect young, hence its name. In the last nymphal form, corpora allata become inactive, thereby resulting in the absence of juvenile hormone. The absence of this hormone permits the appearance of adult features. In the adult, the corpora allata again become active and secrete a gonadotropic hormone, which regulates egg production and development and functioning of the accessory sex glands.

(4) **Prothoracic glands :** These are fairly large, irregular glands situated in the prothorax. They secrete a hormone called ecdyson, which controls moulting of the nymphs. The prothoracic glands degenerate after metamorphosis.

EXERCISE - 1

Q.1 Effect of thyroxine on B.M.R. is-
(1) Increase (2) Decrease
(3) Uncertain (4) No effect

Q.2 Neurohypohysis secretes-
(1) Vasopressin and growth hormone
(2) Oxytocin and estrogen
(3) Vasopressin and oxytocin
(4) Vasopressin and estrogen

Q.3 Adrenal cortex produces-
(1) Adrenaline (2) Epinephrine
(3) Aldosterone (4) Calcitonin

Q.4 Parathyroid gland degenerates.Which activity is disturbed-
(1) Growth
(2) Calcium concentration
(3) Potassium concentration
(4) Sodium concentration

Q.5 Effect of prolactin hormone is on-
(1) Liver (2) Pancreas
(3) Mammary glands (4) Bones

Q.6 Dwarfism is due to-
(1) Absence of insulin
(2) Hyposecretion of GH during childhood
(3) Hyposecretion of GH during adult stage
(4) Excessive secretion of adrenaline

Q.7 Glucagon is produced by-
(1) Peptic cell (2) Oxyntic cells
(3) Alpha cells (4) Beta cells

Q.8 Female sex hormone is-
(1) Estrogen (2) Androgen
(3) Insulin (4) Adrenaline

Q.9 Pancreatic secretion is stimulated by
(1) Secretin
(2) Cholecystokin-Pancreozymin
(3) Duocrinin (4) Enterogastrone

Q.10 Function of enterogastrone is
(1) Regulation of bile flow
(2) Stimulation of pancreatic flow
(3) Inhibition of gastric secretion
(4) Stimulation of gastric secretion

Q.11 Function of thymus is -
(1) Immunity (2) Growth
(3) Formation of RBCs
(4) Emergency hormone

Q.12 Vasopressin performs
(1) Muscle contraction
(2) Increases blood pressure
(3) decreases blood pressure
(4) Both 1 and 2

Q.13 Progesterone is secreted by-
(1) Corpus luteum (2) Thyroid
(3) Thymus (4) Testis

Q.14 Diabetes is a disease in which urine contains
(1) Salt (2) Sugar
(3) Fat (4) Protein

Q.15 Insulin is secreted by
(1) Pituitary (2) Adrenals
(3) Thyroid
(4) lslets of Langerhans

Q.16 Ca^{2+} level is controlled by-
(1) Thyroid (2) Hypothalamu
(3) Pituitary
(4) Thyroid and parathyroids

Q.17 Which one is not secreted by pituitary ?
(1) Thyroxine (2) F.S.H.
(3) G.H. (4) A.C.T.H

Q.18 Iodine is present in the secretion of
(1) Adrenal (2) Thyroid
(3) Pancreas (4) Pituitary

Q.19 Which is correct ?
(1) Glucagon and insulin are secreted by same cells
(2) Glucagon and insulin are secreted by different cells
(3) Glucagon and insulin are secreted by different cells and have opposite effect
(4) None of the above

Q.20 Which gland is often referred in connection with AIDS-
(1) Thymus (2) Thyroid
(3) Adrenal (4) Pancreas

Q.21 A temporary endocrine gland formed in ovary after ovulation is-
(1) Corpus uteri (2) Corpus albicans
(3) Corpus callosum (4) Corpus luteum

Q.22 Reabsorption of water in distal parts of kidney tubules/urine concentration is controlled by
(1) Vasopressin/ADH (2) Oxytocin
(3) Calcitonin (4) Relaxin

Q.23 Endocrine gland for combating emergency is
(1) Adrenal cortex (2) Adrenal medulla
(3) Pancreas (4) Parathyroid

Q.24 Glucagon produced by a-cells of islets of Langerhans-
(1) Converts glucose to glycogen
(2) Converts glycogen to glucose
(3) Decreases concentration of glucose in blood
(4) None of these

Q.25 Basal metabolic rate is under control of
(1) Glucagon (2) Insulin
(3) Thyroxine (4) Both 1 and 2

Q.26 Hormones involved in carbohydrate metabolism are
(1) Insulin, glucagon, epinephrine and parathormone
(2) Insulin, glucagon, epinephrine and glucocorticoids
(3) Insulin, glucagon, glucocorticoid and calcitonin
(4) Insulin, glucagon, norepinephrine and melatonin

Q.27 Which endocrine gland stores its secretion in extracellular spaces before discharging into blood?
(1) Testis (2) Pancreas
(3) Thyroid (4) Adrenal

Q.28 Blood calcium is increased by administration of
(1) Glucagon (2) Thyroxine
(3) Parathormone (4) Calcitonin

Q.29 Parathormone deficiency cause-
(1) Goitre (2) Hypocalcemi
(3) Hypercalcemia (4) All the above

Q.30 Which hormone facilitates child birth?
(1) Oxytocin (2) FSH
(3) LH (4) Prolactin

Q.31 Insulin is-
(1) Vitamin
(2) Proteinaceous hormone
(3) Amine hormone
(4) Steroid

Q.32 FSH is involved in -
(1) Ovulation
(2) Spermatogenesis
(3) Control of blood sugar
(4) Growth

Q.33 Epinephrine is-
(1) Andrenergic (2) Cholinergic
(3) Both 1 and 2 (4) None of the above

Q.34 GH controls growth through-
(1) rRNA (2) tRNA
(3) mRNA (4) None of the above

Q.35 Diabetes insipides is under control of-
(1) ACTH (2) TSH
(3) ADH (4) Aldosterone

Q.36 Thyroxine is a
(1) Vitamin (2) Enzyme
(3) Hormone (4) Excretory product

Q.37 Hormone is
(1) Enzyme
(2) Chemical messenger
(3) Excretory product (4) Glandular secretion

Q.38 Pituitary gland occurs in-
(1) Trachea (2) Abdomen
(3) Gonads (4) Brain

Q.39 Relaxin is produced by-
(1) Testis (2) Adrenals
(3) Pituitary (4) Ovary

Q.40 Thyrocalcitonin
(1) Elevates K^+ level in blood
(2) Lowers Ca^{++} level in blood
(3) Elevates Ca^{2+} level in blood
(4) None of the above

Q.41 Hormone connected with increased rate of glycogenesis, blood pressure and heart beat-
(1) Insulin (2) Glucagon
(3) Adrenaline (4) FSH

Q.42 Secretion is under control of neurosecretory nerve axons is
(1) Pineal (2) Adrenal cortex
(3) Anterior pituitary (4) Posterior pituitary

Q.43 Iodine deficiency in Frog will lead to-
(1) Accelerated metamorphosis
(2) Inhibition of metamorphosis
(3) Development of miniature frog
(4) Development of a giant frog.

Q.44 Secretin hormone is secreted by and stimulates
(1) Duodenum-pancreas
(2) Duodenum-liver
(3) Stomach-gastric glands
(4) Thyroid-thyroid

Q.45 Removal or absence of thymus in early life shall bring about
(1) Lack of lymphocytes
(2) Lack of antibodies
(3) Lack of lymph nodes
(4) All the above

Q.46 Which one controls the secretion of estrogen-
(1) HCG (2) Progesterone
(3) LH (4) FSH

Q.47 Adrenal medulla is derived from-
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) Both (1) and (3)

Q.48 Removal of thymus gland in the early life of an experimental mammal will cause-
(1) Lack of lymphocytes
(2) Lack of antibodies
(3) Lack of lymph nodes and lymph vessels
(4) All of the above

Q.49 Diabetes insipidus is caused by the deficiency of hormone -
(1) insulin (2) vasopressin
(3) glucagon (4) oxytocin

Q.50 Glomerular area of adrenal cortex is responsible for-
(1) water and electrolyte balance
(2) carbohydrate metabolism
(3) steroid and hormone secretion
(4) blood pressure

Q.51 Pineal body develops from-
(1) Dorsal part of diencephalon
(2) Ventral part of diencephalon
(3) Ventral side of cerebrum
(4) Lateral side of cerebrum

Q.52 The hormones controlling secondary sexual characters include-
(1) Thyroxine
(2) FSH and LH
(3) GH and FSH
(4) Testosterone and estrogen.

Q.53 Which of the following is related to obesity, low plasma Na^+, high K^+ and increased blood pressure?
(1) Growth hormone (2) Cortisol
(3) Thyroxine (4) Adrenaline

Q.54 Endocrine gland **respo**nsible for immunity is
(1) Pineal (2) Thymus
(3) Pituitary (4) Adrenal

Q.55 Disease caused by deficiency of parathormone
(1) Cretinism (2) Hypercalcemia
(3) Tetany (4) Myxoedema

Q.56 Cretinism is due to less secretion of
(1) Thyroid (2) Pituitary
(3) Parathyroid (4) Adrenal

Q.57 Hormone that promotes cell division, protein synthesis and bone growth is
(1) ADH (2) ACTH
(3) PTH (4) GH

Q.58 Which of the following takes part in salt balancing ?
(1) Mineralocorticoid (2) Glucocorticoid
(3) Somatotrophic (4) None

Q.59 Which one exclusively comprises endocrine glands
(1) Pituitary, Salivary, Adrenals, Ovary, Testi
(2) Pituitary, Thyroid, Adrenals, Ovary, Testis
(3) Salivary, Thyroid, Adrenals, Ovary, Testis
(4) Adrenals, Ovary, Testis, Salivary, Liver

Q.60 Thyroxin is secreted by which gland ?
(1) Adrenal (2) Parathyroid
(3) Pituitary (4) Thyroid

Q.61 Which substance is secreted by corpus leuteum?
(1) Hormone (2) enzyme
(3) Pheromone (4) Bile

Q.62 Hormone controlling Na^+–K^+ ion concentration is-
(1) Aldosterone
(2) Anti-diuretic hormone
(3) Progesterone
(4) Pitocin

Q.63 Hormones of adrenal cortex are synthesised from
(1) Tyrosine (2) Tryptophan
(3) Cholesterol (4) Glycoproteins

Q.64 Hormone controlling metabolism is
(1) ACTH from pituitary
(2) FSH from pituitary
(3) Thyroxine from thyroid
(4) Adrenaline from adrenal medulla

Q.65 Hypoglycaemic hormone is
(1) Insulin (2) Glucagon
(3) Thyroxine (4) ACTH

Q.66 Oxytocin is released from :
(1) hypothalamus
(2) adenohypophysis (posterior lobe)
(3) adenohypophysis (anterior lobe)
(4) neurohypophysis

Q.67 What is the molecular weight of insulin?
(1) 6000 amu (2) 5000 amu
(3) 4000 amu (4) 15000 amu

Q.68 Parathormone controls :
(1) calcium and phosphate metabolism
(2) Na and K metabolism
(3) fatty acid metabolism
(4) protein metabolism

Q.69 Nor epinephrin is secreted from :
(1) medulla of adrenal (2) zona fasciculate
(3) zona reticularis (4) zona glomerulosa

Q.70 Thymosine stimulates :
(1) milk secretion (2) erthrocytes
(3) T-lymphocytes (4) melanocytes

Q.71 FSH is :
(1) glycoprotein (2) phospholipid
(3) glycolipid (4) metaprotein

Q.72 Prostaglandins affect :
(1) blood pressure (2) defecation
(3) osmoregulation (4) oxygen metabolism

Q.73 Which one of the following is both hormone and enzyme ?
(1) ADH hormone (2) Acetycholinesterase
(3) Angiotensinogen (4) Rennin

Q.74 Myxoedema is due to-
(1) Decreased production of thyroxin
(2) Increased production of thyroxin
(3) Excess GH
(4) Decreased insulin

Q.75 Injection of glucagon will-
(1) Cause hypoglycemia
(2) Cause galactosemia
(3) Increase blood sugar
(4) Cause goitre

Q.76 Hormone produced more in dark is
(1) Thyroxine (2) Melatonin
(3) Adrenaline (4) Insulin

Q.77 Which is not involved in endocrine secretion ?
(1) Leydig cell
(2) Lutein cell
(3) Para-follicular cells of thyroid
(4) Kupffer cells

Q.78 Metamorphosis of Frog from tadpole to adult is controlled by :
(1) adrenalin (2) thyroxin
(3) secretin (4) lymph

Q.79 The basal metabolic rate of the body is regulated by :
(1) parathyroid (2) thymus
(3) pituitary (4) thyroid

Q.80 An endocrine gland known as 'gland of emergency' is :
(1) pituitary (2) parathyroid
(3) adrenal (4) pancreas

Q.81 One of the hormone, which when secreted increase the blood pressure, heart beat, output of glucose in the blood :
(1) thyroxin (2) aldosterone
(3) adrenalin (4) testosterone

Q.82 Goitre influences-
(1) Speech (2) Excretion
(3) Metabolism (4) Vision

Q.83 Pheromones are-
(1) Produced by endocrine glands
(2) mRNAs
(3) Chemicals used in animal communication
(4) Protein

Q.84 Which one hormone of the pituitary of the Rabbit controls the protein metabolism and growth of skeleton?
(1) Iodo thyroxine
(2) Leutotrophic hormone
(3) Somatetrophic hormone
(4) Oxytocine

Q.85 Goitre is a pathological condition associated with-
(1) Glucagon (2) Thyroxine
(3) Progesterone (4) Testosterone

Q.86 Sex hormones can work without the help of-
(1) Insulin (2) Placenta
(3) Pituitary (4) Gonadotropins

Q.87 Which one of the following statements is correct?
(1) Endocrine glands regulate neural activity, but not vice versa
(2) Neurons regulate endocrine activity but vice versa
(3) Endocrine glands regulate neural activity and nervous system regulates endocrine glands
(4) Neither hormones control neural activity nor the neurons control endocrine activity

Q.88 Sertoli cells are regulated by the pituitary hormone known as-
(1) LH (2) FSH
(3) GH (4) Prolactin

Q.89 Which one of the following is not a second messenger in hormone action?
(1) aAMP (2) aGMP
(3) Calcium (4) Sodium

Q.90 A steroid hormone which regulates glucose metabolism is-
(1) Cortisone (2) Cortisol
(3) Cortieosterone
(4) 11-deoxycorticosterone

Q.91 Withdrawal of which of the following hormones is the immediate cause of menstruation?
(1) progesterone (2) Estrogen
(3) FSH (4) FSH-RH

Q.92 Which of the following is an accumulation and release centre of neurohormones?
(1) Anterior pituitary lobe
(2) Posterior pituitary lobe
(3) Intermediate lobe of the pituitary
(4) Hypothalamus

Q.93 Which hormone causes dilation of blood vessels, increased oxygen consumption and glycogenesis-
(1) Glucagon (2) ACTH
(3) Insulin (4) Adrenaline

Q.94 Which of the following hormone consists of cholesterol-
(1) Sex hormone (2) Adrenaline
(3) Thyroxine (4) GH

Q.95 Growth hormone is produced by-
(1) Pituitary (2) Thyroid
(3) Adrenal (4) Testes

Q.96 Hyposecretion of Adrenal cortex causes-
(1) Addison (2) Cretinism
(3) Hashimoto (4) Simond

Q.97 Secretin & Ecdysone are -
(1) Hormone (2) Enzyme
(3) Lipid (4) Cofactor

ANSWER KEY

EXERCISE – 1

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	1	3	3	2	3	2	3	1	2	3	1	4	1	2	4	4	1	2	3	1
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	4	1	2	2	3	2	3	3	2	1	2	2	1	3	3	3	2	4	4	2
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	3	4	2	1	1	4	1	1	2	1	1	4	2	2	3	1	4	1	2	4
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	1	1	3	3	1	4	1	1	1	3	1	1	4	1	3	2	4	2	4	3
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**			
Ans.	3	3	3	3	2	1	3	2	4	2	1	2	4	1	1	1	1			

EXERCISE - 2

Q.1 A hormone is :-
(1) An enzyme
(2) Chemical messenger
(3) Primary messenger (4) 2 and 3 both

Q.2 Pituitary gland does not control the secretory activity of :-
(1) Thyroid (2) Adrenal cortex
(3) Adrenal medulla (4) Testes

Q.3 Which of the following controls spermatogenesis :-
(1) FSH (2) LTH
(3) LH (4) Vasopressin

Q.4 Carbohydrate metabolism is governed by :-
(1) Thyroxine (2) Insulin
(3) Glucocorticoids (4) All

Q.5 Which of the following does not secrete any hormone:-
(1) Testes (2) Spleen
(3) Stomach (4) Intestine

Q.6 The hyposecretion of pituitary hormone cause
(1) Dwarfism (2) Diabetes insipidus
(3) Goitre (4) Diabetes mellitus

Q.7 Neurohypophysis secretes :-
(1) Vasopressin
(2) Oxytocin
(3) Oxytocin & prolactin
(4) Vasopressin & oxytocin

Q.8 Hormone secreted by pituitary gland in chemical nature are :-
(1) All protein
(2) All steroid
(3) Complex compounds of proteins and carbohydrates
(4) Some steroid and some protein

Q.9 The thyroid gland is homologous to which part of lower chordates :-
(1) Neural gland
(2) Pharyngeal gill pouch
(3) Nerve cord (4) Endostyle

Q.10 Growth hormone is produced in :-
(1) Adrenals (2) Thyroid
(3) Pituitary (4) Thymus

Q.11 In dibetes disease the urine contains :-
(1) Salt (2) Fat
(3) Protein (4) Sugar

Q.12 Gonadotropic hormone is produced in :-
(1) Interstitial cells of testis
(2) Adrenal cortex
(3) Adenohypophysis
(4) Posterior part of thyroid

Q.13 A hormone with seat of activity in liver-changing glucose into glycogen is produced by :-
(1) Pituitary (2) Thymus
(3) Parathyroid (4) Pancreas

Q.14 Estrogen is secreted by :-
(1) Liver (2) Spleen
(3) Ovaries (4) Pituitary

Q.15 If thyroid is removed from tadpole of frog, it will
(1) Die soon
(2) Remains tadpole throughout life
(3) Grows in to giant frog
(4) Grows into dwarf frog

Q.16 Interacting system in the body are :-
(1) Endocrine system (2) Nervous system
(3) Blood vascular system
(4) Both endocrine and nervous system

Q.17 Androgens are secreted by :-
(1) Pituitary (2) Testis
(3) Ovaries (4) Thyroid

Q.18 Who isolated thyroxine hormone:-
(1) Best & Banting (2) F. Sanger
(3) William Buemont (4) E. C. Kendall

Q.19 Adrenaline hormone causes :-
(1) Increase in blood pressure
(2) Increase in heart beat
(3) Both of them (4) None of them

Q.20 Main similarity between hormone and enzyme is :-
(1) Both act at particular pH
(2) Both are protein
(3) Both are required in small amount
(4) Both can be used again and again

Q.21 Ovulation in mammals occurs mainly under the influence of :-
(1) TSH and ACTH (2) FSH and LH
(3) TSH and STH (4) MTH and ACTH

Q.22 The hormones responsible for regulation of calcium and phosphorous metabolism is secreted by :-
(1) Pancreas (2) Thyroid
(3) Thymus (4) Parathyroid

Q.23 Injection of which of the following increases metabolic rate :-
(1) STH (2) Insulin
(3) Thyroxine (4) Testosterone

Q.24 On surgical removal of pituitary gland there is fall of sodium level and rise in potassium in serum, this is due to :-
(1) Oxytocin is no longer available from pituitary
(2) Atrophy of adrenal medulla
(3) Atrophy of adrenal cortex
(4) LTH from pituitary is no longer available

Q.25 Endocrine glands can be defined as those glands which pour their secretion :-
(1) Directly into blood (2) Into blood or ducts
(3) When they are cut
(4) Into particular organ

Q.26 Which gland is both exocrine as well as endocrine:-
(1) Pituitary (2) Mammary gland
(3) Thyroid (4) Pancreas

Q.27 Largest amount of iodine is found in :-
(1) Adrenals (2) Liver
(3) Thyroid (4) Testes

Q.28 Hypothyrodism in adults causes :-
(1) Addison's disease (2) Myxoedema
(3) sterility (4) Cretinism

Q.29 A patient of diabetes mellitus drink more water because he eliminates from the blood, extra amount of which substance:-
(1) Protein (2) Sugar
(3) Salt (4) Hormone

Q.30 Chemical structure of man's insulin was studied by:-
(1) Banting (2) Kendal
(3) Tsan (4) Starling

Q.31 Insulin by chemical nature is :-
(1) Carbohydrate (2) Protein
(3) Steroid (4) Lipid

Q.32 Which hormone stimulates contraction of gall bladder:-
(1) CCK-PZ (2) ACTH
(3) LTH (4) FSH

Q.33 If ovaries from a pregnant woman are removed in 4th month of pregnancy then :-
(1) Development of embryo becomes abnormal
(2) Abortion occurs after some time
(3) Embryo develops normally till birth
(4) None

Q.34 Which of the following has no role in secretion of hormone :-
(1) Rickets and mangolism
(2) Diabetes mellitus and cretinism
(3) Giantism and exophthalmia
(4) Cretinism and diabetes

Q.35 If estrogen and progesterone decrease in blood this causes :-
(1) Release of ova from ovaries
(2) Constriction of uterine blood vessels causing sloughing of uterine epithelium
(3) Loss of endometrium
(4) Growth of myometrium

Q.36 Which gland prepares you for flight, fright and fight during adverse conditions :-
(1) Thyroid (2) Parathyroid
(3) Pituitary (4) Adrenals

Q.37 A person with diabetes mellitus excrete glucose in urine although kept on carbohydrate free diet, what is the most probable reason :-
(1) Glycogen is released from muscles into blood
(2) Fats are catabolised and glucose is formed
(3) Amino acid are discharge into blood by liver
(4) Amino acid are catabolised to from sugar in liver

Q.38 Role of progesterone hormone is to :-
(1) Increase blood supply in uterine wall
(2) Thicken uterus wall
(3) To deposit glycogen and fat in uterus wall
(4) All the above

Q.39 If amount of ADH decrease in blood micturition-
(1) Remains unchanged (2) Decreases
(3) Increases (4) None

Q.40 Which hormone secretion is under nervous control:-
(1) Adrenal cortex (2) Anterior pituitary
(3) Posterior pituitary (4) Pineal body

Q.41 Secretion of estrogen is controlled by :-
(1) HCG (2) Progesterone
(3) LH (4) F.S.H.

Q.42 First discovered hormone :–
(1) Thyroxine (2) Adrenaline
(3) Secretin (4) Insulin

Q.43 Immediate cause of induction of ovulation in human female is large plasma surge of :-
(1) Progesterone (2) LH
(3) FSH (4) Estradiol

Q.44 Parathormone regulates :-
(1) Blood calcium level
(2) Blood calcium phosphate level
(3) Body temperature (4) None

Q.45 Which gland store hormone in intercellular space before its secretion into blood :
(1) Pancreas (2) Thyroid
(3) Testis (4) Ovary

Q.46 Urine concentration is controlled by :-
(1) Oxytocin (2) ADH
(3) MSH (4) ACTH

Q.47 Goiter is caused by the abnormal functioning of :-
(1) Pancreas (2) Adrenals
(3) Pituitary (4) Thyroid

Q.48 The follicle stimulating hormone is secreted from :-
(1) Posterior lobe of pituitary gland
(2) Reproductive gland
(3) Thyroid gland
(4) Anterior lobe of pituitary galnd

Q.49 Parathormone deficiency in man causes-
(1) Hyper calcemia (2) Hypocalcemia
(3) Goitre (4) All

Q.50 Sex hormone will work without the help of -
(1) Gonadotropins (2) Placenta
(3) Pituitary (4) Insulin

Q.51 Creatinism is due to abnormal secretion of:
(1) Thyroid stimulating hormone
(2) Thyroxine
(3) Calcitonin (4) Parathormone

Q.52 Bombycol is pheromone secreted by the body of :-
(1) Wasp (2) House fly
(3) Spider (4) Silk moth

Q.53 Stimulation of uterine contraction during child birth is brought about by :-
(1) Adrenaline (2) Progesterone
(3) Oxytocin (4) Prolactin

Q.54 Hypophysectomy leads to :-
(1) Heart attack (2) Increased digestion
(3) Death
(4) Regression of reproductive function

Q.55 Pituitary gland is under control of :-
(1) Hypothalamus (2) Adrenal galnd
(3) Pineal gland (4) Thyroid gland

Q.56 The receptor for protein hormones are present on :-
(1) Nucleus
(2) Endoplasmic reticulum
(3) Cytoplasm (4) Cell-surface

Q.57 Which of the following is not a steroid hormone
(1) Androgen (2) Aldosterone
(3) Estrogen (4) Relaxin

Q.58 Parathormone induces :-
(1) Increase in blood sugar level
(2) Decrease in serum calcuim level
(3) Increase in serum calcium level
(4) Decrease in blood sugar level

Q.59 Which of following is not a protein hormone :-
(1) Relaxin (2) H.C.G.
(3) Placental lactogen (4) Estradiol

Q.60 Progesterone hormone is secreted from :-
(1) Placenta (2) Corpus luteum
(3) Both 1 and 2 (4) None of these

Q.61 Philips collip discovered which of the following hormones :–
(1) Parathyroid hormone
(2) Thyroxine
(3) A.D.H (4) Oxytocin

Q.62 "Sella turcica" is a :–
(1) Depression in brain enclosing pituitary
(2) Cavity of skull enclosing ears
(3) Covering of testis
(4) Kind of endocrine gland

Q.63 The "erythropoietin" hormone regulates :–
(1) Blood pressure
(2) Water level of blood
(3) Glucose level of blood
(4) Rate of formation of red blood cells

Q.64 The main function of prolactin hormone is to:–
(1) Influence the activity of thyroid gland
(2) Control development of graffian follicles
(3) Initiate and maintain secretion of milk by mammary gland
(4) Cause ejection of milk

Q.65 The hormones of neurohypophysis are formed in
(1) Pars nervosa (2) Pars distalis
(3) Supraoptic and para ventricular center
(4) Hypothalamus

Q.66 Hyposecretion of aldosterone causes :–
(1) Gull's disease (2) Grave's disease
(3) Cushing's disease (4) Addison's disease

Q.67 The gastro-intestinal hormone villikinin is responsible for :–
(1) Initiation of gastric juice
(2) Inhibiting the secretion of intestinal juice
(3) Causing movement of intestinal villi helping in absorption of digested food
(4) Protecting gastrointestinal tract from its auto digestion

Q.68 Hormones produced by adrenal cortex and gonads (sex hormone) are chemically :–
(1) Protein
(2) Steroids
(3) Glycoprotein
(4) Phenolic compound

Q.69 I.C.S.H. in male acts on :–
(1) Cells of leydig (2) Sertoli cells
(3) Spermatids (4) Spermatogonia

Q.70 Melatonin is a hormone produced by :–
(1) Adrenal gland (2) Pituitary gland
(3) Pineal gland (4) Thymus gland

Q.71 Hypophysis cerbri is the other name of :–
(1) Adeno hypophysis
(2) Islets of Langerhans
(3) Neurohypophysis (4) Pituitary

Q.72 Which of the following is not an endocrine gland :–
(1) Pancreas (2) Adrenal gland
(3) Thyroid gland (4) Salivary gland

Q.73 Exopthalmic goitre is caused due to hypersecretion of :–
(1) Adrenal (2) Thyroid
(3) Parathyroid (4) Thymus

Q.74 The main function of thyroid gland is to control-
(1) Growth (2) Reproduction
(3) Secondary sexual characters
(4) Basal metabolic rate

Q.75 Hassal's capsules are found in :–
(1) Pineal body (2) Thymus gland
(3) Thyroid gland (4) Adrenal gland

Q.76 The two lobes of thyroid gland are joined by a horizontal connection called :–
(1) Inter thyroidal connective
(2) Inter thyroidal commissure
(3) Intermediary lobe (4) Isthmus

Q.77 Hormone of hypothalamus-are called :–
(1) Regulatory hormones
(2) Growth hormons
(3) Tropic hormones (4) Angiotensins

Q.78 Diabetes insipidus disease is caused due to the deficiency of hormone produced by :–
(1) Pituitary (2) Adrenal
(3) Pancreas (4) Thyroid

Q.79 The function of norepinephrine is :–
(1) Almost similar to epinephrine
(2) Similar to ADH
(3) Opposite to epinephrine
(4) Opposite to ADH

Q.80 The vitamin which works along with para thyroid hormone is :–
(1) Vitamin C (2) Calciferol
(3) Tocopherol (4) Vitamin – B_{12}

Q.81 Hormones are :–
(1) Produced in low amount
(2) Easily diffusible
(3) Non - antigenic (4) All

Q.82 Epinephrine and norepinephrine together known as:–
(1) Steroid (2) Protein
(3) Catecholamine (4) None

Q.83 One of the following is antagonistic :–
(1) FSH & LH
(2) Oxytocin & Vasopressin
(3) Nor adrenaline & adrenaline
(4) Insulin & Glucagon

Q.84 Storage gland is :–
(1) Pancreas (2) Testis
(3) Thyroid (4) Adrenal

Q.85 Presence of "HCG" in urine of female confirm
(1) Addison's disease (2) Gynacomastia
(3) Virlism (4) Pregnancy

Q.86 "Thyroglobulin" is :–
(1) Protein (2) Glycoprotein
(3) Steroid (4) Amino acid

Q.87 Deficiency of which of the following may cause bone deformation :–
(1) PTH (2) Vitamin D
(3) STH (4) Thyroxine

Q.88 Hashimoto's disease is due to :–
(1) Hyposecretion of thyroxine
(2) Hyper secretion of thyroxine
(3) Hyposecreation of adrenaline
(4) None of the above

Q.89 One of the following is volatile :–
(1) Enzymes (2) Hormones
(3) Pheromones (4) All

Q.90 Mammals born without a thymus gland fail to manufacture :–
(1) B - Lymphocytes (2) T – Lymphocytes
(3) Plasma cells (4) Basophils

Q.91 Removal of parathyroid in human beings result in:–
(1) Tetany (2) Simmond's disease
(3) Myxoedema (4) Addison's disease

Q.92 Retension of sodium in body depends up on hormone from :–
(1) Adrenal cortex (2) Adrenal medulla
(3) Parathyroid (4) Thyroid

Q.93 Injection Insulin to Rabbit leads to increased:–
(1) Glucose level of blood
(2) Glucose level of urine
(3) Glucose level of cells
(4) None of these

Q.94 Simmond"s disease is :–
(1) Hyperthyroidism (2) Hypothyroidism
(3) Hypopituitarism (4) Hyperpituitarism

Q.95 Hyper secretion of STH leads to :–
(1) Dwarf & Acromegaly
(2) Goitre& Sterility
(3) Cretinism& Myxoedema
(4) Gigentism & Acromegaly

Q.96 Which part of adrenal secretes hydrocorticosterone hormone :–
(1) Zona reticularis (2) Zona glomerulosa
(3) Zona fasciculata (4) Medulla

Q.97 The structure and amino acid sequence of the hormone insulin was discovered by :–
(1) Benting (2) Sanger
(3) Pauling (4) Cullen

Q.98 Which of the following pituitary hormone does not have another endocrine gland as its target organ :–
(1) Melanophore stimulating hormone
(2) Follicle stimulating hormone
(3) Adrenocorticotropic hormone
(4) Thyroid stimulating hormone

Q.99 Pheromones secreted by :–
(1) Endocrine gland (2) Exocrine gland
(3) Apocrine gland (4) Mixed gland

Q.100 FSH & LH is a :–
(1) Catecholamine (2) Glycoprotein
(3) Polypeptide (4) None

Q.101 Which hormone has anti insulin effect :–
(1) Cortisol (2) Oxytocin
(3) Aldosterone (4) Glucagon

Q.102 Term "Hormone" was coined by :–
(1) W.M. Baylis (2) E.H. Schally
(3) E.H. Starling (4) Harris

Q.103 Ectodermal in origin is :–
(1) Pituitary gland (2) pineal body
(3) Lens of eye (4) All of the above

Q.104 "Geradiol" is a pheromone of :–
(1) Honey bee (2) Silk moth
(3) Butterfly (4) All

Q.105 One of the following is homologus to pituitary gland of vertebrates :–
(1) Muller's organ of Amphioxus
(2) Subneural gland of Ascidian
(3) Both of the above
(4) None of the above

Q.106 "Anti abortion" hormone is :–
(1) Relaxin (2) Oxytocin
(3) Progesterone (4) Oestrogen

Q.107 Diabetic comma is due to hyposecretion of insulin in which :–
(1) Glucose level increased in blood
(2) Ketoacidosis take place
(3) Dehydration process start
(4) All the above

Q.108 "Brain sand" is found in :–
(1) Thyroid (2) Thymus
(3) Pineal body (4) All

Q.109 One molecule of insulin contains :–
(1) 30 Amino acid (2) 41 amino acid
(3) 51 amino acid (4) 70 amino acid

Q.110 Which is largest endocrine gland of the body-
(1) Thyroid (2) Liver
(3) Pituitary (4) Thymus

Q.111 Epiphysis (pineal body) atrophies at the age of
(1) 5 - years (2) 7 - years
(3) 9 - years (4) 19 - years

Q.112 "Pinealocytes cells" occurs in :–
(1) Pineal body (2) Pituitary gland
(3) Adrenal gland (4) Thyroid gland

Q.113 Renin is produced by kidney :–
(1) Stimulate haemopoisis
(2) Change angiotensinogen into angiotensin
(3) Influence ultrafiltration
(4) All of the above

Q.114 One of the following is oral dose of insulin :–
(1) IZS only (2) PZI only
(3) Both of the above (4) None of the above

Q.115 Conn's disease is due to :–
(1) Hyposecretion of aldosterone
(2) Hyper secretion of aldosterone
(3) Hyposecretion of STH
(4) None of the above

Q.116 "4s gland" is :–
(1) Pancreas (2) Liver
(3) Thyroid (4) Adrenal

Q.117 Ca^{++} acts as :–
(1) 1^{st} messenger (2) 2^{nd} messenger
(3) 3^{rd} messenger (4) None

Q.118 Structure which has no role in endocrine secretion:–
(1) Duodenal epithelium
(2) Testes
(3) Adrenal medulla
(4) Submaxillary gland

Q.119 MSH is secreted in man by which part of pituitary :–
(1) Anteriro Pituitary
(2) Middle lobe of pituitary
(3) Posterior lobe of pituitary
(4) None of these

Q.120 Oxytocin is used in :-
(1) Milk secretion (2) Parturition
(3) K^+ Excretion (4) All of the above

Q.121 Hormone that decrease calcium level in blood
(1) Thyroxine (2) Parathormone
(3) Thyrocalcitonin (4) Cortisol

Q.122 MSH Produced by the pars intermidia of pituitary causes in lower vertebrates :–
(1) Darkening of skin
(2) Light colouration of skin
(3) Both (4) None of these

Q.123 LTH is also known as :–
(1) Lactogenic Hormone
(2) Prolactin
(3) Mammotropic Hormone
(4) All

Q.124 Adrenaline increases :–
(1) Heart beat (2) Blood pressure
(3) Both (4) None

Q.125 The diabetes mellitus is caused by :–
(1) Hyper secretion of Insulin
(2) Hyposecretion of Insulin
(3) Hyposecretion of ADH
(4) Hyper secrection of ADH

Q.126 BMR is increased due to :–
(1) Sympathetic nervous system
(2) Adrenaline
(3) Parasympathetic nervous system
(4) Thyroxine

Q.127 Life saving hormone are secreted by :–
(1) Pituitary (2) Pineal
(3) Adrenals (4) Thyroid

Q.128 Which of these is not a ketone bodies :–
(1) Acetoacetic acid (2) Succinic acid
(3) Beta hydroxy butyrate
(4) Acetone

Q.129 Growth hormone of pituitary is more effective in :–
(1) Presence of thyroxine
(2) Absence of thyroxine
(3) Absence of Insulin
(4) Presence of adrenaline

Q.130 "Secondary messenger" is :–
(1) Cyclie A.M.P. (2) ATP
(3) ADP (4) DNA

Q.131 Function of renin is :–
(1) To reduce blood pressure
(2) Vasodilation
(3) Degradation of angiotensinogen to angiotensin II
(4) Urination

Q.132 Which gland does not originate from embryonic Endoderm :–
(1) Thymus (2) Parathyroid
(3) Adrenal Cortex (4) Thyroid

Q.133 Gonado tropic hormone is :–
(1) FSH (2) LH
(3) LTH (4) FSH, LH, LTH

Q.134 Which of the following Hormone is secreted by kidney :–
(1) Renin
(2) Renomedullary Prostaglandin
(3) Erythropoietin (4) All of these

Q.135 Endocrine structure of kidney is :–
(1) Cortex (2) Medulla
(3) Juxtra-medullary node
(4) Pelvis

Q.136 Adrenaline causes-
(1) Hypoglycemia (2) Hyperglycemia
(3) Diabetes insipidus (4) Diabetes mellitus

Q.137 Nor-epinephrine functions as both hormone and-
(1) Fuel for cellular respiration
(2) Neurotransmitter
(3) Ions to promote action potential
(4) Solutes to promote osmotic

Q.138 The main function of norepinephrine is to increase-
(1) Urine formation
(2) Cellular respiration
(3) Release of epinephrine
(4) Blood pressure

Q.139 Which of the following hormones is responsible for the emotional state such as fear, anger, pain and causes rise to blood pressure and rate of heart beat-
(1) Insulin (2) Adrenaline
(3) Progesterone (4) Thyroxine

Q.140 Both ectoderm and mesoderm contribute in the development of-
(1) Thyroid (2) Pancreas
(3) Adrenal (4) Pituitary

Q.141 Destruction of adrenal cortex leads to-
(1) Simmond's disease (2) Cushing syndrome
(3) Graves disease (4) Addison's disease

Q.142 Treatment with alloxan destroys-
(1) STH cells
(2) Alpha cells of islets of Langerhans
(3) Beta cells of islets of Langerhans
(4) Cells of Leydig

Q.143 Which of the following is not a ketone body-
(1) Acetone (2) Acetoacetic acid
(3) Beta-hydroxybutyrate
(4) Succinic acid

Q.144 Which hormone possesses anti-insulin effect-
(1) Cortisol (2) Calcitonin
(3) Oxytocin (4) Aldosterone

Q.145 Compression of gallbladder is enhanced by-
(1) Secretin (2) Cholecystokinin
(3) Gastrin (4) Enterogastrone

Q.146 Hormones taken in the form of drugs for contraception are-
(1) Aldosterone
(2) Estrogens and progesterone
(3) Cortisol
(4) Testosterone

Q.147 Relaxin is chemically-
(1) Steroid (2) Protein
(3) Carbohydrate (4) Both (1) and (3)

Q.148 The hormone that stimulates the stomach to secrete gastric juice is-
(1) Gastrin (2) Enterogastrone
(3) Enterokinase (4) Renin

Q.149 Injection of glucagon will-
(1) Cause goitre
(2) Cause galactosemia
(3) Cause hypoglycemia
(4) Increase blood sugar level

Q.150 Which of the following hormones is a derivative of amino acid-
(1) Estrogen (2) Epinephrine
(3) Progesterone (4) Prostaglandin

ANSWER KEY

Exercise – 2

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	3	1	4	2	1	4	3	4	3	4	3	4	3	2	4	2	4	3	3
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	2	4	3	3	1	4	3	2	2	3	2	1	3	1	3	4	4	4	3	3
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	4	3	2	2	2	2	4	4	2	4	2	4	3	4	1	4	4	3	4	3
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	1	1	4	3	3	4	3	2	1	3	4	4	2	4	2	4	1	1	1	2
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	4	3	4	3	4	2	2	1	3	2	1	1	3	3	4	3	2	1	2	2
Ques.	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
Ans.	4	3	4	1	3	3	4	3	3	1	2	1	2	3	2	4	2	4	1	2
Ques.	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
Ans.	3	1	4	3	2	4	3	2	1	1	3	3	4	4	3	2	2	4	2	3
Ques.	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**										
Ans.	4	3	4	1	2	2	2	1	4	2										

EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Oxytocin mainly helps in **[CBSE-1999]**
(1) Milk production (2) Child birth
(3) Diuresis (4) Gametogenesis

Q.2 Which hormone is concerned with the concentration of urine **[CBSE-2002]**
(1) Oxytocin (2) Vassopressin
(3) Prolactin (4) Cortisol

Q.3 Acromegaly is caused by **[CBSE-2002]**
(1) Excess of S.T.H.
(2) Excess of Thyroxine
(3) Deficiency of Thyroxine
(4) Excess of Adrenaline

Q.4 Oxytocin is released from **[RPMT-2000]**
(1) Adenohypophysis (Anterior lobe)
(2) Adenohypophysis (Posterior lobe)
(3) Hypothalamus
(4) Neurohypophysis

Q.5 FSH is **[RPMT-2000]**
(1) Glycoprotein (2) Metalloprotein
(3) Glycolipid (4) Phospholipid

Q.6 The synthesis of Vasopressin is done by **[RPMT-2001]**
(1) Hypothalamus (2) Kidney
(3) Anterior pituitary (4) Post. pituitary

Q.7 Which one of the pituitary of the rabbit controls the protein metabolism and growth of skeleton **[RPMT-2002]**
(1) lodo thyroxine
(2) Leutotrophic hormone
(3) Somatotrophic hormone
(4) Oxytosine

Q.8 Function of thyrocalcitonin **[CBSE-1998]**
(1) To reduce the calcium level in blood
(2) To increase the calcium level in blood
(3) Oppose the action of thyroxine
(4) Maturation of gonads

Q.9 Parathormone deficiency leads to **[CBSE-1999]**
(1) Decrease of Ca^{+2} level in blood
(2) Increase of Ca^{+2} level in blood
(3) Osteoporosis
(4) Hypercalemia

Q.10 Parathormone controls **[RPMT-2000]**
(1) Fatty acid metabolism
(2) Sodium and potassium metabolism
(3) Calcium and phosphate metabolism
(4) Protein metabolism

Q.11 Parathyroid hormone **[NCERT]**
(1) is produced by the thyroid gland
(2) is released when blood calcium levels fall
(3) stimulates osteoblasts to lay down new bone
(4) Stimulates calcitonin release

Q.12 Melatonin is secreted by **[CBSE-2000]**
(1) Pineal body (2) Skin
(3) Pituitary Gland (4) Thyroid

Q.13 M.S.H is secreted by in human – **[CBSE-2000]**
(1) Anterior lobe of pituitary
(2) Middle lobe of pituitary
(3) Posterior lobe of pituitary
(4) Endostyle

Q.14 Thymosin stimulates **[RPMT-2000]**
(1) Milk secretion (2) Erythrocytes
(3) T-lymphocytes (4) Melanocytes

Q.15 Norephinephrin hormone is secreted from **[RPMT-2000]**
(A) Zona glomerulosa (2) Zona fasiculata
(3) Zona reticularis (4) Medulla of adrenal

Q.16 Which gland is concerned with salt equilibrium in body **[RPMT-2001]**
(A) Anterior pituitary (2) Pancreas
(3) Adrenal (4) Thyroid

Q.17 Norepinephrine leads to increase in **[RPMT-2004]**
(1) Blood pressure
(2) Urine production
(3) Cellular respiration
(4) Release of epinephrine

Q.18 Steroid hormones **[NCERT]**
(1) have only cell surface receptors
(2) are lipophobic
(3) act through altering the activity of proteins in the target cell
(4) are produced by only adrenal cortex

Q.19 Both adrenaline and cortisol are secreted in response to stress. Which of the following statements is also true for both of these hormones ?
(1) They act to increase blood glucose
(2) They are secreted by the adrenal cortex
(3) Their secretion is stimulated by adrenocorticotropin
(4) They are secreted into the blood within seconds of the onset of stress.

Q.20 Which of the following act as both hormone and enzyme **[RPMT-2000]**
(1) ADH hormone
(2) Acetylcholinesterase
(3) Angiotensinogen (4) Renin

Q.21 What is the molecular weight of Insulin **[RPMT-2000]**
(1) 15000 (2) 5000
(3) 4000 (4) 6000

Q.22 Prostaglandins affect
(1) Blood pressure (2) Defaection
(3) Osmoregulation (4) Oxygen metabolism

Q.23 Which cells of pancreas secrete the hormone insulin **[RPMT-2001]**
(1) Alpha-cells of langerhans
(2) Beta-cells of langerhans
(3) Interstitial cells
(4) Gamma-cells of langerhans

Q.24 In Rabbit, which of the following organ acts as both endocrine & exocrine gland **[RPMT-2001]**
(1) Testes (2) Ovary
(3) Pancreas (4) Stomach

Q.25 Which temporary endocrine gland forms in ovary after ovulation **[RPMT-2003]**
(1) Corpus callosum (2) Corpus albicans
(3) Corpus luteum (4) Corpus striata

Q.26 Insulin differs from Growth hormone in **[CBSE-1999]**
(1) Increases activity of m-RNA and Ribosomes
(2) Increase the permeability of cell membrance
(3) Affects metabolism of fats by inducing lipogenesis
(4) Increasing protein synthesis

Q.27 Which gland decreases in size with increasing age **[CBSE-1999]**
(1) Thyroid (2) Adrenal
(3) Thymus (4) Pituitary

Q.28 Reason, why hair loss is more in old age **[CBSE-2000]**
(1) Reduction of blood supply
(2) Decrease in protein synthesis
(3) Low energy production
(4) Reduced storage of glycogen

Q.29 Melanin protect from **[CBSE-2002]**
(1) U.V. rays (2)Visible rays
(3) Infrared rays (4) X-rays

Q.30 Which one of the following pairs correctly matches a hormone with a disease resulting from its deficiency **[CBSE-2002]**
(1) Relaxin – Gigantism
(2) Prolactin – Cretinism
(3) Parathyroid hormone – Tatany
(4) Insulin – Diabetes insipidus

Q.31 Which of the following act as local messenger **[RPMT-2000]**
(1) Carrier protein (2) Glycoprotein
(3) Phospholipid (4) Glycolipid

Q.32 Sodium-potassium pump is **[RPMT-2001]**
(1) A hormone (2) An enzyme
(3) A protein carrier (4) An organelle

Q.33 Why thyroxine is a hormone, not an enzyme **[RPMT-2001]**
(1) It is secreted in small quantity
(2) It is not a polypeptide
(3) It has not special effect
(4) It is directly poured into blood

Q.34 Which one of the following pair's correctly matches a hormone with a disease resulting from its deficiency **[CBSE-2004]**
(1) Insulin – Diabetes insipidus
(2) Thyroxine – Tetany
(3) Parathyroid hormone – Diabetes mellitus
(4) Luteinizing hormone – Failure of ovulation

Q.35 Which hormone causes dilation of blood vessels, increaed oxygen consumption and gluconeogenesis ? **[CBSE-2006]**
(1) Adrenalin (2) Glucagon
(3) ACTH (4) Insulin

Q.36 Sertoli cells are regulated by the pituitary hormone known as **[CBSE-2006]**
(1) Prolactin (2) LH
(3) FSH (4) GH

Q.37 A steroid hormone which regulates glucose metabolism is **[CBSE-2006]**
(1) 11-deoxycorticosterone
(2) Cortisone
(3) Cortisol
(4) Corticosterone

Q.38 Which one of the following is not a second messenger in hormone action? **[CBSE-2006]**
(1) Sodium (2) cAMP
(3) cGMP (4) Calcium

Q.39 Tadpoles of frog can be made to grow as giant sized tadpoles, it they are: **[AIIMS-2006]**
(1) Administered antithyroid substance like thiourea
(2) administered large amounts of thyroxine
(3) reared on a diet rich in egg yolk
(4) reared on a diet rich in both egg yok and glucose

Q.40 Thyroid hormone has regulatory effect on **[AMU-2000]**
(1) Protein metabolism
(2) Carbohydrate metabolism
(3) Fat metabolism (4) All of the above

Q.41 Which of the hormone is polypeptide : **[AMU-2000]**
(1) LH (2) FSH
(3) Insulin (4) Thyroxine

Q.42 A group of compounds now recognised as local hormones are **[AMU-2002]**
(1) Prostaglandins (2) Prostacyclins
(3) Cytokinins (4) Substance 'P'

Q.43 The fate of hormone bound to the specific receptors on the cell surface can be traced through **[AMU-1999]**
(1) X-ray
(2) Laser-photo-bleaching
(3) Ultra scanning
(4) Resonance imaging

Q.44 Reabsorption of Na^+ is controlled by which one the folowing hormones **[AMU-2002]**
(1) Aldosterone (2) Oestrogen
(3) Glucocorticoids (4) Testosterone

Q.45 Insulin is secreted by **[HPPMT-2006]**
(1) α-cell of islets of langerhans
(2) δ-cell of islets of langerhans
(3) β-cell of islets of langerhans
(4) pancreatic acinur cell

Q.46 ADH responsible for reabsorption of water and reduction of urine secretion is synthesize by **[HPPMT-2006]**
(1) Posterior pituitary gland
(2) Juxtaglomerular apparatus
(3) Anterior pituitary gland
(4) Hypothalamus

Q.47 The lorain-levi syndrome is due to **[JK-CET-2006]**
(1) Hyper functioning of pituitary
(2) Hypothyroidism
(3) Hyperthyroidism
(4) Deficiency of growth hormone

Q.48 The excessive secretion of mineral ocorticiods independent of renin-angiotensin-aldosterone system results in **[J.K.CET-2006]**
(1) Cushing's disease (2) Conn's disease
(3) Addison's disease (4) Grave's disease

Q.49 Steroid hormones transmit their information by **[UPCPMT-2006]**
(1) Stimulating the receptors present on cells membrane
(2) Entering into the cell and modifying cellular contents.
(3) Entering into the cell modifying nuclear organisation
(4) The help of an intracellular second messenger.

Q.50 Metamorphosis in tadpole can be increased by treatment of water with **[UPCPMT-2006]**
(1) NaCl (2) Thyroxine
(3) Iodine (4) GH

Q.51 The hormones that initiates ejetion of milk stimulates milk production and grwoth of ovarian follicles are respectively known as **[KERALA-PMT-2006]**
(1) PRL, OT and LH
(2) OT, PRL and FSH
(3) LH, PRL and FSH
(4) PRH, OT and LH

Q.52 In heart cells, which one serves as a second messenger, speeding up muscel cell contraction in response to adrenaline?
[KERALA-PMT-2006]
(1) CAMP (2) CGMP
(3) GTP (4) ATP

Q.53 Which one of the following endocrine gland functions as a biological clock and neurosecretory transducer ?
[KERALA-PMT-2006]
(1) Adrenal gland (2) Thyroid gland
(3) Pineal gland (4) Thymus gland

Q.54 Match the hormone in column I with their function in column II **[KERALA-2006]**

Column I	Column II
(a) FSH	(i) Prepare endometrium for implantation
(b) LH	(ii) Develop female secondary Sexual characters
(c) Progesterone	(iii) Contraction of uterine wall
(d) Estrogen	(iv) Development of corpus luteum
	(v) Maturation of graafian follicle

(1) a-v, b-iv, c-i, d-ii (2) a-iii, b-iv, c-i, d-ii
(3) a-iv, b-iii, c-ii, d-i (4) a-i, b-ii, c-iii, d-iv

Q.55 LH and FSH are collectively called
[BHU(screening) 2006 , MPPMT-2002]
(1) Oxytocin (2) Somatotrophins
(3) Luteotrophic (4) Gonadotrophins

Q.56 Who is known as "father of endocrinology"
[BHU(Screening)-2006, RPMT 2008]
(1) R.H. Whittakar (2) Pasteur
(3) Einthoven (4) Thomas Addison

Q.57 Mammalina thymus is mainly concerned with
[BHU(Screening)-2006]
(1) Regulation of body temperature
(2) Regulatrion of body growth
(3) Immunological functions
(4) Secretion of thyrotropin

Q.58 During emergency which of of the following hormone is secreted **[BHU(Screening)-2006]**
(1) Aldosterone (2) Thyroxine
(3) Adrenaline (4) Calcitonin

Q.59 The Islets of langerhans are found in
[BHU(Screening)-2006]
(1) Pancreas (2) Stomach
(3) Liver (4) Alimentary canal

Q.60 Which of the following gland is both endocrine as well as exocrine **[MPPMT-2002]**
(1) Thyroid (2) Pancreas
(3) Payers patches (4) Thymus

Q.61 Insulin is proudced from **[MPPMT-2001]**
(1) α-cells (2) β-cells
(3) Adrenal cortex (4) testes

Q.62 Which of the following is secondary messenger **[MPMT-2002]**
(1) ATP (2) Cyclic AMP
(3) GTP (4) ATP and AMP

Q.63 Corticosteroids are secreted by
[MPPMT-2006]
(1) Adrenal gland (2) Pineal gland
(3) Pituitary gland (4) Thyroid gland

Q.64 Melatonin is secreted by **[MPPMT-2006]**
(1) Pineal gland (2) Parathyroid gland
(3) Pituitary gland (4) Thyroid gland

Q.65 Corpus luteum secretes **[MPPMT-2006]**
(1) LH (2) FSH
(3) Progesterone (4) Testosterone

Q.66 Insulin is related with **[MPPMT-2006]**
(1) Diabetes (2) Migrain
(3) Jaundice (4) All of the above

Q.67 Blood pressure is controlled **[MPPMT-2004]**
(1) Thyroid gland (2) Thymus gland
(3) Adrenal gland (4) Parathyroid gland

Q.68 Hormone responsible for metamorphosis in tadpole is **[UGET MANIPAL-2005]**
(1) Adrenaline (2) Thyroxine
(3) Aldosterone (4) Vasopression

Q.69 Hormone responsible for ovulation is
[UGET MANIPAL-2005]
(1) LH (2) GSH
(3) Progesterone (4) Testosterone

Q.70 Aldosterone is secreted by
[UGET MANIPAL-2005]
(1) Zona glomerulosa (2) Zona faciculata
(3) Zona reticularis (4) Zona pellucida

Q.71 Which of the following is gonadotrophic hormone **[UGET MANIPAL 2005, UP-2005]**
(1) Collips hormone (2) Prolactin
(3) Oxytocin (4) Luteinzing hormone

Q.72 Which gland stores hormone before its secretion and then release it **[ORRISSA-JEE-2005]**

(1) Thyroid (2) Pancreas

(3) Pineal (4) Pituitary

Q.73 Abnormal conditon when mammary gland of man become female like **[ORISSA-JEE-2005]**

(1) Gynosism (2) Gynochorism

(3) Feminization (4) Gynaecomastia

Q.74 Which of the following disease is not related to thyroid gland **[AFMC-2005]**

(1) Goitre (2) Cretinism

(3) Myxoedema (4) Acromegaly

Q.75 Match item in column 'A' with those given in column 'B' **[KERALA-PMT-2005]**

Column 'A'	Column 'B'
A ADH	i Pituitary
B ACTH	ii Mineralocorticoid.
C Aldosterone	iii Diabetes mellitus
D Insulin	iv Diabetes insipidus
E Testosterone	v Vasodilator

(1) A = i, B = iv, C = ii, D = iii, E = v

(2) A = iv, B = ii, C = i, D = iii, E = v

(3) A = iv, B = i, C = ii, D = iii, E = v

(4) A = iv, B = i, C = iii, D = ii, E = iv

Q.76 Which of the following is not paired correctly **[KERALA-PMT-2005]**

(1) Myxoedema - swollen facial tissues

(2) Insulin - raises blood glucose

(3) Parathyroid - tetany

(4) Cretinism - mentally retarted

Q.77 A patient of diabetes mellitus excreted glucose in urine even when he kept in a carbohydrate free diet. It is because **[ORISSA-JEE-2005]**

(1) Fats are catabolised to form glucose

(2) Amino acids are catabolised in liver

(3) Amino acids are discharged in blood stream from liver

(4) Glycogen from muscles are discharged in blood stream from liver

Q.78 Match the list I with list II **[MANIPUR-2005]**

A Adenohypophysis	(1) Epinephrine
B Adrenal medulla	(2) Somatotropin
C Parathyroid gland	(3) Thymosin
D Thymus gland	(4) Parathormone

(1) A = 3, B = 1, C = 4, D = 2

(2) A = 1, B = 2, C = 3, D = 4

(3) A = 2, B = 1, C = 4, D = 3

(4) A = 4, B = 3, C = 2, D = 1

Q.79 If receptor molecule is removed from target organ for hormone action , the target organ will **[MANIPUR-2005]**

(1) Continue to respond but require higher concentration of hormone

(2) Continue to respond but in opposite way

(3) Continue to respond without any difference

(4) Not respond to hormone

Q.80 Which gland atrophies in adult **[DPMT-2005]**

(1) Pancreas (2) Thymus

(3) Thyroid (4) Adrenal

Q.81 Grave's disease is due to **[DPMT-2005]**

(1) Hyperactivity of thyroid gland

(2) Hypoactivity of adrenal cortex

(3) Hyperactivity of adrenal medulla

(4) Hypoactivity of islets of langerhans

Q.82 Placenta proudced which hormone **[HAR. -PMT-2005]**

(1) GH (2) Gastrin

(3) ACTH (4) Progesterone

Q.83 Hypothyroidism causes in adult **[HAR. –PMT-2005]**

(1) Obesity (2) Diabetes

(3) Cretinism (4) Myxoedema

Q.84 The hormone that controls the level of calcium and phosphorus in the blood is the secreted by **[AFMC-2005]**

(1) Thyroid (2) Parathyroid

(3) Pituitary (4) Thymus

Q.85 FSH is proudced by **[BHU-2005]**

(1) Adrenal cortex

(2) Anterior lobe of pituitary gland

(3) Middle lobe of pituitary gland

(4) Posterior lobe of pituitary gland

Q.86 Which of the following statement are false/true **[Kerala-2007]**

(A) Calcitonin regulated the metabolism of calcium

(B) Oxytocin stimulates contraction of uterine muscle during birth

(C) Grave's disease is caused by malfunctioning of adrenal gland

(D) ADH stimulates absorption of water and increase the urine production

(1) A and C are true B and D are flase

(2) A and B are ture C andD are flase

(3) A and D are true B and C are flase

(4) A, B and C are true, D only false

Q.87 Which hormone helps in reabsorption of water from kidney **[UTTARANCHAL PMT-2004]**

(1) ADH (2) STH

(3) ACTH (4) TTH

Q.88 Which of the following is largest gland in adult man **[UTTARANCHAL PMT-2005]**

(1) Thymus (2) Liver

(3) Thyroid (4) Pancreas

Q.89 Normal blood calcium level in an adult is **[WEST BENGAL JEE-2007]**

(1) 5 mg/dl (2) 8.5/10.5 mg/dl

(3) 15.5 – 20mg/dl

(4) 20 mg/dl – 30 mg/dl

Q.90 Ketone bodies are formed in **[WEST BENGAL JEE - 2007]**

(1) Liver (2) spleen

(3) kidney (4) heart

Q.91 Addison's disease in caused due to **[WEST BENGAL JEE-2007]**

(1) hypersecretion of adernal cortical hormones

(2) hypersecretion of growth hormone

(3) hypersecretion thymus

(4) none of the above

Q.92 Growth hormone is secreted by **[WEST BENGAL JEE-2007]**

(1) acidophillic α cells

(2) acidophilic β cells

(3) basophilic α cells

(4) basophilic β cells

Q.93 Which hormone is responsible for maintenance of preganancy **[WEST BENGAL JEE-2007]**

(1) HCG (2) progesterone

(3) estrogen (4) prostaglandin

Q.94 Addison's disease results from **[JHARKHAND-2004]**

(1) hypertrophy of gland

(2) hypo-secretion of adrenal cortex

(3) hyperactivity of cells of leydig

(4) none of the above

Q.95 Para-thyroid hormone is a **[JHARKHAND-2004]**

(1) peptide (2) carbohydrate

(3) lipid (4) steroid

Q.96 Vasopressin influences **[JHARKHAND-2002]**

(1) electrolyte efflux

(2) nerve excitability

(3) water reabsorption

(4) all of these

Q.97 Pheromones when secreted upon the skin surface, its oduour generally affects **[JHARKHAND-2004]**

(1) skin colour (2) genitalia

(3) breast

(4) mutual behaviour of members of a species

Q.98 If ADH level of blood is less **[BIHAR-2005]**

(1) volume of urine increases

(2) volume of urine decreases

(3) volume of urine is normal

(4) volume of urine is unaffected

Q.99 Which of the follwing act as secondary messenger in metabolism **[BIHAR-2004]**

(1) ATP (2) C-AMP

(3) ADP (4) NAD

Q.100 Hormone prolactin is secreted by **[BIHAR-2005]**

(1) posterior pituitary (2) thyroid

(3) anterior pituitary (4) hypothalamus

Q.101 Steroid hormone is derived from **[BIHAR-2004]**

(1) corticoid (2) cholesterol

(3) ADH (4) protein

Q.102 Increse glucose level in human is called **[BIHAR]**

(1) hypoglycemia (2) hyperglaycaemia

(3) hyposuria (4) hypersuria

Q.103 Spermatogenesis is influenced by **[BIHAR-2003]**

(1) Progesterone (2) FSH
(3) STH (4) LTH

Q.104 Which hormone is responsible for ovulation **[BIHAR-2003]**

(1) FSH (2) LH
(3) Testosterone (4) Oestrogen

Q.105 Progesterone is secreted by **[BIHAR-2002]**

(1) corpus luteum (2) corpus albicans
(3) corpus callosum (4) corpus striatum

Q.106 Female hormone is **[BIHAR-2002]**

(1) progesterone (2) estrogen
(3) estradiol (4) all of these

Q.107 Which of the following hormones helps in the contraction of uterus during child birth **[UP-CPMT 2001]**

(1) ADH (2) androgen
(3) oxytocin (4) glucocorticoid

Q.108 Which of the following hormones stimulates the secretion of milk from female **[UP-CPMT 2001]**

(1) LH (2) prolactin
(3) oxytocin (4) progesterone

Q.109 The modern idea about ageing is that our body slowly loses the power of defence against the invasion of germs and pathogens. This process starts by the disappearance of which organ **[UP-CPMT 2001]**

(1) spleen (2) thymus gland
(3) pituitary gland (4) parathroid gland

Q.110 Parathormone is secreted during **[UP-CPMT 2002]**

(1) increased blood calcium level
(2) decreased blood calcium level
(3) increased blood sugar level
(4) decreased blood sugar level

Q.111 Chronical disturbance in hormone secretion of thyroid gland causess **[UP-CPMT 2003]**

(1) goitre (2) diabetes
(3) Addison's disease (4) colourblindness

Q.112 The formation of egg and sperm is affected by **[UP-CPMT 2003]**

(1) LH (2) MSH
(3) TSH (4) FSH

Q.113 ACTH is secreted by **[UP-CPMT 2003]**

(1) thyroid gland (2) thymus gland
(3) pituitary gland
(4) Islets of Langerhans

Q.114 Which of the following hormones secreted by pancreas **[UP-CPMT 2003]**

(1) Insulin and glucagon
(2) Epinephrin and nor-epinephrin
(3) Thyroxin and melanin
(4) Prolatin and oxytocin

Q.115 Metamorphosis in frog is hastened by **[UP-CPMT 2003]**

(1) thyroxine (2) insulin
(3) glucagon (4) adrenalin

Q.116 Mammalian prolactin is secreted by **[UP-CPMT 2004]**

(1) adenohypophysis (2) neurohypophysis
(3) adrenla cortex (4) adrenal medulla

Q.117 Hypersecretion of grwoth hormone in the period of growth lead to **[UP-CPMT 2004]**

(1) acromegaly (2) cushing syndrome
(3) midgets (4) Gigantism

Q.118 Which of these is not a ketone body **[UP-CPMT 2004]**

(1) Acetoacetic acid (2) Acetone
(3) Succinic acid
(4) Betahydroxy butyric acid

Q.119 Fight and flight hormone is **[UP-CPMT 2007]**

(1) adrenaline (2) thyroxine
(3) ADH (4) oxytocin

Q.120 Which of the following are correct for axolotal larva **[UP-CPMT 2007]**

(i) it shows neoteny and paedogenesis
(ii) absence of thyroxine affect metamorphosis
(iii) it is the larva of hemichordata

(1) (i), (ii) & (iii) (2) (i) & (ii)
(3) (ii) & (iii) (4) (iii)

Q.121 Blood pressure is controlled by **[MP-PMT 2004]**

(1) Thyroid gland (2) Thymus gland
(3) Adrenal gland (4) Parathyroid gland

Q.122 Hormone which is responsible for maintainance of corpus leuteum is **[MP-PMT 2004]**

(1) Estrogen (2) Aldosteron
(3) Progesterone (4) Testosteron

Q.123 The effect caused by non-functioning of islets of Langerhans **[MP-PMT 2006]**
(1) Heart beat rate increase
(2) Increased BMR
(3) hyperglycaemia
(4) tatani

Q.124 Structure involved in Addison's disease is **[MP-PMT 2006]**
(1) Adrenal medulla (2) adrenal cortex
(3) thyroid (4) pituitary

Q.125 Acromegaly is a disease caused by **[MP-PMT 2001]**
(1) Over secretion of growtth hormone in childhood
(2) Over secretion of growth hormone in adulthood
(3) Under secretion of growth hormone in adulthood
(4) Deficiency of calcium and phosphorous in the diet.

Q.126 If thyroid gland is compppleteloy removed from a tadpole, it will **[MP-PMT 2001]**
(1) Die immediately
(2) Turn into a giant frog
(3) Turn into a dwarf frog
(4) Remain tadpole throughout life

Q.127 'Hashimoto' diseases is caused, when **[MP-PMT 2001]**
(1) Adrenal gland is destroyed by autoimmunity
(2) Thyroid gland is destroyed by autoimmunity
(3) Kidney is destoryed
(4) Pancreas is destroyed

Q.128 The emergency hormone is **[MP PMT 2001]**
(1) Throxine (2) Adrenaline
(3) Insulin (4) Progesterone

Q.129 Insulin is secreted by **[MP-PMT 2001]**
(1) Beta cells of Islets of Langerhans
(2) Alfa cells of Islets of Langarhans
(3) Kuffer cells
(4) Gall bladder

Q.130 In absence of ADH, the disease casused by **[MP-PMT 2001]**
(1) Diabetes mellitus
(2) Diabetes insipidus
(3) Oligouria
(4) Acromegaly

Q.131 In man removal of Parathyroid gland leads to **[MP-PMT 2001]**
(1) Acromegaly (2) Tetany
(3) Polyuria (4) Diabetes insipidus

Q.132 Parathormone induces **[MP-PMT 2002]**
(1) Increase in blood sugar level
(2) Decrease in serum calcium level
(3) Increase in serum calcium level
(4) Decrease in blood sugar level

Q.133 Thyrotropin-releasing factor (TRF) is proudced by **[MP-PMT 2002]**
(1) Cerebrum (2) Optic lobe
(3) Cerebellum (4) Hypothalamus

Q.134 Which one secretes fight and flight hormone **[MP-PMT 2002]**
(1) Pituitary gland (2) Pineal gand
(3) Adrenal gland (4) Thyroid gland

Q.135 Which disease is caused by under secretion of adrnal cortex **[MP-PMT 2002]**
(1) Cretinism (2) Dwarfism
(3) Sterility (4) Addison's disease

Q.136 Gonadotropic hormones are **[MP-PMT 2002]**
(1) Estrogen and progesterone
(2) Luteinizing hormone and follicle stimulatin hormone
(3) Testosterone and androsterone
(4) Prolactin and Luteotropin

Q.137 The name second messenger is given to **[MP-PMT 2002]**
(1) ATP (2) Cyclic AMP
(3) AMP (4) Both ATP and AMP

Q.138 Which gland is both exocrine and endocrine **[MP-PMT 2002]**
(1) Pancreas (2) Thyroid
(3) Pituitary (4) Adrenal

Q.139 The function of glucagon hormone is **[MP-PMT 2003]**
(1) To increase glycogenesis
(2) To decrease blood sugar level
(3) To release glucose from liver cells and glycogenolysis promotion
(4) To increase the absorption of glucose and faty acids through cell

Q.140 Diabetes insipidus is due to **[MP-PMT 2003]**
(1) Hypersecretion of insulin
(2) Hyposecretion of vasopressin
(3) Hypersecretion of vasopressin
(4) Hposecretion of insulin

Q.141 Pineal body originates from **[MP-PMT 2003]**
(1) Dorsla part of diencephalon
(2) Ventral part of diencephalon
(3) Ventral part of cerebellum
(4) Dorsal part of cerebellum

Q.142 Which of the following pituitary hormone is a direct action hormone **[MP-PMT 2003]**
(1) MSH (2) ICSH
(3) ACTH (4) TSH

Q.143 Addisons disease is caused due to **[MP-PMT 2003]**
(1) Hypertrophy of gland
(2) Hyposecretion of adrenal contex
(3) Hyperactivity of Leydig cells
(4) Hypersecretion of pituitary

Q.144 T-cells mature in **[CBSE-2006]**
(1) Peyer's patch (2) Lymph node
(3) Thymus (4) Brusa of fabric

Q.145 Which of the following steriod sex hormone influenced secondary sex organs ? **[MP-PMT 2003]**
(1) Progesterone (2) Oestrogen
(3) LH (4) LTH

Q.146 Progesterone is secreted from **[MP-PMT2003]**
(1) Testes (2) Adrenal gland
(3) Pituitary gland (4) Corpus luteum

Q.147 Adrenal gland is derived from **[MP-PMT 2007]**
(1) Ectoderm
(2) Mesoderm
(3) Ectoderm and mesoderm
(4) Ectoderm and endoderm

Q.148 Which hormone is responsible for milk ejection after the birth of the baby **[MP-PMT 2007]**
(1) Oxytocin (2) Progesterone
(3) Prolactin (4) Estrogen

Q.149 We know that the thryoxine controls metabolism body. An autoimmune disease where the body own antibodies attack the cells of the thyroid is called **[MP-PMT 2007]**
(1) Hyperthyroidism (2) Hashimoto's disease
(3) Grave's disease (4) Turner syndrome

Q.150 Which one of the following pairs of organs includes only the endocrine glands ? **[AIPMT-2008]**
(1) Thymus and Testes
(2) Adrenal and Ovary
(3) Parathyroid and Adrenal
(4) Pancreas and Parathyroid

Q.151 The blood calcium level is lowered by the deficiency of **[AIPMT-2008]**
(1) Both calcitonin and Parathormone
(2) Calcitonin
(3) Parathormone
(4) Thyroxine

Q.152 In human adult females oxytocin **[AIPMT-2008]**
(1) Stimulates pituitary to secrete vasopressin
(2) Causes strong uterine contractions during parturition
(3) is secreted by anterior pituitary
(4) stimulates growth of mamary glands

Q.153 A health disorder that results from the deficiency of thyroxine in adulats and characterised by (i) a low metabolic rate, (ii) increase in body weight and, (iii) tendency to retain water in tissues is : **[CBSE 2009]**
(1) cretinism (2) myxoedema
(3) simple goitre (4) hypothyroidism

Q.154 Goitre can occur as a consequence of all of the following except : **[WB. JEE 2009]**
(1) Grave's disease (2) Iodine deficiency
(3) Pituitary adenoma
(4) Excessive intake of exogenous thyroxine

Q.155 The hormone that increases the blood calcium level and decreases its excretion by kidney is: **[DUMET 2009]**
(1) insulin (2) thyroxine
(3) calcitonin (4) parathormone

Q.156 Obesity of face, hyperglycemia and virilism in females are characteristics of : **[AMU 2009]**
(1) Grave's disease (2) Conn's disease
(3) Cushing's syndrome
(4) Addison's disease

Q.157 Which of the following hormones is not steroid? **[CPMT 2009]**
(1) Androgen (2) Vasopressin
(3) Aldosterone (4) Testosterone

Q.158 Which of the following hormones does not contain a polypeptide? **[Karnataka CET 2009]**
(1) Insulin (2) Oxytocin
(3) Prostaglandin
(4) Antidiuretic hormone

Q.159 Signalling between cells usually results in the activation of protein : **[DUMET 2009]**
(1) lipases (2) kinases
(3) proteases (4) nucleases

Q.160 Steroid hormones easily pass through the plasma membrane by simple diffusion because they : **[DUMET 2009]**
(1) Are lipid soluble
(2) Are water soluble
(3) Enter through pores
(4) Contain carbon and hydrogen

Q.161 Estrogen and testosterone are steroid hormones and are most likely bind to : **[DUMET 2009]**
(1) Cytoplasmic receptors
(2) Membrane ions channels
(3) Enzyme-linked membrane receptors
(4) G-protein linked membrane receptors

Q.162 Match the hormone with is source of secretion: **[Kerala PMT 2009]**
(1) A = 5, B = 1, C = 6, D = 3, E = 2
(2) A = 1, B = 2, C = 4, D = 3, E = 5
(3) A = 2, B = 6, C = 4, D = 5, E = 3
(4) A = 5, B = 1, C = 4, D = 2, E = 3
(5) A = 1, B = 3, C = 4, D = 2, E = 5

Q.163 Match List I with List II and choose the correct answer : **[Kerala PMT 2009]**
(1) A = 4, B = 1, C = 2, D = 3, E = 5
(2) A = 4, B = 1, C = 2, D = 5, E = 3
(3) A = 2, B = 1, C = 4, D = 3, E = 5
(4) A = 2, B = 1, C = 5, D = 4, E = 3
(5) A = 5, B = 1, C = 3, D = 2, E = 4

Q.164 The chemical nature of hormones secreted by α and δ cells of pancreas is : **[WB. JEE 2009]**
(1) steroid (2) glycolipid
(3) polypeptide (4) glycoprotein

Q.165 Which is 32 amino acid water soluble peptide hormone ? **[AMU 2010]**
(1) Gastrin (2) Calcitonin
(3) Glucagon (4) Insulin

Q.166 Which of the following hormones is correctly matched with its deficiency disease? **[AFMC 2010]**
(1) Parathormone — Tetany
(2) Relaxin — Cretinism
(3) Insulin — Diabetes insipidus
(4) Prolactin — Astigmatism

Q.167 Parathormone influences calcium absorption in the small intestine by regulating the metabolism of : **[AMU 2010]**
(1) vitamin C (2) vitamin D
(3) vitamin B_6 (4) enterogastrone

Q.168 Toxic agents present in food which interfere with thyroxine synthesis lead to the development of : **[CBSE 2010]**
(1) toxic goitre (2) cretinism
(3) simple goitre (4) thyrotoxicosis

Q.169 Endemic goitre is a state of :**[WB. JEE 2010]**
(1) increased thyroid function
(2) normal thyroid function
(3) decreased thyroid function
(4) moderate thyroid function

Q.170 The hormone which regulates sleep-wake cycle in man is : **[Keral PMT 2010]**
(1) oxytocin (2) vasopression
(3) thyroxine (4) melatonin
(5) thyrocalcitonin

Q.171 The inability to regulate the concentration of sodium ions in the blood could be due to the improper functioning of one of the following: **[EAMCET 2010]**
(1) Adenohypophysis-It produces ACTH
(2) Adrenal cortex-It produces Aldosterone
(3) Adrenal medulla-It produces Epinephrine
(4) Pars nervosa-It produces ADH

Q.172 Which one of the following pairs is incorrectly matched ? **[CBSE 2010]**
(1) Glucagon — Beta cells (Source)
(2) Somatostatin — Delta cells (Source)
(3) Corpus luteum — Relaxin (Secretion)
(4) Diabetes mellitus (Disease)

Q.173 Which of the following is not the function of inslin ? **[Karnataka CET 2010]**
(1) Increases the permeability of cell membrane to glucose
(2) Increases the oxidation of glucose in the cells
(3) Initiates the conversion of glycogen to glucose
(4) Initiates the formation of hepatic glycogen from excess of glucose

Q.174 Human chorionic gonadotropin is secreted by: **[Kerala PMT 2010]**

(1) chorion (2) amnion

(3) corpus luteum (4) placenta

Q.175 What is correct to say about the hormone action in humans ? **[AIPMT Pre 2012]**

(1) Secretion of thymosins is stimulated with aging.

(2) In females, FSH first binds with specific receptors on ovarian cell membrane.

(3) FSH stimulates the secretion of estrogen and progesterone.

(4) Glucagon is secreted by β-cells of Islets of Langerhans and stimulates glycogenolysis.

Q.176 In a normal pregnant woman, the amount of total gonadotropin activity was assessed. The result expected was : **[AIPMT Pre 2012]**

(1) High level circulating HCG to stimulate endometrial thickening.

(2) High levels of FSH and LH in uterus to stimulate endometrial thickening.

(3) High level of circulating HCG to stimulate estrogen and progesterone synthesis.

(4) Hig level of circulating FSH and LH in the uterus to stimulate implantation of the embryo.

Q.177 A person entering an empty room suddenly finds a snake right in front on opening the door. Which one of the following is likely to happen in his neuro-hormonal control system? **[AIPMT Pre 2012]**

(1) Neurotransmitters diffuse rapidly across the cleft and transmit a nerve impulse.

(2) Hypothalamus activates the parasympathetic division of brain.

(3) Sympathetic nervous system is activated releasing epinephrin and norepinephrin from adrenal cortex.

(4) Sympathetic nervous system is activated releasing epinephrin and norepinephrin from adrenal medulla.

Q.178 Which one of the following pairs of hormones are the examples of those that can easily pass through the cell membrane of the target cell and bind to a receptor inside it (mostly in the nucleus) **[AIPMT Pre 2012]**

(1) Thyroxin, Insulin

(2) Somatostatin, oxytocin

(3) Cortisol, testosterone

(4) Insulin, glucagon

ANSWER KEY

Exercise – 3

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	2	2	1	2	1	1	3	1	1	3	2	1	1	3	4	3	1	3	1	4
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	4	1	2	3	3	3	3	1	1	3	1	3	4	4	1	3	3	1	1	4
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	3	1	4	1	3	4	4	2	3	3	2	1	3	1	4	4	3	3	1	2
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	2	2	1	1	3	1	3	2	1	1	4	1	4	4	3	2	1	3	4	2
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	1	4	4	2	2	2	1	3	3	1	4	1	2	2	1	3	4	1	2	3
Ques.	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
Ans.	2	2	2	2	1	4	3	2	2	2	1	4	3	1	1	1	4	3	1	2
Ques.	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
Ans.	3	3	3	2	2	4	2	2	1	2	2	3	4	3	4	2	2	1	3	2
Ques.	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**	**151**	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**
Ans.	1	1	2	3	2	4	3	1	2	3	3	2	2	4	4	3	2	3	2	1
Ques.	**161**	**162**	**163**	**164**	**165**	**166**	**167**	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**		
Ans.	1	4	2	3	2	1	2	3	3	4	2	1	3	4	2	3	4	3		

INSTRUCTIONS FOR Q. NO. 1 TO 63

In the following questions (40 to 57), a statement of assertion (A) is followed by a statement of reason (R).

(1) If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark (1).

(2) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark (2).

(3) If Assertion is true statement but Reason is false, then mark (3).

(4) If both Assertion and Reason are false statements. then mark (4).

Q.1 **A :** Vasopressin is a neurohormone
R : Vasopressin is synthesized by pars nervosa of pituitary gland

Q.2 **A :** Pituitary gland is ectodermal in origin
R : Both parts of pituitary develop from nervous tissue

Q.3 **A :** Thyroxine is presponsible for over all development of animals since childhood.
R : It is diabetogenic hormone and it increases peripheral utilization of glucose

Q.4 **A :** Deficiency of Insulin proudce polyurea conditon
R : Glucagon is antagonastic hormone of Insulin.

Q.5 **A :** Deficiency of vitamine-D is very less known.
R : It is obtained from intrinsic sources regularly.

Q.6 **A :** MSH & Melatonin are antagonistic hormones
R : MSH help in the wide distribution of melanin in melanocytes while melatonin collects the melanin at one place in melanocyte.

Q.7 **A :** Adrenal gland have dual origin.
R : The adrenal cortex develop from endoderm while adrenal medulla develop from mesoderm.

Q.8 **A :** Pineal gland found on the epithalamus of Diencephalon.
R : It is a one type of exocrine gland which is active in later age of life.

Q.9 **A :** Pancrease is heterocrine gland.
R : Pancreas secretes both protein & steroid hormone.

Q.10 **A :** Aldosterone is polypeptide hormone and control the Na^+ & K^+ ratio in body.
R : Aldosterone increase reabsorption of Na^+ from plasma of blood and to check its loss and increase loss K^+ in body fluid.

Q.11 **A :** Thymus gland is found in abdominal region.
R : It is a exocrine gland which secretes lymphocyte.

Q.12 **A :** MSH & Melatonin are similar hormone.
R : MSH help in the collection of melanin in melanocytes while melatonin distribute the melanin at one place in melanocyte.

Q.13 **A :** Two pitutary hormones of the mother take part in feeding the infant on milk.
R : Prolactin from anterior pituitary stimulated mammary glands for the formation of milk, and oxytocin from the post. Pituitary causes the release of milk when the infant sucks breast.

Q.14 **A :** Vasopressin in also called as antidiuretic hormone
R : Vasopressin reduces the loss of water in the urine by increasing water reabsorption in the nephrons.

Q.15 **A :** Aldosterone is known as salt retaining hormone.
R : It reduces Na reabsorption from urine to increase its loss from the body.

Q.16 **A :** Cortisol therapy is useful in organ transplantation
R : Cortisol act as immunosuppresant

Q.17 **A :** Catecholamines (adrenaline) are emergency hormones.
R : Catecholamines are released from adrenal cortex

Q.18 **A :** The hormone FSH stimulates R.B.Cs. maturation.
R : On reaching the red bone marrow FSH stimulate the maturation of RBCs

Q.19 **A :** Thyrocalcitonin & Parathormone have antagonistic effect on blood calcium level.
R : Thyrocalcitonin lower the blood calcium level and parathormone raises the blood calcium level by removal of calcium from bone and reabsorption of calcium from nephrons.

Q.20 **A :** Hormones are said to be similar to enzyme in action and chemical nature
R : Hormones and enzymes are proteinaceous in nature and act as informational nature.

Q.21 **A :** Adrenal cortex can be removed without causing death.
R : Adrenal cortex is not vital for survival.

Q.22 **A :** In recent study, pineal body is called third eye.
R : It is having photosensitive cells and show the response for light.

Q.23 **A :** Growth hormone, Thyroxine and cortisol hormone are called diabetogenic hormone.
R : When the Hypersecretion of thyroxine occurs then produce diabetes mellitus.

Q.24 **A :** Excessive amounts of calcitonin hormone in the blood causes softening of bones.
R : Calcitonin causes mobilisation of calcium from the bones of the blood plasma.

Q.25 **A :** Failure of secretion of somatotropin from an early age cause drawfism in the patient.
R : Somatotropin hormone stimulates the body growth and elongation of long bones.

Q.26 **A :** The dietary deficiency of iodine causes exophthalmic goitre.
R : Iodine is required for the formation of thyroid hormones.

Q.27 **A :** Oxytocin is also known as Anti Diuretic hormone (ADH).
R : Oxytocin can cause an increase in the renal reabsorption of water.

Q.28 **A :** Failure of secretion of thyroid gland hormones from childhood causes cretinism disease.
R : Thyrotropin hormone maintains BMR and promote growth of body tissue .

Q.29 **A :** The tadpoles become giant tadpoles when fed on thiourea.
R : Thiourea is an antithyroid substance.

Q.30 **A :** Hormones are similar to enzymes in their action and chemical nature.
R : Hormones and enzymes are proteinaceous in nature and act as informational molecules.

Q.31 **A :** Failure of secretion of hormone vasopressin causes diabetes mellitus in the patient.
R : Vasopressin reduces the volume of urine by increasing the reabsorption of water from the urine.

Q.32 **A :** The parathyroid glands are said to be under the feedback control of blood calcium levels.
R : Parathormone of parathyroids mobilises calcium form the bones to the blood plasma.

Q.33 **A :** Prolactin is also called the 'Milk ejection hormone'.
R : Prolactin stimulates the smooth muscle contractions of the mammary glands.

Q.34 **A :** Adrenal medulla and sympathetic nervous system are said to function as a closely integrated system.
R : It is because both of them get stimulated in physical and emotional stress conditions.

Q.35 **A :** Prostate and seminal vesicles are said to be primary sex organs.
R : Prostate and seminal vesicles participate and help in reproduction.

Q.36 **A :** A tumour of adrenal cortex may cause Addison's disease.
R : This happens due to over secretion of cortisol by the tumor.

Q.37 **A :** Aldosterone increases the volume of blood and other extracellular fluids.
R : The secretion of aldosterone is stimulated by a fall in the circulating volume of blood.

Q.38 **A :** Adrenal cortex can be removed without causing death.
R : Adrenal cortex is not vital for survival.

Q.39 **A :** Adrenal cortex is called the gland for 'fight, fright and flight'.
R : The hormones adrenaline and noradrenaline help the body to combat against stress and emergency conditions.

Q.40 **A :** FSH is also known as interstitial cell stimulating hormone.
R : It is because of the fact that FSH stimulates the interstitial cells of testis.

Q.41 **A :** Insulin is said to be anabolic hormone.
R : Failure of insulin secretion causes diabetes.

Q.42 **A :** Females have less stature than males after puberty.
R : This happens because of the presence of HCG in the blood of females.

Q.43 **A :** Glucagon is said to lower down the blood sugar level.
R : Glucagon increases the utilization of glucose in the tissues and the synthesis of liver glycogen.

Q.44 **A :** Endocrine glands are called glands of internal secretion.
R : These are ductless and release their hormones in the blood.

Q.45 **A :** Hormones are also called chemical messengers or information molecules.
R : These carry the message of target cells to the endocrine glands.

Q.46 **A :** Hormones differ from the enzymes in a number of properties.
R : Enzymes are always proteinous while hormones may or may not be proteinous.

Q.47 **A :** Hormones show certain similarities with nervous system.
R : Both are electrochemical signals and are conducted towards specific direction.

Q.48 **A :** All hormones act after a lag period.
R : c-AMP is formed after certain lag period.

Q.49 **A :** Adrenal gland is electomesodermal in origin.
R : Adrenal cortex is ectodermal in origin while adrenal medulla is mesodermal in origin.

Q.50 **A :** Metamorphosis of tadpole larva occurs in presence of thyroxine hormone.
R : A thyroidless tadpole larva just increases in size and fails to metamorphosize.

Q.51 **A :** Thyroxine hormone controls BMR and physical, mental and sexual growth.
R : Hypothyroidism in the infants leads to cretinism.

Q.52 **A :** Goitre is very less reported in the persons near the coastal areas.
R : Iodine is abundantly present in the sea water.

Q.53 **A :** TCT and PTH are antagonistic hormones.
R : TCT increases the Ca^{++} level in blood while PTH decreases Ca^{++} in the blood.

Q.54 **A :** Nor-epinephrine is also called Triple F-harmone.
R : It increases the metabolism during fight, flight and fright.

Q.55 **A :** Adrenal gland is also called 4 S-gland.
R : Hormones of adrenal gland regulate salt retention, sugar metabolism, sex-hormones secretion.

Q.56 **A :** Pancreas is a purely endocrine gland.
R : It is totally endocrine and secretes only hormones.

Q.57 **A :** Aldosterone is called salt retaining hormone.
R : Aldosterone increases Na^+ and K^+ reabsorption from nephric filtrate.

Q.58 **A :** Epinephrine is commonly called sympathomimic hormone.
R : Epinephrine and sympathetic nerve fibres both have same actions on same organs.

Q.59 **A :** Diabetes insipidus is due to deficiency of insulin and is characterized by diuresis, polydipsia, hyperglycaemia and glycosuria.

R : In diapedes insipidus, body cells cannot use glucose and liver cells cannot store glucose.

Q.60 **A :** Pituitary gland is cranioepithelial in origin.

R : Its anterior lobe is formed from pharynx while posterior lobe is formed from the hypothalamus of brain.

Q.61 **A :** Pituitary gland is also called master gland.

R : It secretes a number of trophic hormones which regulate secretion from other endocrine glands.

Q.62 **A :** Acromegaly is gorilla-like appearance due to oversecretion of STH from childhood.

R : Acromicria is with smaller hands, feet and face due to less secretion of somatostatin.

Q.63 **A :** FSH is a gonadotrophic and gametokinetic hormone.

R : FSH controls gametogenesis in both testes and ovaries.

ANSWER KEY

Exercise – 4

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	3	3	3	2	1	1	3	3	3	4	4	4	1	1	3	1	3	4	1	4
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	4	1	3	4	1	5	4	3	5	4	5	2	4	1	5	4	2	4	5	4
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	2	3	4	1	3	1	3	4	3	3	1	3	3	4	1	4	1	1	4	1
Ques.	**61**	**62**	**63**																	
Ans.	1	4	1																	

Bansal Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

NERVOUS SYSTEM

- System which regulate the various activities of the body through nerve. impulses is called the **nervous system**. Through this system the messages are transmitted at a faster rate.
- The nervous – system controls and also co-ordinates the various activities of the organs of the animals.
- Whole nervous – system of human being is derived from embryonic **Ectoderm**.

NERVOUS SYSTEM

CNS

(1) BRAIN

FORE BRAIN/PROSENCEPHALON

Olfactory/Rhinencephalon
(Smelling)

Cerebrum/Telencephalon
Intellegence/Memory, Language

Diencephalon/Thalamencephalon
(Receives all sensory impulses)

MID BRAIN/MESENCEPHALON

Optic Lobes
(Vision)

Crura Cerepri
(Coordination between For & Mid Brain)

HIND BRAIN/RHOMBENCEPHANON

Cerebellum/Metencephalon
(Posture, Equilibrium, Voluntary Muscles)

Pons Varolii
(Connects lateral cerebellar hemisphere)

Medulla Oblongata
Mylenecephalon
(Metabolism, Involuntary activities)

(2)SPINAL CORD
Arise from foraman of magnum
Length – 25 cm
Weight – 5 gm
Covered with 3 meninges
Durameter (Outermost)
Arachnoid (Middle)
Piamater (Inner)

PNS

(1) CRANIAL NERVES (12 PAIRS)

I →Olfactory (S)
(O-Olfactory lobe, F-smelling)

II Optic →(S)
(O-Optic lobe-F-vision)

III →Occulomotor (M)
(O–Crura Cerebri, F-Eyeball movement)

IV → Trochlear (M)
O-between optic & cerebellum
F-Eyeball movement)

V → Trigeminal
(O-Ponsvarolii, F-skin & Zaw)

VI → Abduence (M)
(O – Medulla, F – Eyeball)

VII →Facial (X)
(O – Medulla, F-facial expression, Tast e)

VIII → Auditory (S)
(O – Medulla, F-Hearing)

IX → Gloss opharyngeal (X)
(O – Medulla, F-Pharynx, Tongue)

X →Vagus (X)
(O – Medulla, F-Heart, Stomach, Lungs)

XI → Spinal accessory (M)
(O – Medulla,F-Neck, Larynx)

XII → Hypoglossal (M)
(O – Medulla, F-Tongu movement)

(2)SPINAL NERVES (37 pairs)

Cervical	**(1 – 8)**	— 8
Thorasic	**(9 – 20)**	— 12
Lumber	**(21 – 27)**	— 7
Secral	**(28 – 31)**	— 4
Caudal	**(32 – 37)**	— 6

O–Origin, F – Function

ANS

(1) SYMPATHETIC

→ **Preganglionic Sympathetic Nerve fibres**
→ **Sympathetic trunk**
→ **Post Ganglionic Symperthetic Nerve fibres**
→ **Prevertebral ganglia**
- → Coeliac
- → Anterior Mesentric
- → Posterior Mesentric

(2) PARASYMPATHETIC

→ **CRANIAL OUTFLOW**
III →Eye
VII → Tear Gland
IX →Salivary Glag
X →Heart, Lungs & other visoral organs

→ **SACRAL OUT FLOW**
II, III, IV → → Rectum, Urinary Bladder & Gonads

CENTRAL NERVOUS SYSTEM :

– It includes the brain and the spinal-cord. These are formed from the neural-tube which develops from the ectoderm after the gastrula stage of embryo.

Development of CNS :

It develops from neural tube in intrauterine life (I.U.L.). Anterior part of neural tube develops into brain while caudal part of neutral tube develops into spinal cord.

Approximately 70-80% part of brain develops by 2 year of age & complete development is achieved in 6 years of age & spinal cord develops completely in 4 to 5 years of age.

BRAIN / ENCEPHALON :

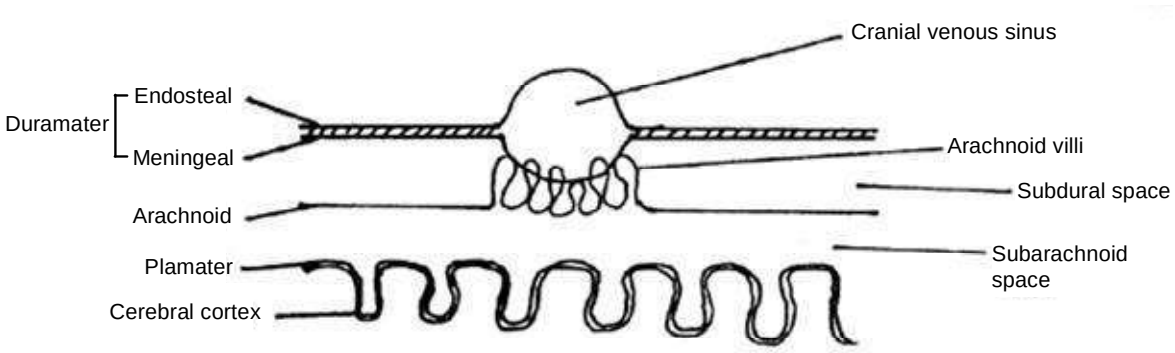
It is situated in cranial box which is made up of 1 frontal bone, 2 parietal bone, 2 temporal bone, 1 occipital bone. The weight of brain of an adult man is 1400 gm and of female is 1250 gm.

BRAIN

(A) Fore brain	(B) Mid brain	(C) Hind brain
(Prosencephalon)	(Mesencephalon)	(Rhombencephalon)
(1) Rhinencephalon (Infront)	(1) Optic lobe	
(2) Telencephalon or	(2) Crura - Cerebri	(1) Cerebellum
Cerebrum (middle)		(metencephalon)
(3) Diencephalon or		(2) Pons varolii
(Behind) Thalamencephalon		(3) Medulla - oblongata
		(Myelencephalon)

BRAIN MENINGES :

Brain is covered by three membrances of connective tissue termed as **meninges** or **menix**.



Meningeal layer

(1) Duramater :

This is the first and the outermost membrane which is thick, very strong and non-elastic. It is made up of collagen fibres. This membrane is attached with the innermost surface of the cranium.

– It is double layer – **outer Endosteal layer** which is closely attached with inner most surface of carnium & no space is found between skull & Duramater (No Epidural space).

Inner meningeal layer which is related with other meninges of brain.

Both are vascular.

Generally both layers are fused with each other, but at some places these are separated from one another & from a sinus called cranial **venous sinus**. These sinuses are filled with venous blood.

(2) Arachnoid :

It is middle, thin and delicate membrane, made up of connective tissue.

It is found only in mammals.

It is non vascular layer.

Infront of cranial venous sinus, it becomes folded, these folds called **Arachnoid villi.**

These villi reabsorb the cerebrospinal fluid (CSF) from sub arachnoid space & pour it into cranial venous sinuses.

(3) Piamater :

It is Innermost, thin and transparent membrane, made up of connective tissue.

Dense network of blood capillaries are found in it, so it is **highly vascular**.

It is firmly adhere to the brain.

Piamater & arachnoid layer at some places fuse together to form **leptomeninges**.

Piamater merges into sulci of brain & densely adhere to it.

At some places it directly merges in the brain and called **telachoroidea**.

Telachoroidea form the choroid plexus in the ventricles of brain.

Sub Dural Space :

Space between duramater & arachnoid. It is filled with serous fluid.

Sub Arachnoid Space :

Space between Arachanoid & Piamater is filled with C.S.F.

Cranial nerves also pass through this space.

Menigitis : any inflammation of menix is called as meningitis. It may be caused by viruses, bacteria or protozoa.

DIVISIONS OF HUMAN BRAIN : Human brain divided into three parts -

⇒ **Fore brain –** Cerebrum, Diencephalon.

⇒ **Mid brain –** Consist of many groups of nerve cells called "Nuclei".

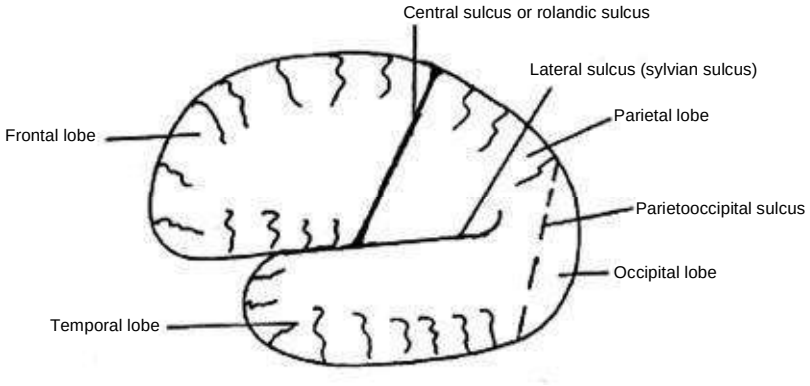
⇒ **Hind Brain –** Pons. Cerebellum, Medulla.

During embryonic stage, brain develops from three hollow vesicles -

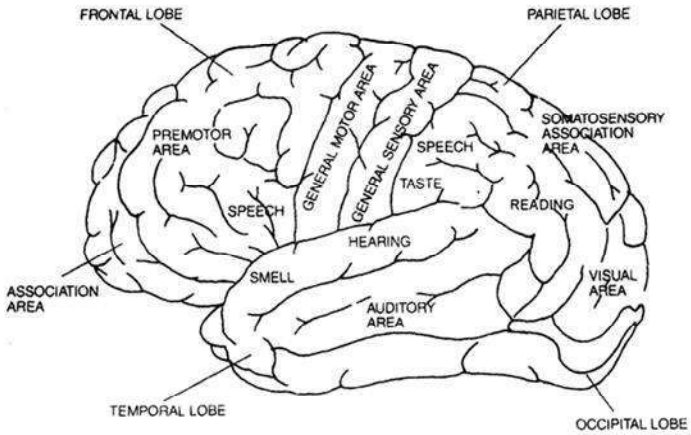
Forebrain develops from **prosencephalon.** → Telencephalon [Cerebrum], Diencephalon

Mid brain develops from **mesencephalon.**

Hind brain develops from **rhombencephalon** → Metencephalon (Pons, Cerebellum), Myelencephalon (Medulla oblongata (M.O.))



DORSAL SURFACE OF CEREBRAL HEMISPHERE



Human brain inside view showing location of certain functions

One pair of **olfactory lobes** are small spherical & solid in human brain.

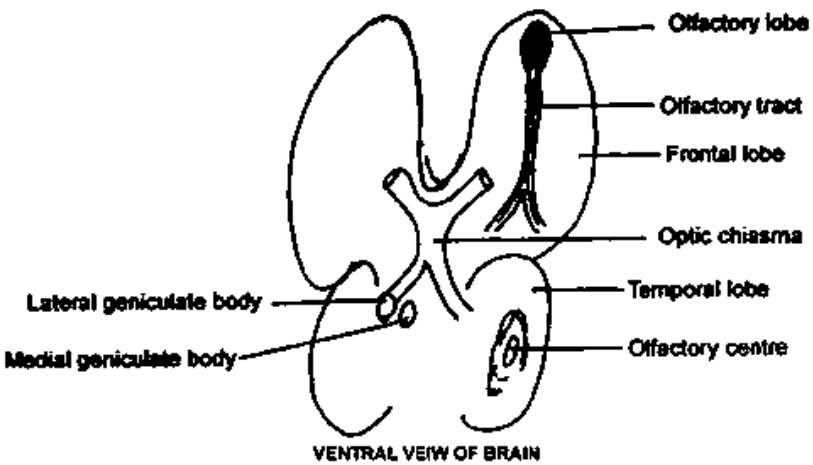
No ventricle is found in it.

Both olfactory lobe are separate with each other & are embedded into ventral surface of the both Frontal lobe of cerebral Hemisphere.

Olfactory centre is situated in temporal lobe.

Functions : It is supposed to be centre of smelling power.

Its size is small in mammals comparatively because most of its parts becomes a part of cerebrum some animals like sharks and dogs have well developd olfactory lobes.



VENTRAL VEIW OF BRAIN

CEREBRUM :

- It is first & most developed part of brain.
- It makes 2/3 part of total brain.
- Cerebrum consist of two cerebral hemispheres on the dorsal surface. A longitudinal groove is present between two cerebral hemispheres called as **median fissure.** Both the cerebral hemispheres partially connected with each other by curvede thick nerve fibres called **corpus callosum.**
- Each cerebral hemisphere is divided into 4 lobes – Anterior, middle, posterior and lateral.

  Anterior lobe is also called frontal lobe (largest lobe). Middle lobe is also called parietal lobe.

S.No.	Name of Area	Location	Relation or Analysis
1.	Prefrontal cortex	Frontal lobe	Seat of intelligence, knowledge, creative ideas, ability to abstract, memory. **(organ of mind).**
2.	Premotor area	Frontal lobe	– **Written centre** – Associated Movement of eye. head & body – Control complex movement of jaw, tongue, pharynx, larynx
3.	Motor area	Frontal lobe	Analysis of all type of voluntary muscle
4.	Frontal Eye field	Frontal lobe	Responsible for conjugate movement of eye. Opening & closing of eye lid
5.	Broca's Area In Rt handed person In Lt handed person	Frontal lobe present of Lt. side present of Rt. side (Motor speech area)	Analysis for speak if injury to this region inability to speak (**aphasia**) even though muscle concerned are no paralysed
6.	Auditory area	Temporal	Analysis for sound.
7.	Olfactory	Temporal or Hippocampal gyrus	Analysis for smell.
8.	Wernicke's area (Sensory area of speech)	Temporal	Analysis for **language** Sensory analysis for speech
9.	Gustatory area	Parietal	Analysis for Taste
10.	Somesthestic area	Parietal	Analysis for touch, pressure, pain, knowledge about position in space taking in information from environment etc.
11.	Angular gyrus	Parietal	Sansory analysis for writing
12.	Occipital area	Occipital	Analysis for vision

Central sulcus separates frontal lobe from parietal lobe. Lateral lobe or temporal lobe is separated from frontal lobe & parietal lobe by incomplete sulcus called **lateral sulcus.**

Posterior lobe is also called occipital lobe, it is separated from parietal lobe by a sulcus called **parieto occiptal sulcus.**

In right handed person, left hemisphere is dominant while in left handed person right hemisphere is dominant.

Many ridges & grooves are found on dorsal surface of cerebral hemisphere. Ridges are known as gyri while grooves are called **sulci**. These cover the 2/3 part of cerebrum.

⇒ Gyri & sulci are more developed in human being so human being are most intelligent living beings.

Intelligency quotienent (I.Q) = $\frac{\text{mental age}}{\text{chronological age}} \times 100$		
Idiot	–	0–24 %
imbecile	–	25–49 %
Moron	–	50–69 %
Borderline	–	70–79 %
Low normal	–	80–89 %
Normal	–	90–109 %
Superior	–	110–119 %
Very superior	–	120–139 %
Genius	–	140–More

Corpus callosum :

It is largest commissure of Brain.

Exclusive feature of mammals.

Curved thick band of white nerve fibre situated between two cerebral hemispehre in the median fissure.

Anterior truncated part of corpus callosum is called **Genu** while posterior truncated part is called **splenium.**

An oblique band is formed by body of corpus callosum & it goes towards Genu called **fornix.**

A small cavity is developed enclosed by callosum, Genu & fornix called as **V^{th} ventricle or pseudocoel.** This ventricle is covered by a thin membrane called as **septum lucidum.**

Functions : It is the most developed part in mammals.

It is the most important part of brain because it controls and regulates different parts of brain.

This is the centre of conscious senses, will power, voluntary movements, knowledge, memory, speech and thinking, reasoning etc.

Different sense organs send impulses here, and in this part of brain analysis and coordination of impulses is done then messages are transferred according to the reactions through voluntary muscles. **All the voluntary actions are controlled by cerebral hemispheres**.

Diencephalon :

It is small and posterior part of fore brain. It is covered by cerebrum. It consists of **Thalamus, hypothalamus, Epithalamus.**

(i) Thalamus : It forms upper lateral walls of Diencephalon.

It forms 80 % part of Diencephalon.

It acts as a **relay centre**.

It receives all sensory impulses from all part of body & these impulses are send to the cerebral cortex.

(ii) Hypothalamus : It forms lower lateral wall of Diencephalon.

A cross like structure is found on anterior surface of hypothalamus called as **optic chiasma**.

Pituitary body is attachd to middle part of hypothalamus by infundibulum.

(iii) Corpus mammillare or Corpus albicans or **mammilary body.**

It is found on the posterior part of hypothalamus.

It is a character of mammalian brain.

It integrates and controls the visceral activities.

The hypothalamus, through its connection with brain stem, maintains homeostasis and the body's internal equilibrium, specialising in involuntary behaviour control.

The nuclei in it signal the body to eat, drink, get angry, keep cool, and make love and so on.

Hyothalamus organises behaviour related to survival of species : fighting, feeding, fleeing and mating.

It keeps body temperature of roughtly 37ºC by means of a complex thermostat system.

It also influences respiration and heartbeat and sends out signals to correct them when they are wrong.

Through connections with the pituitary glans, the hypothalamus controls growth and sexual behaviour.

Epithalamus :

It forms the roof of diencephalon. Pineal body is found in epithalamus.

Functions : Its dorsal side is called **epithalamus** in which pineal bod is situated, that controls the sexual maturity of animal.

- **Thalamus :** Act as relay centre for sensory stimulation.

  In lower animal, Cerebral cortex is not developed then **Thalamus act** as **sensory centre**.

  It is related with RAS.

  It is also act as limbic part.

- **Functions of Hypothalamus :**

  (1) Thermoregulation

  (2) Behaviour and emotion

  (3) Endocrine control

  (4) Biological clock system

  (5) ANS control.

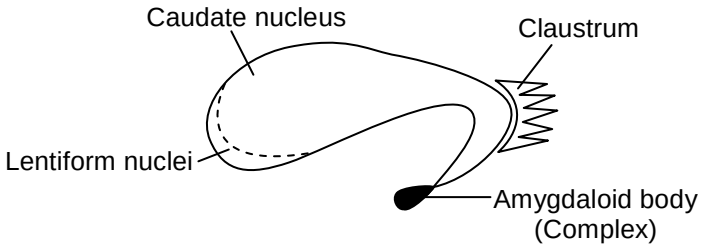
  These are found centres of animal feelings/Emotions like sleep, anger, intercourse, hate, love, affection, and temperature control emotional, pain, hunger, thirst and satisfaction in thehypothalamus.

- The regulatory hormones of hypothalamus control the acitivty of endocrine glands.
- Modern scientists suppose that **hypothalamus is the "master gland" not the pituitary**.
- Optic chiasma found in the hypothalamus carry optic impulses received from eyes to the cerebral hemispheres.
- Animal becomes blind if this part is destroyed by chance.

Basal Nuclei :

Situated in the wall of cerebral hemisphere.

Corpus striatum (Caudate nucleus + lentiform nucleus) + Amygdaloid body + claustrum.



BASAL NUCLEI

Function :

(1) It maintains muscle tone.

(2) It regulates automatic associated movement like swinging of arms during walking.

(3) In lower animals, when cerebral cortex is not developed basal nuclei acts as motor centre

Lesion in basal nuclei leads to a disease called as **parkinsonism** (Rigidity, Tremor at rest, mask like face).

Reticular activating system :

It is special sensory fibre which is situated in Brain stem & further go into Thalamus. It is related with **consiousness, alertness** & **awakening**. Therefore it is also called **gate keeper of consiousness.**

Limbic system : It is visible like a wish bone. tuning fork or liplike.

Limbic lobe (area of temporal Lobe)

+

Hippocampus + Hypothalamus including septum + Part of Thalamus + Amygdaloid complex.

Function of Limbic system :

(1) Behaviour, Emotion, rage and anger (Hypthalamus, amygdaloid body)

(2) Receni memory & short term memory converts into long term memory (Hipopocampal lobe)

(3) Food habit (Hypothalamus) (4) Sexual Behaviour (Hypothalamus) (5) Olfaction (Hippocampal lobe and Limbic lobe)

Mid brain :

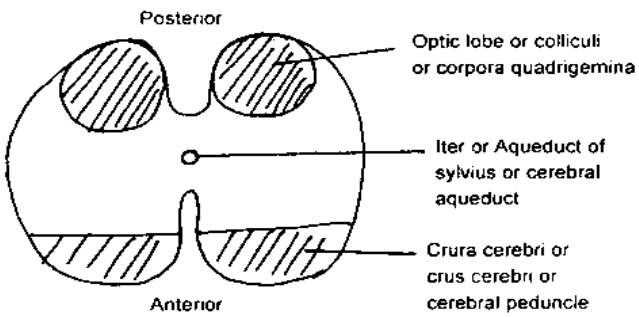
It is small & contracted part of brain.

Anterior par tof mid brain contains two longitudinal myelinated nerve fibres peduncles called **Cerebral peduncles** or **crus cerebri or crura cerebri**.

On the posterior part of mid brain are found four spherical projection called **colliculi** or **optic lobes**.

Four colliculi are collectively called as **corpora quadrigemina** (2 upper & 2 lower).

Only 2 colliculi or optic lobes are found in mid brain of frog called as **corpora bigemina**.



T. S. OF MID BRAIN

Functions :

- Four optic lobes or colliculus present, superior optic lobes are the main centres of **pupillary light reflexes**. Inferior optic lobes are related **accoustic (sound) reflex action**.
- Crura cerebri controls the muscles of limbs.

Hind Brain :

3 Parts – **(1)** Pons **(2)** Cerebellum **(3)** Medulla Oblongata (M.O.)

(1) Pons or Pons varolli :

It is small spherical projection, which is situated below the midbrain & upper side of the M.O.

It consists of many transverse & longitudinal nerve fibres.

Transverse nerve fibres connect with cerebellum.

Longitudinal fibres connect cerebrum to M.O.

Functions : It regulates the breathing reation through pneumotaxic centre.

(2) Cerebellum :

Made up of 5 lobe [2 lateral lobe, 1 vermis and 2 floccular lobes.

Both lateral lobes becomes enlarged & spherical in shape, so lateral lobe of cerebellum are also called as **cerebellar heimisphere**.

Due to this reason, regulation & Coordination of voluntary muscle is more developed as compared to other animals.

In **terminal part of vermis, one pair of floccular lobes are found.**

Three cerebellar peduncle are formed.

Superior cerebellar peduncle attach with mid brain.

Middle cerebellar peduncle attach with pons.

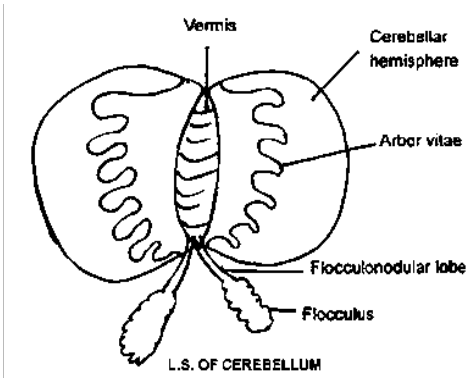
Inferior cerebellar peduncle attach with M.O.

Functions : Impulses are received from different voluntary muscles and joints and then controlling of the their movements and their regulation and coordination accordingly.

Maintains the body balance.

Persons which take alcohol in excess, their cerebellum gets affected, as a result of that they can not maintain their balance and their walking is disturbed.

Thus It is related with fine & skillful voluntary movement & also related with body balance. equillibrium, posture & tone.



L.S. OF CEREBELLUM

(3) Medulla Oblongata (M.O.) :

Posterior part of brain is conical in shape.

- In this respiratory, cardiovascular and vomiting centres are present
- Vagus nerve originates from here.
- Roof is thin, non-nervous and forms **posterior choroid plexus.**
- There are present three pores below plexus.
- One pair of posterior pere called foramen of lushka and a single median formen of megendie
- These poses join external and internal parts of brain.
- Most of the sensory and motor nerves cross at medulla, and therefore right cerebral hemisphere controls left half of body and left cerebral hemisphere controls body's right half.

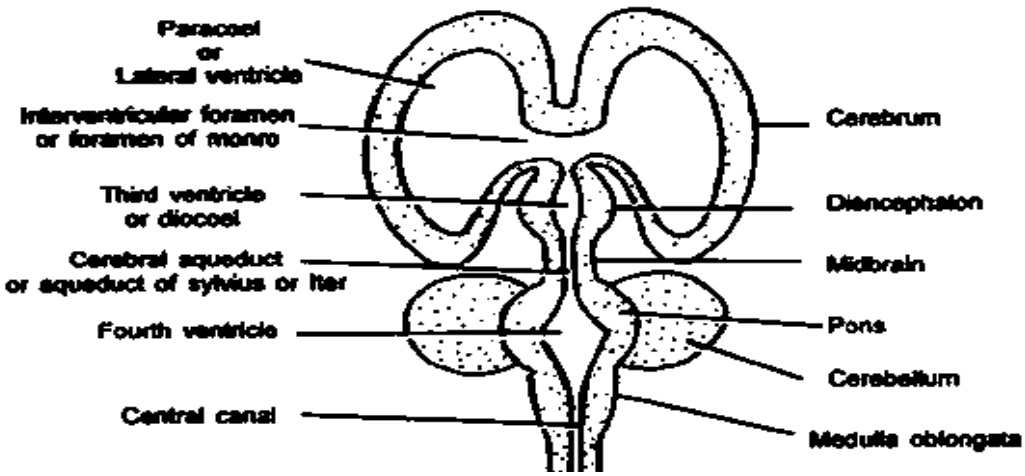
Functions : It is the most important part of brain which controls all the involuntary activities of the body e.g. heart beats, respiration, metabolism, secretory actions of different cells rate of engulfing food etc.

It acts as conduction path for all impulses between spinal cord and remaining portions of brain.

- It is also concerned with **Reflex**-Sneezing reflex, salivation reflex, coughing reflex, swallowing reflex, vomiting reflex, yawning reflex.

Mid brain, pons &medulla are situated in one axis and called as Brain stem.

Internal Structure of Brain

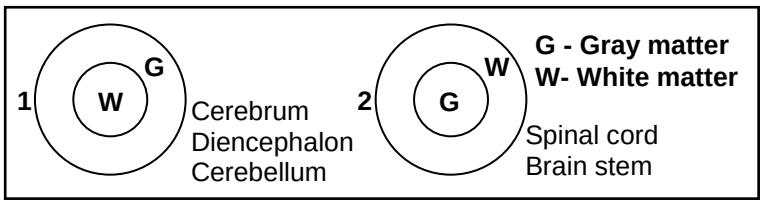


L.S. OF BRAIN

- **Except Midbrain, Cerebellum, Pons & olfactory lobe** complete brain is internally hollow. Its cavity is lined by **ependymal epithelium**. (Ciliated Columnar Epithelium)
- Cavities of brain are known as ventricles, filled with cerebrospinal fluid (C.S.F.).
- **In Rabbit, Cavity of olfactory lobe is hollow called as 1st ventricle or Rhinocoel. Both Rhinocoel continue in cavity of cerbral hemisphere, know as 2nd ventricle or paracoel or latealventricle.**
- On the posterior side, both paracoel combine with each other & open into cavity of Diencephalon through an aperture known as **Foramen of Monro**.

- Cavity of diencephalon is known as 3rd ventricle or Diocoel.
- A tent shape space or cavity present between anterior pons, medulla & posterior cerebellum called IVth ventricle.
- 3rd and 4th ventricle are connected with each other through a hollow tube **known as Iter or Aqueduct of sylvius**. IVth ventricle continues in the metacoel and metacoel continues in the cavity of spinal cord called **neurocoel or central canal**.
- One aperture is found on dorsal surface of metacoel known as **foramen of Magendie**. Two apertures are found on lateral sides of metacoel know as **Formen of Luschka [1–1]**.

HISTOLOGY OF BRAIN :



- On dorsal surface of cerebral hemisphere, gray matter becomes more thick, this thick layer of gray matter is known as **Cerebral cortex/Neopallium/Pallium**.
- Outer part of cerebellum is made up of gray matter while inner part is white matter.
- White matter projects outside & forms a branched tree like structure known as **Arbor Vitae**.

Choroid plexus : Tela choroidea (Part of Piamater)

+

Blood capillaries + Ependymal Epithelium

Site : Two major plexuses in Lateral ventricles.

2 minor plexuses in IIIrd ventricle

1 minor plexus in IVth ventricle

Function : Formation of CSF by secretion of plasma

Sometime (Congenitally or infection) Iter or aqueduct become blocked therefore improper circulation of CSF or blockage of CSF circulation occur and Intracranial pressure increases, head becomes enlarged, this condition called **Hydrocephalus**.

Cerebrospinal-fluid (CSF) :

This fluid is clear and alkaline in nature just like lymph.

It has protein (Albumin, globluin), glucose, cholesterol, urea, bicarbonates, sulphates and chlorides of Na, K. **Protein & cholesterol concentration is lesser than plasma & Cl^- conc. is higher than plasma.**

- In a healthy man, in 24 hrs, 500 ml of C.S.F. is formed & absorbed by arachnoid villi. At a time total volume of C.S.F. is 150 ml.
- CSF is present in ventricle of brain, subarachnoid space of brain & spinal cord.

Formation : Mainly in choroid plexus of lateral ventricles, minor quantity is formed in IIIrd ventricle & IVth ventricle.

Collection of CSF for any investigation is done by lumbar puncture (L.P.). It is done at **L_3–L_4 region.**

Spinal anaesthesia is also given by L.P.

Functions of C.S.F. :

- Protection of Brain : It act as shock absorbing medium and work as cushion.
- It provides buoyancy to the brain, so net weight of the brain is reduced from about 1.4 kg to about 0.18 kg.
- Excretion of waste products.
- Endocrine medium for the brain to transport hormones to different areas of the brain.

Circulation : From the ventricles CSF comes into subarachnoid space through **foramen of Magendie & foramen of Luschka.**

In subarachnoid space, CSF is absorbed by arachnoid villi which pour it into cranial venous sinus. From venous sinus CSF enters in blood circulation.

C.S.F. Circulation

Choroid plexus ⟶ Lateral ventricle ⟶ Foramen of Monro ↓ Diocoel ↓ Iter ↓ IV^{th} ventricle ↓ Metacoel ↓ Foramen of Magendie and Foramen of Luschka ⟵ Arachnoid space ⟵ Arachnoid villi ⟵ Cranial venous sinus ⟵ Blood circulation

SPINAL CORD :

- Medulla oblongata comes out from foramen of magnum & continues in neural canal of vertebral column, the continued part of MO is known as Spinal cord.

  It extends from base of skull to lower vertebra of lumbar. (L_1)

- Its upper part is wide while lower most part is narrow known as **conus-medullaris**.

  Conus medullaris present **upto L_1 vertebra**.

  Terminal part of conus medullaris extend in the form of thread like structure made up of fibrous connective tissue caled **filum terminale**.

- Filum terminale is **non-nervous part**

  Metacoel also continues in spinal cord where it is known as **neurocoel or central canal**.

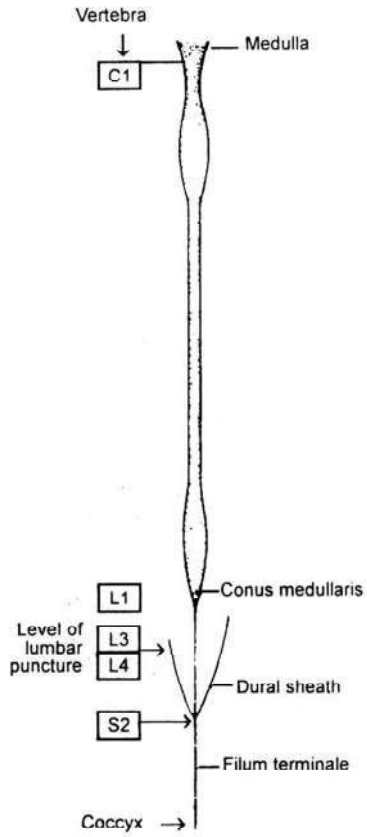
- Spinal cord is also covered by Duramater, Arachnoid & piamater.

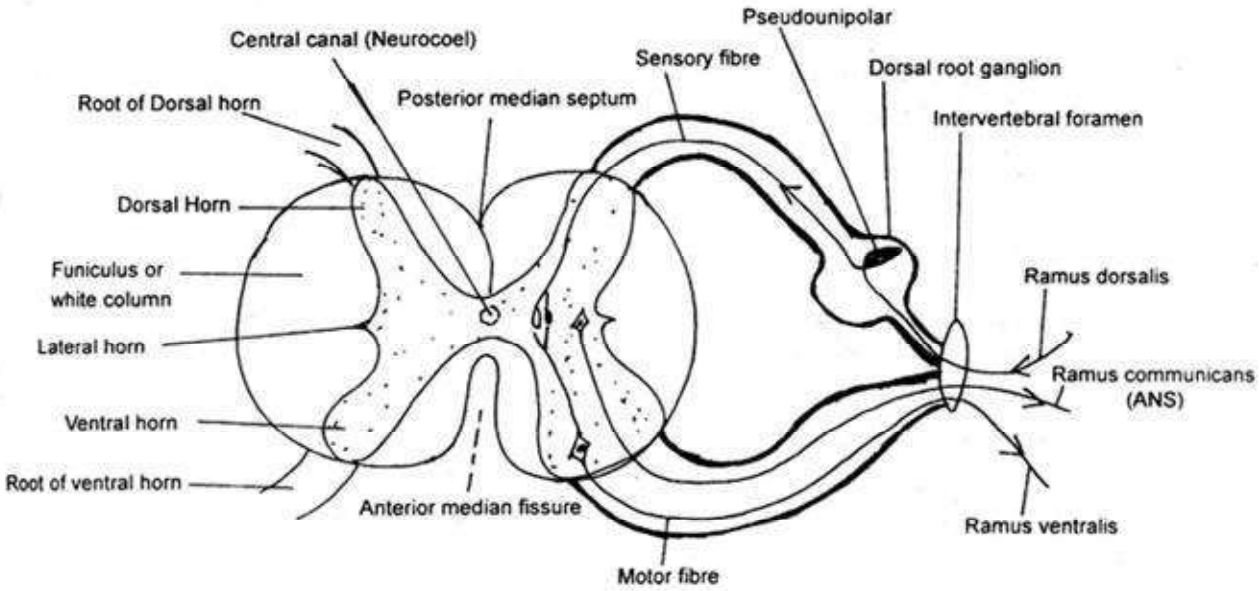
A narrow space is found between vertebra & duramater known as **Epidural space**.

Length of spinal cord is **45 cm**.

Length of filum terminale is **20 cm**.

Weight of spinal cord is approximately **35 gm**.





Transverse section of spinal cord

- The outer-part of spinal cord is of white matter while inner-part contain gray matter.
- On the dorso-lateral & ventro-lateral surface of spnal cord, the gray matter projects outside & forms the one pair dorsal & ventral horn.
- Due to formation of dorsal & ventral horn white matter is divided in 4 segments & segment is known as **Funiculus of white column**.
- Dorsal & ventral horn continue in a tube like (bundle of never fibres) structure known as **root of Dorsal & Ventral Horn**. In root of dorsal horn, ganglia is present called **Dorsal root ganglia**.
- Both roots are combined with each other at the place of **intervertebral foramen**.
- Sensory neurons are found in the dorsal root ganglia which is **pseudounipolar** in nature.
- Motor neurons are found in the ventral roots. Cyton is found in ventral horn while its dendrons are embedded into gray matter of spinal cord where they make synapse with axon of sensory neuron.
- Axon of motor neuron extends upto interverbral foramen.
- Both sensory & motor nerve fibers combindly come out from intervertebral foramen & form spinal nerve.
- In some part of spinal cord on both side.
- Lateral horns are also found & lateral horn cell, are found in these horn, there nerve fibre come through ventral root & futher come into intervertebral foramen. These fibre called **Ramus communicans**.
- The group of spinal nerve at the terminal end (L_1) of spnial cord form tail like structure called cauda equina (horse tail).
- **Ramus communicans foms ANS.**
- **Spnial nerve & its branches are mixed type except Ramus communicans.**

FUNCTIONS OF SPINAL CORD :

(1) It acts as bridge between brain & organs of the body.

(2) It also provides relay path for the impulses coming from brain.

(3) Spinal cord regulates and conducts the reflex action.

PERIPHERAL NERVOUS SYSTEM :

- All the nerves arising from brain and spinal cord are included in peripheral nervous system.
- Nerves arising from brain are called **cranial nerves**, and nerves coming out of spinal cord are called **spnial nerves**.
- 12-paris of cranial nerves are found in reptlies, birds and mammals but amphibians and fishes have only **10 – pairs** of cranial nerves.
- In human, I, II and VIII cranial nerves out of 12-paris of total cranial nervges are pure sensory in nature.
- III, IV, VI, XI and XII cranial nerves are motor nerves and V, VII, IX & X cranial nerves mixed type of nerves.
- Fibres of autonomous nervous system are found in III, VII, IX & X cranial nerves.
- Longest cranial nerve is Vagus nerve.
- Largest cranial nerve is Trigeminal nerve.
- Smallest cranial nerve is Abducens cranial nerve.

Table : Summary of the Human Cranial Nerves

No.	Name	Origin	Distribution	Nature	Function
I.	Olfactory	Olfactory Epithelum	Enters Olfactory lobe, Extends to temporal lobe	Sensory	Small
II.	Optic	Retina	Leads to occipital lobe	Sensory	Sight
III.	Oculomotor	Midbrain	Four eye muscles	Motor	Movement of eyeball
IV.	Trochlear (Pathetic)	Midbrain	Superior oblique eye muscle	Motor	Movement of eyeball
V.	Trigeminal (Dentist nerve) (i) Opthalmic (ii) Maxillary (iii) Mandibular	Pons – – –	– Skin of nose, upper eyelids, forehead, scalp, conjunctiva, larchymal gland. Mucous membrane of cheeks and upper lip and lower eyelid. Lower jaw, lower lip, pinna	Mixed Sensory Senory Mixed	 Sensory supply to concerning part – Muscle of Mastication
VI.	Facial	Pons	Face, neck, taste buds, salivary gland	Mixed	Taste (ant' 2/3 part of Tongue) Facial expression saliva secretion.
VIII.	Auditory (i) Cochlear (ii) Vestibular	Pons	Internal ear	Sensory	Hearing and equilibrium.
IX.	Glossopharyngeal	Medulla	Muscles and mucous Membrane o pharynx and tongue.	Mixed	Taste (post^{r} 1/3 part of Tongue) Facial expression saliva secretion.
X.	Vagus (Pneumogastric)	Medulla	Larynx, lungs, heart, stomach, intestine	Mixed	Visceral Sensations and movements.
XI.	Accessory spnial	Medulla	Muscles of pharynx, larynx	Motor	Movement of pharynx, larynx.
XII.	Hypoglossal	Meduula	uscles of tongue	Motor	Movement of tongue

SPINAL NERVES :

- In rabbit, there are 37 pairs of spinal nerves, while in frog there are 9 or 10 pairs of spinal-nerves.
- In Human only 31 pairs of spinal-nerves are found.

– Each spinal nerve is mixed type and arises from the roots of the horns of gray matter of the spinalcord. In dorsal root only afferent or sensory fibres and in ventral root efferent or motor fibres are found.

– Both the roots after moving for distance in the spinalcord of vertebrates combine with each other and come out from the inter verterbal foramen in the form of spinal nerves.

– As soon as the spinal nerves come out of the inter vertebral foramen they divide into 3 branches :

(i) Ramus - dorsalis ←
Somatic nerve
(ii) Ramus - ventralis ←

(iii) Ramus Communicans ➡ **A.N.S.** → Sympathetic nervous system
→ Parasympathetic nervous system

There are 37 pairs of spinal nerves in rabbit. These are divided into 5 groups according to place –

Rabbit

1.	Cervical spinal nerves	–	8 pairs	1	to	–VIII
2.	Thoracic spinal nerves	–	12 pairs	IX	to	–XX
3.	Lumbar spinal nerves [In human → 21 to 25 (5 pair)]	–	7 pairs	XXI	to	–XXVII
4.	Sacral spinal nerves [In human → 26 to 30 [5 pair]]	–	4 pairs	XXVIII	to	–XXXI
5.	Caudal spinal nerves (In human-1 pair coccygeal nerve)	–	6 pairs	XXXII	to	–XXXVII

– Caudal spinal nerves are absent because human is a tailless animal and only 1 pair coccygeal nerve are present.

REFLEX ACTION :

– "Marshal Hall" first observed the reflex actions.

– Reflex actions are spontaneous, automatic, involuntay, mechanical responses produced by specific stimulating receptors.

– Reflex actions are **involuntary actions**. Reflex actions are completed very quickly as comapred to normal actions. **No adverse effect**.

– It is form of animal behaviour in which the stimulation of sensory organ (receptor) result in the activity of some organ without the intervention of will.

Reflex actions are of 2 types :

(A) Cranial reflex :

These actions are completed by brain. No urgency is required for these actions. These are slow actions e.g. watering of mouth to see good food.

(B) Spinal reflex :

These actions are completed by spinal cord. Urgency is required for these actions. These are very fast actions e.g. Displacement of the leg at the time ofpinching by any needle.

Classification of reflex actions on the basis of previous experiences :

(A) Conditioned reflex :

Previous experience is required to complete these actions e.g. swimming, cycling, dancing, singing etc. These actions were actions were studied first by **Evan Pavlov** on dog.

Initially these actions are voluntary at the time learning and after perfection, these becomes involuntary.

(B) Unconditioned reflex :

These actions do not require previous experience e.g. sneezing, coughing, yawning, sexual behaviour for opposite sex partner, migration in birds etc.

REFLEX ARCH :

- The path of completion of reflex actin is called **reflex arch**.
- Sensory fibres carry sensory impulses in the gray matter.

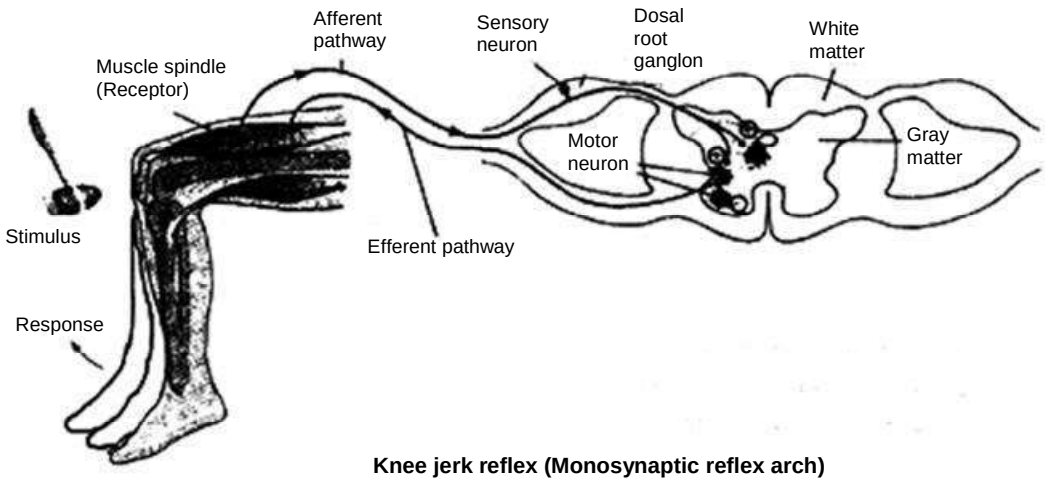
These sensory impulses are converted now into motor impulses and reach up to muscles.

These muscles show reflex actions for motor impulses obtained from motor neurons.

Reflex arch is of two types.

(1) Monosynaptic :

In this type of reflex arch, there occurs direct synapse (relation) between sensory and motor neurons, thus nerve impuse travels through only one synapse. eg.- Stretch reflex.



Knee jerk reflex (Monosynaptic reflex arch)

(2) Polysynaptic :

In this type of reflex arch, there are found one or more small neurons in between the sensory and motor neurons.

These small neurons are called connector neuroun or inter neurons or internuncial neurons e.g. **withdrawal reflex**.

Nerve impulse wil have to travel through more than one synapses in this reflex arch.

With drawal Reflex – Sensory neuron supplied the sensation through dorsal root ganglia & terminal branches of Axon divide in the gray matter & one is supplied agonist muscle & other is supplied antagonist muscle.

EPSP develop in synapse between motor fibre of agonist mucle sensory fibre & due to interconnection of interneuron with antagonist muscle neuron,

IPSP develop in synapse between colateral branch of sensory fibre and antagonist muscle.

Therefore, contraction of agonist muscle and relax the fibre of antagonist muscle.

	Knee jerk reflex	**Withdrawl reflex**
1.	No any involvement of interneuron.	Role of interneuron is important.
2.	It is an example of monosynaptic reflex.	It is an example of polysynaptic reflex.

AUTONOMIC NERVOUS SYSTEM

(1) The autonomic nervous system is that part of the peripheral nevous system which controls acivities inside the body that are normally involuntary, such as heart beat, peristalsis, sweating etc.

(2) It consists of motor neuron passing to the smooth muscle of internal organs.
Smooth muscles are involuntary muscles.
Most of the activties of the autonomic nervous system is controlled within the spinal cord or brain by rreflexes known as visceral reflexes and does not involve the conscious control of higher centres of the brain.

- Overall control of the autonomic nervous system is maintained, however, by centres in the medulla (a part of the hind brain) and hypothalamus.
- These receive and integrate sensory information and coordinate this with information from other parts of the nervous system to produce the appropriate response.
- ANS plays an important role in maintaining the constant internal evironment (homeostasis).
- The autonomic nervous system is composed of two type of neurons, a **preganglionic neuron** (myelinated) which leaves the central nervous systm in the venteral root before synapsing several postganglionic neurons (nonmyelinated) leading to effector (concerning organs).
- **Sites of ANS –**

Involuntary muscles, Exocrine glands, Blood vessels, skin (Pilomotor muscles, Blood vessels, Sweat glands)

There are the two division of the autonomic nervous system the **sympathetic** (SNS) and the **parasympathetic** (PNS).

(i) Sympathetic system is related with such visceral reactons. Which increase the protection of body in adverse atmospheric condictions along with calorie consumption.

(ii) Parasympathetic system is relsated with those reactions in which energy is conserved.

In this way, autonomic nervous system controls the activites of visceral organs double sided i.e. antagonistic to each other.

(a) Sympathetic Nervous system. It is represented by a chain of 21 sympathetic ganglia on either side of spinal cord.

It receives preganglionic sympathetic fibres from the spinal cord which make their exit alongwith thoracic and lumbar nerves and constitue thoraco-lumbar outflow.

These fibres synapse with the neurons present in sympathetic ganglia.

From the sympathetic gangila arise post ganglionic fibres which terminate on the viscera.

Each sympathetic ganglion is connected to the spinal cord by a white communicans and the spinal nerve by a gray communicans.

Some preganglionic fibres pass through the sympathetic chain without synapsing and then join to from splanchnic nerves eminating in some **collateral ganglia** which include a coeliac ganglion, an anterior mesenteric ganglion and a posterior mesenteric ganglion.

The post ganglionic fibres arising from collateral ganglia supply digestive system and urinogential system.

(b) Parasympathetic Nervous system. It consists of preganglionic parasympathetic fibres, parasympathetic ganglia and distganglionic parasympathetic fibres.

Preganglionic parasympathetic fibres make their exit along with the III, VII, IX and X cranial nerves, and II, III, IV scaral nerves.

They together form cranio-sacral outflow.

The parasympathetic ganglia do not form any chains and instead lie on or near the viscera.

The post ganglionic parasympathetic fibres aires from these ganglia and supply the viscera.

The neurotransmitter within the ganglion is **acetylcholine** for both sympathetic and parasympathetic nerves.

However, the neurotransmitter between the terminal autonomic neuronic axon and the target organ is different in the two antagonistic autonomic nervous system.

In the parasympathetic system, the neurotransmitter at the terminal synapse is **acetylchloine**, just as it is in the ganglion.

In the sympathetic system, the neurotransmitter at the terminal synapse is either adrenaline or noradrenaline, both of which have an effect oppsoite to that of acetylcholine.

There is one exception : the sympathetic postanglionic neuron that terminates on the sweat glands, uses **acetylcholine.**

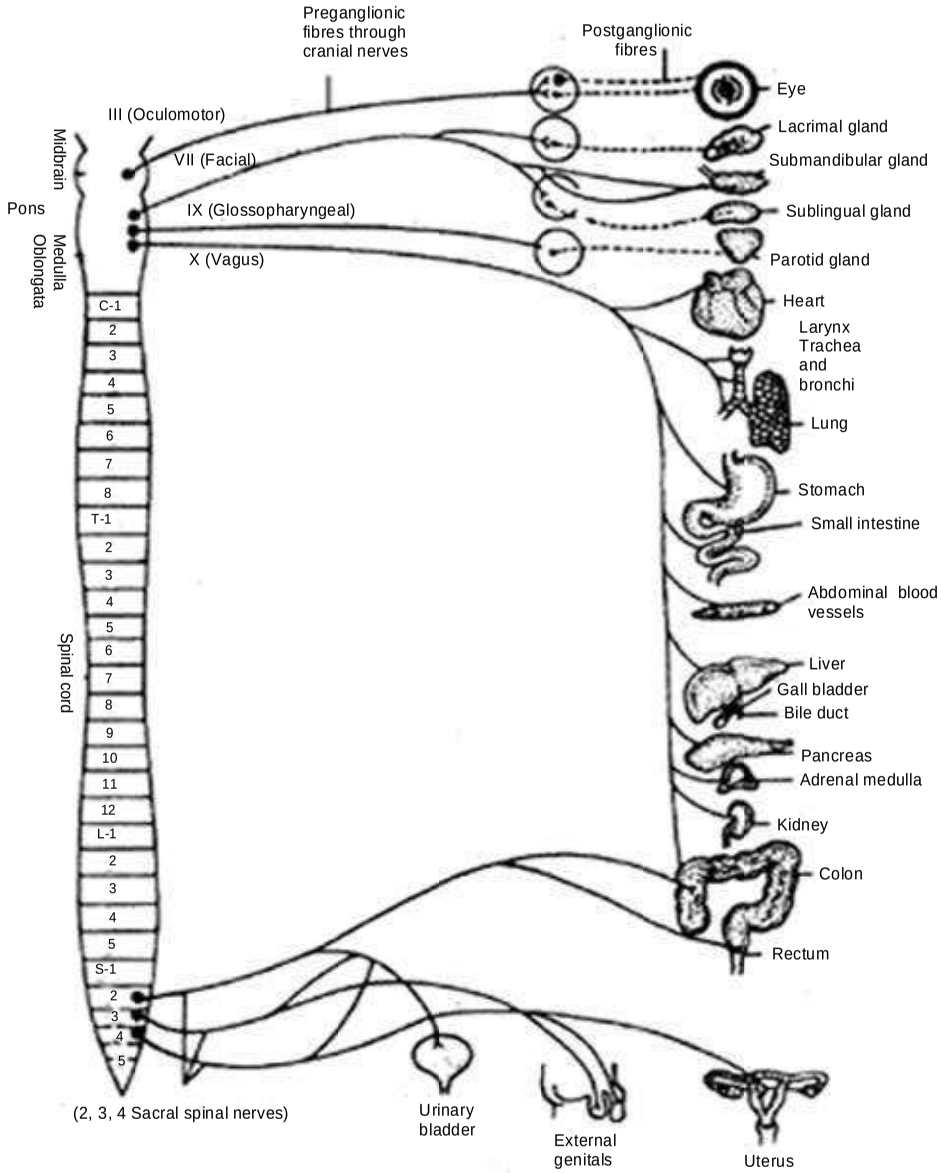
Thus, depnding on which of the two paths is selected by the CNS, an arriving signal will either stimulate or inhibit the organ.

Thus an organ receiving nerves from both nervous system is subjected to the effects of two opposing neurotransmitters.

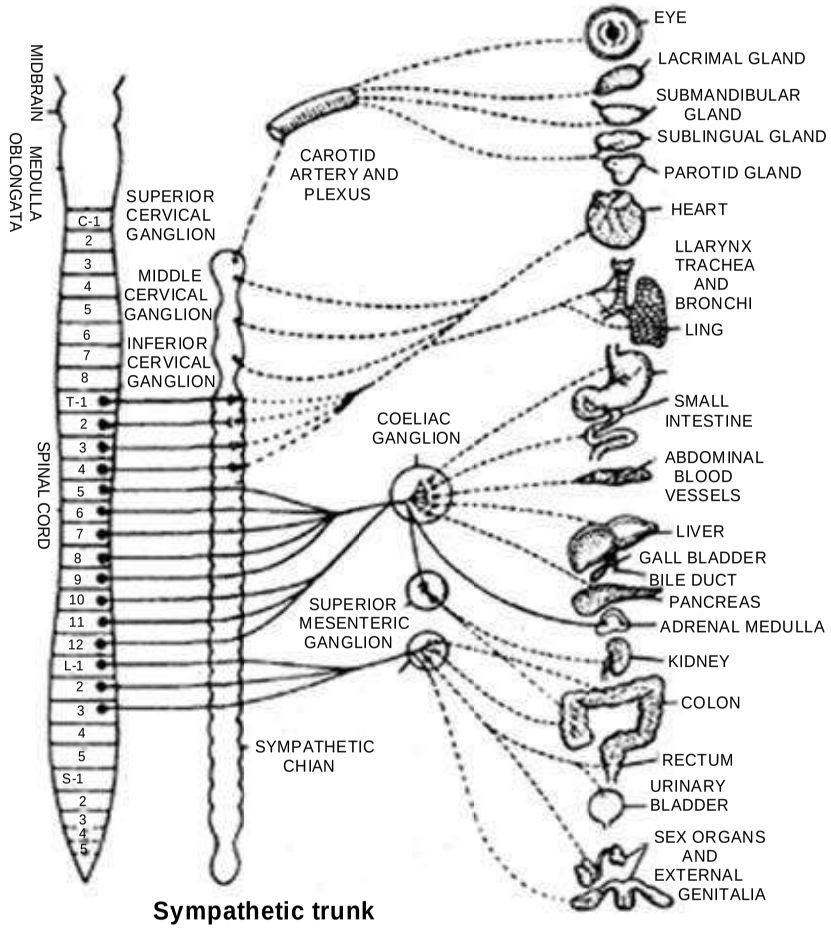
If the sympathetic nerve ending excites a particular organ, the parasympathetic usualy inhibits it.

With few exception, organs of the body are innervated by "dual innervations", and each has a different effect.

Functon of autonomic nervous system is to control and coordinate the activities of visceral organs. The two components work against one another.



Parasympathetic Nervous System



Sympathetic trunk

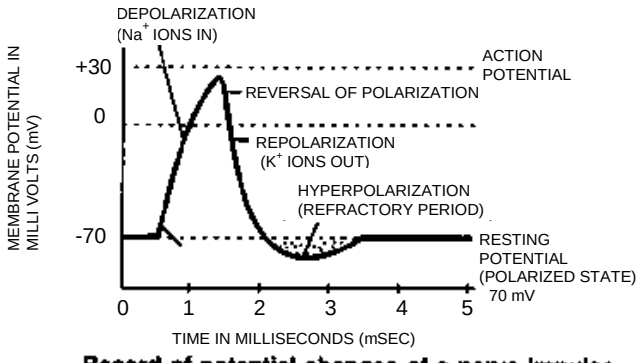
Sympathetic Nervous System

	Sympathetic NS		Parasympathetic NS
1.	Thoracico lumbar outflow (T_1 to L_3) (Ramus communicans of T_1 to L_3)	1.	Cranio sacral outflow (cranial nerves) 3, 7, 9, 10 and sacral's ramus communication 2, 3, 4)
2.	Just lateral to vertebral column sympathetic trunks are there on both sides (each made up of 22 ganglia)	2.	Ganglia are situated separately either near the organ or surface of organ.
3.	Preganglionic nerve fibres (Ramus communicans of spinal nerves) are smaller than post ganglionic nerve fibres (arises from sympathetic trunk or ganglia to organs)	3.	Preganglionic nerve fibres are longer than postganglionic nerve fibres.
4.	Preganglionic nerve fibres ar cholinergic (filled with acetylcholine). and post ganglionic nerve fibres are adrenergic (filled with noradrenaline) except sweat gland which have cholinergic postganglionic nerve fibres.	4.	Both pre and post ganglionic nerve fiber are cholinergic.
5.	Supply (a) **Cervical ganglia** → Head, face (b) **Cervical and thoracic ganglia** → Heart (c) Throacic ganglia → Trachea, bronchi and lungs (d) Preganglionic nerve fibres of abdominal part do not form synapse in sympathetic trunk. They form synapse in prevertebral ganglia (coeliac, superior mesenteric and inferior mesenteric). **Coeliac and superior mesenteric supply** – stomach to proximal colon **Inferior mesenteric asupply** → distal colon, urinogenital organ, rectum and anal canal. **Exception** adrenal medulla receive preganglionic nerve directly. (No any postanglionic fibres)	5.	Supply (a) Cranial nerve iii – iris. ciliary muscles vii – Tear glands, palate, pharynx, submandibular and sublingual glands. ix – Parotid gland, buccal cavity x – Neck to proximal colon. (b) Sacral 2, 3, 4 distal colon, rectum, anal canal and urinogenital organ.
6.	Preganglionic nerve fibres are made up of white ramus communicans and postaganglionic nerve fibres are made up of gray ramus communicans.		

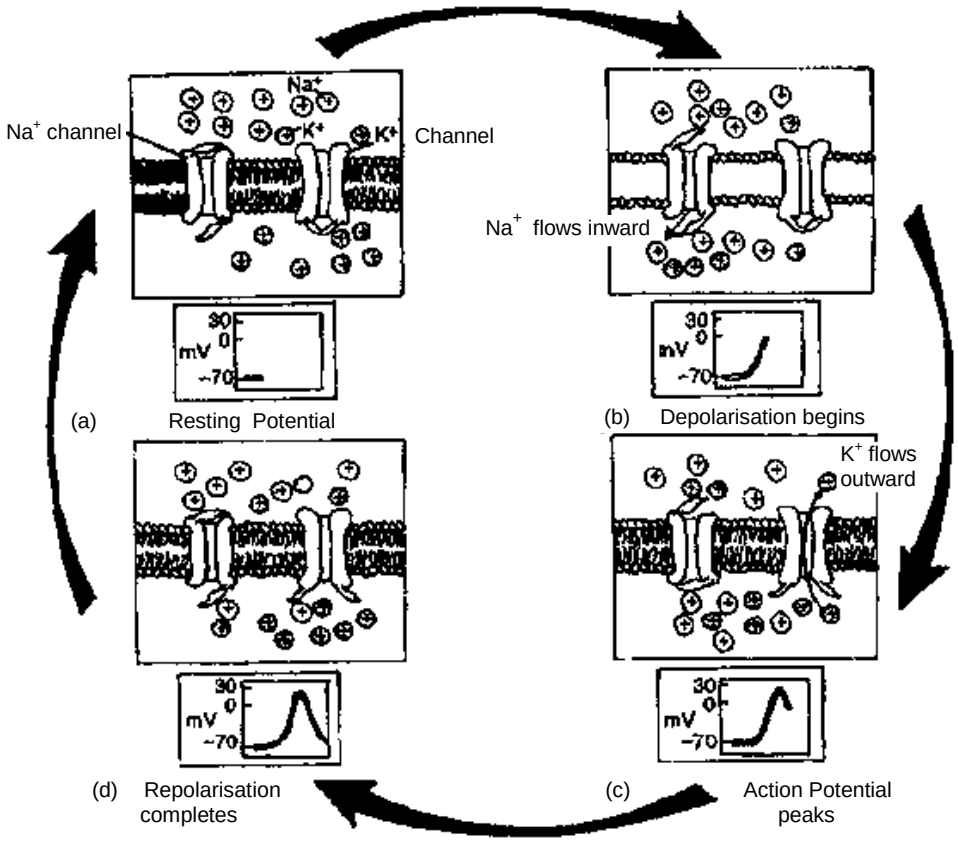
Table of Nervous Control of Visceral Organs

Name of Visceral Organs		Affect of sympathetic nervous system	Affect of parasympathetic nervous system
1.	Secreton	Acetyl chloine + sympathetin	Only acetylcholine
2.	Iris of eye	Dilates pupils	Constricts pupils
3.	Tear glands or lachymal glands	Stimulates secretion of lachrymal glands	Inhibits secretion of lachrymal glands.
4.	Heart	Increases the rate of cardiac contraction i.e. accelrates heart beat	Inhabits the rate of cardiac contrction i.e. retards heart beat.
5.	Secretion of adrenal gland	Stimulates adrenal secretion	Inhibits adrenal secretion.
6.	Salivary secretion	Inhibits the secretion of salivary and digestive glands	Stimulates the secretion of salivary and digestive glands
7.	Blood vessels	Constricts cutaneous blood vessels, which causes increased blood pressure but dilates blood vessels of brain lungs, heart, striated muscles. Incrases RBC count in blood.	Dialte all blood vessels (except coronary vessels) decreasing blood pressure
8.	Lungs, trachea and bronchi	Dilates trachea bronchi & lungs for easy breathing	Constricts these organs during normal breathing.
9.	Alimentary canal	Inhibits peristalsis of alimentary canal.	Stimulates the secretion of the glands
10.	Digestive glands	Inhibits the secretion of these glands	Stimulates the secretion of the glands
11.	Sweat glands	Stimulates secretion of sweat	Inhibits secretion of sweat.
12.	Arrector pilli muscles	Stimulates contraction of these muscles of skin, causing goose flesh	Relaxes Arrector pilli muclses
13.	Urinary bladder	Relaxes the muscles of urnary bladder.	Contracts the muscles for ejaculation of urine Micturition).
14.	Anal sphincter	Closes anus by contracting and sphincters.	Relaxes anal sphincter and opens the anuns (Defaecation)
15.	External genitalia	Ejaculation	Erection
16.	Basal metabolic rate	Accelrates BMR	Retards BMR.

NERVE IMPULSE INDUCTION :



Record of potential changes of a nerve impulse



Stages in axon membrane potential during resting, depolarisation, action potential and repolarisation

The resting membrane potential in resting phase :

⇒ The potential difference (a charge) which exists across the cell surface membrane of nerve cells is always, negative inside the cell with respect to the outside. The membrane is said to be **polarised**.

⇒ The potential difference across the membrane at rest is called the **resting membrane potential** and this is about – 70mV (the negative sign indicates that inside the cell is negative with respect to the outside). (Range → – 60 to – 85 mV)

⇒ The resting potential is maintained by active transport and passive diffusion of ions.

⇒ Resting membrane potential is maintained by the active transport of ions against their electrochemical gradient by **sodium potassium pump**.

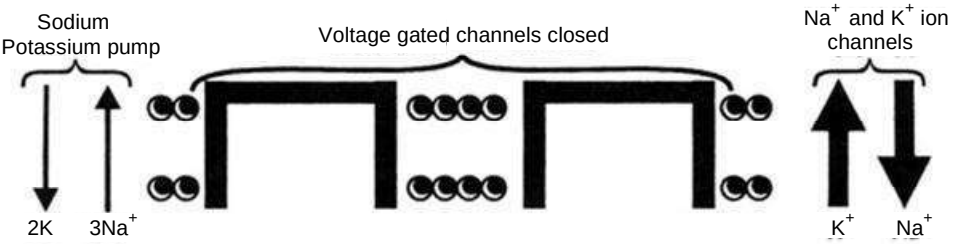
There are **carrier protein** located in the cell surface membrance. They are driven by energy supplied by ATP and couple the removal of three sodium ions from the axon with the uptake of two potassium ions.

The rate of diffusion is determined by the permeability of the axon membrane to the ion.

Potassium ions have a membrane permeability greater than that of sodium ions. Therefore potassium ions loss from the axon is greater than sodium ion gain. This leads to a net loss of potassium ions from the axon, and the production of negative charge within the axon (organic anions).

Due to active transport (mainly) and diffusion process, positive charge is more outside and negative charge is more inside.

Outer covering of axolemma is positively charged and inner membrane of axolemma is negatively charged.



Depolarisation and Action potential :

Once the event of depolarization has occured, a nerve impulse or spike is initiated.

Action potential is another name of nerve impulse.

This is generated by a change in the sodium ion channels. These channels, and some of the potassium ion channels, are known as voltage gated channel, meaning they can be opened or closed with change in voltage.

In resting state these channels are closed due to binding of Ca^{++}.

An action potential is generated by sudden opening of the sodium gates. Opening of gates increases the permeability of the axon membrane to **sodium ions** which enter by diffusion.

This increases the number of positive ions inside the axon.

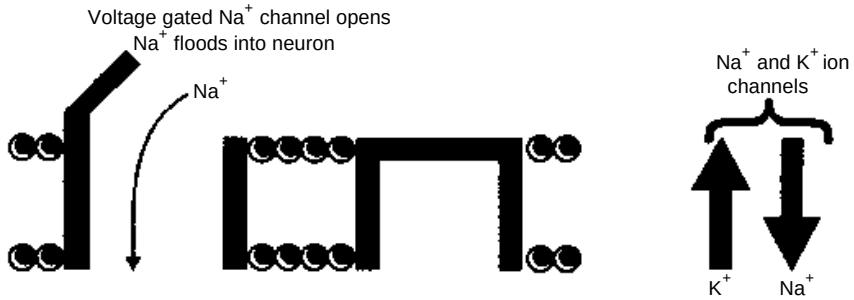
A change of –10mV in potential difference from RMP through influx is sufficiently significant to trigger a rapid influx of Na^+ ions leading to generation of action potential.

This change of –10 mV is called as **threshold stimulus**.

At the point where membrane (Axolemma) is completely depolarised due to rapid influx of Na^+ ions, the negative potential is first cancelled out and becomes 0 (Depolarisation). This axolemma is called as **excited membrane or depolarised membrane**.

Due to further entry of Na^+, the membrane potential "over shoots" beyond the zero and becomes positive upto + 30 to + 45mV.

This "over shoot" peak corresponds to maximum concentration of sodium inside the axon. This potential is called as **action potential or spike potential**. In this state, the inner surface of axolemma becomes positively charged and outer surface becomes negatively charged.



Repolarisation :

⇒ After a fraction of second i.e., 0.5 m.sec, the sodium gates closed, Depolarisation of the axon membrane causes potassium gates to open, potassium therefore diffuse out of cell.

⇒ Since potassium is positively charged, this makes the inside of cell less positive, or more negative and the process of repolarization or return to the original resting potential begins.

⇒ The repolarization period returns the cell to its resting potential (–70 mV). The neuron is now prepared to receive another stimulus and conduct it in the same manner.

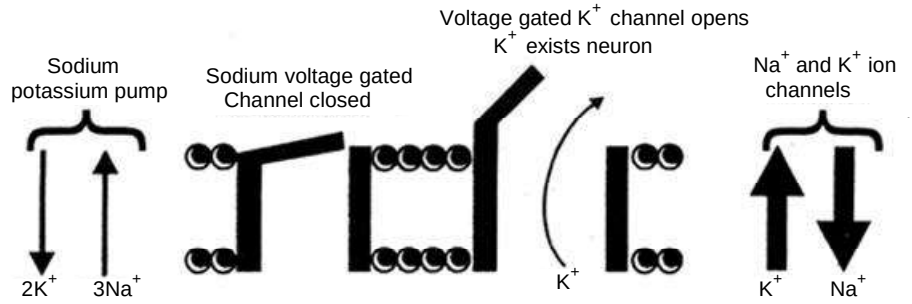
⇒ At this point membrane show hyper polarization.

⇒ Sodium pump starts working to maintain the normal resting membrane potential by expelling Na^+ and in take of K^+.

The time taken for restoration of resting potential is caled **refractory period**, because during this periods the membrane is incapable of receiving & conduicting another impulse.

⇒ Nerve impulse travels as action potential which passes along axon as a wave of depolarization.

⇒ The whole process of depolarisation and repolarisation is very fast. It takes only about **1 to 5 milli second (ms)**.



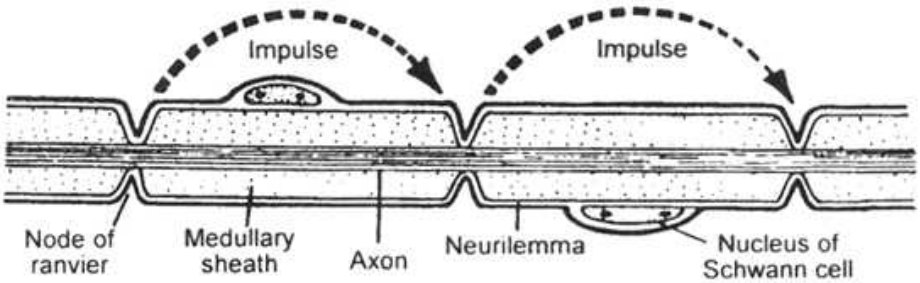
Physiology of Nerve

Process	Na^+ K^+ pump	Passaive diffusion	Na^+ C	K^+ GC	Potential with value	Inside Charge
Polarisation	✓	✓	×	×	RMP (–60 to –85 mv)	Negative
Depolarisation	×	✓	✓	×	AP (overshoot value) (+ 30 to + 45 mv)	Positive
Repolarisation	✓	✓	×	✓	–	Negative
Hyperpolarisation	✓	✓	×	✓	– 90 mV	Negative

Open/Operating → ✓ Closed → ×

Saltatory conduction of nerve impuse :

⇒ This type of conduction occur in **myelinated fibre**. Myelin is fatty material with a high electrical resistance and act as electrical insulator in the same way as the rubber and plastic covering of electrical wiring.



– The combined resistance of the axon membrane and myelin sheath is very high, but where breaks in the myelin sheath occur known as **nodes of Ranvier**, the resistance to current flow between the axoplasm and the fluid outside the cell is low. It is only at these nodes local circuits are setup.

– This means, in effect that the action potential jump from node to node and passes along the myelinated axon faster as compared to the series of small local circuits in a non-myelinated axon. This type of conduction is called **saltatory conduction**.

– Leakage of ions takes place only in nodes of Ranvier and less energy is required for saltatory conduction.

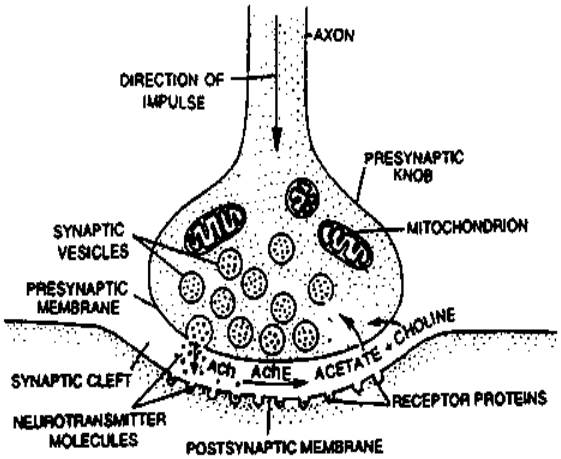
Synaptic Transmission

Telodenria of one neutron form synapse with dendron of next neuron.

It is the junction between two neurons where information is transferred from one neutron to another neuron but no protoplasmic connection.

Synapse = Pre synaptic knob + synaptic cleft + post synaptic membrane

- Telodendria membrane is called **pre synaptic membrane** & membrane of dendron of other neuron called as **post synaptic membrane**. Space between pre and post synaptic membranes is called **synaptic cleft**.
- When the AP develop in pre synaptic membrane. it becomes permeable for Ca^{++}.
- Ca^{++} enter in pre synaptic membrane & vesicles burst due to the stimulation by Ca^{++} and causes release of neurotransmitters (Ach) in synaptic cleft.
- Ach reaches the post synaptic membrane via synaptic cleft & bind to receptors. It develops **excitatory post synaptic potential (EPSP)**. EPSP develop due to opening of Na^{+} gatted channnels.



Transmission of nerve impulse at a chemical synapse

- Cholinesterase enzyme is found in the synaptic fluid of synapse.
- This enzyme decomposes the Ach into choline & Acetate.
- Neuro inhibitory transmitter (GABA) binds with post synaptic membrane to open the Cl^{-} gated channels and hyperpolarization of neutron occurs. Now the potential is called **inhibitory post synaptic potential (IPSP)** & further nerve conduction is blocked.

Physiological properties of nerve fibre are detected by cathode ray oscilloscope :

Type of synapse :

(i) Axodenritic – b/w axon & dendron
(ii) Axosomatic – b/w axon & cyton
(iii) Axoaxonic – b/w axon & axon

SYNAPSE :

	Electrical	Chemical
Conduction	Fast	Slow
Synaptic cleft	Upto 0.2 nm	Upto 20 nm
Neutrotransmitter	Absent	Present
Synaptic delay	Absent	Present
Blocking	Can not be controlled	Controlled by neutrotransmitter

Name synapse was proposed by Charles Sherrington

Neuron conducts the impulse in the form of electro chemical wave.

- Conduction of nerve impulse is unidirectional.
  It follow **all or none law**. Magnitude of response will always be same irrespective of strength of stimulus above threshold stimulus.
- Velocity of nerve impuse $\propto$ Diameterof neuron.
- In mammals, the velocity of nerve impulse is **100 to 130 meter/sec.**
- This velocity is affected by physical & chemical factor, such as pressure, cold, heat, chloroform and ether etc.

Special Points

1. In the brain of **frog** only 2 shkull meninges are presnt. The middle meninge that is the Archnoid is absent.
2. In rabbit, man and mammals-**3** skull menninges are present.
3. Increase in the amount of cerebro-spinal fluid is diseased condition termed as the **Hydrocephalus**.
4. "**Meningitis**". It arises due to infection or inflamation on injury in the meninges. Infection may be due to virus or bacteria or both.
5. Piamater is the most vascular and conducting and provides nutrition.
6. The power of regeneration is very less in a neuron.
7. The optic lobes of frog are hollow and in them **optocoel** cavity is found.
8. In frog, 2 optic-lobes are present. These are hollow and termed as **Corpora-bigemina**. In mammals, 4 solid optic-lobes are present.
9. Around the brain of fishes, only one menix is found called : **Menix-primitiva**".
10. The **vlave of vieussens** joins the optic-lobes with the cerebellum.
11. Cerebral-cortex is made up of gray – matter and is divided into 3 area -
    (i) Sensory area (ii) Motor area (iii) Associated area
12. The sensory and associated areas determine the **shape, colour, sound, taste** and **smell of any object**.
13. Motor area regulaters **muscular-contraction**.
14. **Broca's area :** It is known as motor speech area.
15. Broca's area is present in the lateral part of the **frontal-lobe** of the cerebrum. This area makes aware of language; and **translates the written words into speed**.
16. If Broca's area are gets destroyed the animal beecomes unable to speak.
17. The temporal-lobes of cerebrum regulates the mechanism of hearing.
18. Cerebrum is the centre of following :
    (1) Intelligence (2) Emotion (3) Will-power (4) Memory
    (5) Consciousness (6) Experience (7) Knowledge
    (8) Voluntary control (9) Laughing and weeping (10) Defaecation and micturition.

19. Diencephalon is the centre of carbohydrate – metabolism and fat-metabolism.
20. In rabbit, "**Swammerdam's gland**" are absent. These glands are presenet at the origin place of spinal nerves in vertebrates & present in frog. It provide extra supply of Ca^{++} for synaptic transmission.
21. Cerebellum made up of three layers and in the middle of cerebellum of brain lobes of flask-shaped cells are found called the "**Purkinje-cells**".
22. In the nerve-cells, "centrosome" are absent so once formed in developement, the nerve-cells do not divide and **remain in Inter-phase stage** throughout their life : and grow in size with the growth of the body.
23. The velocity of nerve-impulse is 5 to 50 times more faster in Myelinatd nerve-fibres than in Non-myelinated nerve-fibres.
24. In mammals the speed of nerve impuse is **100-130** m/sec (maximum). In frog, the speed of nerve impulse is 30 m/sec. In reptiles the speed is **15** to **35** m/sec.
25. Acetylcholinesterase enzyme helps in the dissociation of Acetylcholine.
26. In the form of inhibitory neuro-hormons, - GABA are present.
    GABA – gamma amino butyric – acid.
27. Acetylcholine is synthesized by the Mitochondria.
28. For the conduction of nerve-impulses, $\mathbf{Na^{+}}$ is necessary.
29. The marking of brain waves is donie through **E, E, G** i.e. Electro-encephalo gram.
30. In embryonic – stages inside the brain the layer of grey-matter is towards inside and that of white-matter is towards outside.
    In adults, this arrangement continues in the spinal-cord but during the development of the wall of the brain the gray-matter is transferred outside.
31. In 1 minute **750 ml** of blood is conducted to the human-brain.
32. Corpus callosum is the largest commissure of the brain.
33. Largest cranial venous sinus is **cavernous venous sinus** which is situated in the middle cranial fossa.
34. All preganlionic-sympathetic nerve fibre are myelinated while post ganglionic nerve fibre are non myelinated.
35. In PNS myelinogenesis process is occurs by neurilemma (Schwan cells) while in CNS myelinogenesis process is occurs by oligodendrocytes (Neugroglia).
36. **Alzheimer's disease** – In this disease, the cerebral cortex is atrophied and ultimately the ventricle enlarges. Symptoms consist of memory particulary recent memory. Alzheimer disease is more common in down syndrome.
    Treatment – No effective treatement.
37. **Stroke** – May be caused by haemorhage into the brain.
    Symptoms – Unconsiousness.
    Treatment – Intra venous tissue plasminogen activator.
38. **Epilepsy** – Epilepsy is characterized by short, recurrent periodic attack of motor, sensory or opshychological malfunction.

Cause – due to abnormal discharge of cerebral neurons.

Symptons – seizures, unconsiousness, Involuntary contraction of muscle.

Treatment – Anti epileptic drugs.

39. In human brain more than 100 billion neurons are present.
40. Each neuron cell connect with 25,000 other cell.
41. Phrenic nerve is branch of cervical plexues which supply diaphragm.
42. **Malathione :** This substance is used as insecticide and it destroy the acetyl cholinesterease in synapse area.
43. **Botulism :** It is food poisoning disease and it produces by *Clostridium botulinum* bacteria. This bacteria release neurotoxin.
44. **Curare :** is drug blocks acetylcholine receptor on skeletan muscle, so that it can be used by surgeon for keeping a muscle relaxes during operation.
45. Corpus striatum regulates planning and execution of stereotyped movement.
46. The region between the thalamus and spinal cord is referred to as **brain stem**.
47. All impulse traversing a given neuron have the same amplitude, differing only in the frequency of impulse.
48. **Glycine** is neuro inhibitory hormone present in spinal cord.
49. **Glutamate** is excitatory amino acid.
50. Trigeminal nerve is also called " **the dentists nerve**" because the denstists desensitizes this nerve with some anaesthetic before pulling out the troubling tooth.

EXERCISE – 1

Q.1 Which cranial nerves are sensory :–
(1) 1, 2, 8 (2) 3, 4, 6, 11, 12
(3) 5, 7, 9, 10 (4) None of them

Q.2 GABA (gama amino butyric acid) is a :–
(1) Inhibitory neurohumor
(2) Neuro humor
(3) Anti coagulant
(4) None

Q.3 Nissl-bodies found in neurons are :–
(1) Made of DNA
(2) Masses of ribosome and RER
(3) Help in formation of neurofibrils
(4) Masses of mitochondria

Q.4 Control centre of autonomic nervous system :
(1) Diencephalon (2) Hypothalamus
(3) Optic thalami (4) Cerebrum

Q.5 Voluntary activities of body are controlled by :–
(1) Diencephalon (2) Cerebrum
(3) Crura cerebri (4) Cerebellum

Q.6 Nerve fibers of autonomic nervous system run between :–
(1) Receptors and C.N.S.
(2) C.N.S. and effector
(3) Receptor – C.N.S. – effector
(4) None

Q.7 The nervous system is derived from :–
(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) Ecto and Mesoderm

Q.8 Epiphysis and Hypophysis are found attached with–
(1) Fore brain (2) Mid brain
(3) Hind brain (4) None of the above

Q.9 The nerves connected to receptor are called:–
(1) Afferent (2) Efferent
(3) Motor (4) Spinal

Q.10 The number of brain meanings in fishes, amphibians and mammals are respectively :–
(1) 1, 2, 3 (2) 3, 3, 3
(3) 1, 3, 3 (4) 2, 2, 3

Q.11 Foramen of monro is a aperture in :–
(1) Heart (2) Brain
(3) Cranium (4) Eye

Q.12 Ventral root of spinal nerve has :–
(1) Sensory fibers
(2) Motor fibers
(3) Sensory and motor fibers both
(4) None

Q.13 Posterior choroid plexus in brain is found in the wall of :–
(1) Diencephalon (2) Cerebrum
(3) Cerebellum (4) Medulla

Q.14 Which is a solid part of mammalian brain :–
(1) Optic lobes (2) Pons varoli
(3) Cerebellar hemisphere
(4) All the above

Q.15 The cavity of brain is lined by :–
(1) Neural epithelium
(2) Ependymal epithelium
(3) Cerebrospinal fluid
(4) Glandular epithelium

Q.16 Smallest cranial nerve is :–
(1) X-cranial nerve (2) VI-cranial nerve
(3) VII-cranial nerve (4) II-cranial nerve

Q.17 The dorsal wall of cerebrum is very thick and called–
(1) Gyri and Sulci (2) Dura mater
(3) Neopellium (4) Carpus callosum

Q.18 "Filum terminale" is :–
(1) Non-nervous terminal part of spinal cord
(2) Nervous terminal part of spinal cord
(3) Terminal end of cranial nerves
(4) Terminal part of brain

Q.19 Some scientist claim the presence of centrioles in neurons, helps in :–
(1) Cell division
(2) Formation of neurofibrils
(3) Formation of neurites
(4) Formation of cilia

Q.20 "Aque duct of sylvius" found in :–
(1) Heart (2) Eye (3) Brain (4) Ear

Q.21 Cerebral hemispheres of mammals consist of
(1) Outer gray matter and central white matter
(2) Outer white matter and central gray matter
(3) Gray matter and white matter inter mingled
(4) Gray matter only

Q.22 Meninges surrounding the brain of Rabbit from outside to inside are :–
(1) Duramater, arachnoid, piamater
(2) Piamater, arachnoid, duramater
(3) Duramater, piamater, arachnoid
(4) Piamater, duramater, arachnoid

Q.23 Glands of swammerdams are associated with
(1) Nervous system (2) Muscles
(3) Bones (4) All of the above

Q.24 Impulse for voluntary forced breathing starts in:–
(1) Spinal cord (2) Medulla oblongata
(3) Cerebral hemisphere (4) Vagus nerve

Q.25 Tongue is under the control of which nerve :–
(1) Vagus (2) Trigeminal
(3) Glossopharyngeal (4) Both 2 & 3

Q.26 Purely motor cranial nerve includes :–
(1) I, V, VII (2) I, II, IV
(3) III, IV, VI, XI (4) None of these

Q.27 Corpus callosum connects :–
(1) Two cerebral hemisphere
(2) Two optic lobes
(3) Two olfactory lobes
(4) Optic chiasma

Q.28 Cavity in spinal cord is called :–
(1) Entero coel (2) Blasto coel
(3) Schizo coel (4) Neuro coel

Q.29 "Foramen of monro" is an aperture found between
(1) Third ventricle and forth ventricle
(2) Diocoel and metacoel
(3) Brain and spinal cord
(4) Lateral ventricle and third ventricle

Q.30 If heart is stimulated through its vagus supply heart rate will :–
(1) Decrease (2) Increase
(3) Show no change (4) None

Q.31 Parasympathetic system increase activity of
(1) Lachrymal gland, sweat gland, arrector pili
(2) Heart, lachrymal gland, pancreas
(3) Heart, adrenal gland and sweat gland
(4) Gut, iris and urinary bladder

Q.32 Hearing is controlled by :–
(1) Cerebral hemisphere
(2) Temporal lobes
(3) Cerebellum (4) Hypothalamus

Q.33 Conditioned reflex was first explained by :–
(1) Funk (2) Karl von frich
(3) Pavlov (4) William harvey

Q.34 Which nerve is purely motor :–
(1) Abducens (2) Trigeminal
(3) Olfactory (4) Vagus

Q.35 The III, VI and XI cranial nerve in mammals are respectively :–
(1) Occulomotor, abducens and hypoglossal
(2) Occulomotor, abducens and spinal accessory
(3) Trochlear, facial and spinal accessory
(4) Trigeminal, abducens and vagus

Q.36 Heart is innervated by :–
(1) Vagus (2) Trigeminal
(3) Facial (4) Glossopharyngeal

Q.37 Which part of brain is responsible for hearing
(1) Cerebrum (2) Cerebellum
(3) Medulla (4) Hypothalamus

Q.38 Brain of rabbit differs from that of frog in having
(1) Large olfactory lobe
(2) Small hypothalamus
(3) Small cerebellum
(4) Corpus callosum

Q.39 Outer most covering of brain is called :–
(1) Choroid (2) Duramater
(3) Piamater (4) Arachnoid

Q.40 Which of the following processes occur only in animals :–
(1) Hormonal control (2) Respiration
(3) Nervous control (4) Nutrition

Q.41 Thermo regulatory center in human brain is :–
(1) Pituitary (2) Diencephalon
(3) Hypothalamus (4) None

Q.42 Number of spinal nerves in man :–
(1) 31 pairs (2) 32 pairs
(3) 12 pairs (4) 37 pairs

Q.43 Cerebellum of brain is concerned with :–
(1) Balancing during sitting
(2) Coordination of muscular movements
(3) Balancing during active movement
(4) Initiation of muscular contraction

Q.44 Number of cranial nerves in rabbit :–
(1) 12 pairs (2) 10 pairs
(3) 11 pairs (4) 9 pairs

Q.45 Which nerve originates from medulla oblongata:–

(1) Optic (2) Occulomotor

(3) Vagus (4) Acoustic

Q.46 Difference between brain of rabbit and that of frog is–

(1) Presence of corpus callosum

(2) Corpus albicans

(3) Four optic lobes

(4) All of these

Q.47 Total number of spinal nerves in frog are :–

(1) 31 pair (2) 37 pair

(3) 10 pair (4) 12 pair

Q.48 Largest cavity in brain is called :–

(1) Diocoel (2) Paracoel

(3) Metacoel (4) Rhinocoel

Q.49 Saltatory conduction occurs in :–

(1) Non-myelinated fibers

(2) Myelenated fibers

(3) Both of them

(4) None of them

Q.50 Which is the function of parasympathetic nervous system :–

(1) Pupil constriction

(2) Acceleration of heart beat

(3) Stimulation of sweat gland

(4) Contraction of hair muscles

Q.51 The most common chemical substance which take part in synaptic transmission is :–

(1) Adrenaline (2) Epinephrine

(3) Colchicine (4) Acetylcholine

Q.52 Which cell in our body is more than a foot long-

(1) Nerve cell (2) Muscle cell

(3) Bone cell (4) Gland cell

Q.53 "Purkinje cells" occurs in :–

(1) Brain (2) Heart

(3) Liver (4) Muscles

Q.54 Second cranial nerve is distributed in :–

(1) Lens and retina

(2) Eye muscles and retina

(3) Retina alone

(4) Irish and eye-muscles

Q.55 In rabbit autonomic nervous system is composed of–

(1) Sympathetic and parasympathetic nerves

(2) Cranial and spinal nerves

(3) Brain and spinal nerves

(4) Medullated and non-medullated nerves

Q.56 How many pairs of cranial nerves are purely sensory –

(1) Two (2) Three

(3) Four (4) Five

Q.57 Optic nerve is the :–

(1) Fifth cranial nerves

(2) Second cranial nerve

(3) Seventh cranial nerve

(4) Ninth cranial nerve

Q.58 Number of cranial nerve in frog is :–

(1) Ten only (2) Ten pairs

(3) Twenty pairs (4) Twelve pairs

Q.59 Drinking of alcohol affects :–

(1) Cerebrum (2) Cerebellum

(3) Medulla oblongata (4) Both 1 & 2

Q.60 Which part of the brain regulates the body temperature, hunger and water balance :–

(1) Hypothalamus (2) Infundibulum

(3) Medulla oblongata (4) Pons veroli

Q.61 Nerve fibres are surrounded by an insulating fatty layer called :–

(1) Adipose sheath (2) Myelin sheath

(3) Hyaline sheath (4) Peritoneum

Q.62 Which of the following forms the cerebro spinal fluid

(1) Chorid plexus

(2) Duramater

(3) Arachnoid mater

(4) Cerebrum and spinal cord

Q.63 Arbor vitae is composed of :–

(1) Neuroglea cells (2) Grey matter

(3) White matter (4) All of the above

Q.64 Which cell stop dividing after birth :–

(1) Epithelium (2) Neuron

(3) Glial cells (4) Liver

Q.65 Which one of the following is the immediate covering of a nerve fibers :–

(1) Endoneurium (2) Epineurium

(3) Perineurium (4) Sarcoplasm

Q.66 In brain structures genu and splenium are associated with :–

(1) Vermis (2) Cerebrum

(3) Cerebellum (4) Medulla oblongata

Q.67 The parts of the neurons that perform basic cellular functions such as protein synthesis are the

(1) Axons (2) Dendrites

(3) Synaptic knobs (4) Soma

Q.68 Which of the following is a richly vascular layer with lots of blood capillaries :–

(1) Duramater of brain

(2) Piamater of spinal cord

(3) Epidermis of skin

(4) Epithelial lining of trachea

Q.69 I, II, VIII spinal nerves are–

(1) Motor (2) Sensory

(3) Mixed (4) None of the above

Q.70 The nerves leading to the central nervous system are called :–

(1) Afferent (2) Efferent

(3) Motor (4) None

Q.71 The neurotransmitter which is not excitatory in function is :–

(1) Serotonin

(2) Dopamine

(3) Gamma-amino butyric acid (GABA)

(4) Acetyl choline

Q.72 The sympathetic nervous system is otherwise called

(1) Thoracico lumber system

(2) Cervico sacral system

(3) Visceral system

(4) Mesenteric system

Q.73 "Jumping of the action potential" at the nodes of ranvier is known as :–

(1) Saltatory conduction

(2) Neuro transmission

(3) Recovery phase

(4) Active phase

Q.74 The energy required during transmission of impulse is provided by :–

(1) Brain (2) Nerve fiber

(3) Liver (4) Stimulating agent

Q.75 The nodes of ranvier are :–

(1) The points in which the axons is exposed

(2) The contact points found over the non-myelinated nerve fiber

(3) Areas in which the axons swell up

(4) Areas where the nurilema touches the axon

Q.76 In a nerve cell potassium concentration :–

(1) Less on the inside

(2) Greater on the outside of membrane

(3) More concentrated inside

(4) Equal on both sides of membrane

Q.77 Nerve impulses are initiated by nerve fibers only when the membrane shall become more permeable to :–

(1) Adrenaline (2) Phosphorus

(3) Sodium ions (4) Potassium ions

Q.78 Power of regeneration is lowest in :–

(1) Brain cell (2) Liver cell

(3) Bone cell (4) Muscles cell

Q.79 Which part of the brain is more develop in human is

(1) Medulla (2) Cerebellum

(3) Cerebrum (4) Optic lobes

Q.80 Ions needed for nerve conduction :–

(1) Na^{+} (2) Ca^{++}

(3) Mg^{++} (4) None

Q.81 Crura cerbri is located in :–

(1) Fore brain (2) Hind brain

(3) Mid brain (4) None

Q.82 Which of the following is responsible for control of reflex actions :–

(1) Motor nerves

(2) Sensory nerves

(3) Central nervous system

(4) Sympathetic nervous system

Q.83 Last end of spinal cord is called :–

(1) Cauda equina (2) Filum terminal

(3) Funi culus (4) Fasciculi

Q.84 Anterior commissure occurs between :–

(1) Corpus callosum (2) Optic thalami

(3) Optic lobes (4) Corpus striatum

Q.85 Lumber spinal nerve in rabbit :–

(1) 4-pairs (2) 6-pairs

(3) 7-pairs (4) 5-pairs

Q.86 Unit of nervous system :–
(1) Neuron (2) Neuroglia
(3) Axon (4) Cyton

Q.87 How many lobes are present in cerebellum of rabbit–
(1) 1 (2) 3 (3) 5 (4) 7

Q.88 Corpus striata is part of :–
(1) Cerebellum (2) Cerebrum
(3) Diencephalon (4) Medulla oblongata

Q.89 Which of the following fissures is present in brain:–
(1) Sylvian fissure (2) Medium fissure
(3) Rhinal fissure (4) All of these

Q.90 Speed of impulse on nerves in mammals is :–
(1) 1 meter/sec. (2) 100 meter/sec.
(3) 1000 meter/sec. (4) None of these

Q.91 The functional connection between two neurons is called :–
(1) Synapse (2) Synaptid
(3) Chiasma (4) Chiasmata

Q.92 The most abundant lipid found in nervous tissue is –
(1) Phospholipids
(2) Cerebrosides and gangliosides
(3) Cholesterol
(4) Sulpholipid

Q.93 Which of the following nerve helps in maintaining the equilibrium of body :–
(1) Trochlear (2) Abducens
(3) Auditory (4) Facial

Q.94 Conduction of nerve impulse is :–
(1) Faster in non-myelinated fibres
(2) Faster in myelinated fibers
(3) No difference in the rate of conduction in myelinated & non myelinated fiberes
(4) None of above

Q.95 Which of the following amino acid metabolised in brain :–
(1) Glutamic acid (2) Glycine
(3) Leucine (4) Aspartic acid

Q.96 The two additional cranial present in mammals are
(1) Pharyngeal & vagus
(2) Spinal accessory and hypoglossal
(3) Trigeminal and glossopharyngeal
(4) Hypoglossal and sciatic

Q.97 Sylvian fissure divides each cerebral hemisphere into two lobes which are known as :–
(1) Parietal & temporal
(2) Temporal and occipital
(3) Occipital and hippocampal
(4) Frontal and temporal

Q.98 Enzyme acetycholinesterase is concerned with :–
(1) Digestion of protein
(2) Synthesis of protein
(3) Digestion of polypeptide
(4) conduction of nerve impulse

Q.99 A neopallium or cerebral cortex is not found in the brain of :–
(1) Mammals (2) Birds
(3) Reptiles (4) Frogs

Q.100 In brain of crura cerbri is a structure made of
(1) Six bands of nerve fibres
(2) Eight bands of nerve fibres
(3) Two large bands of nerve fibres
(4) Four bands of nerve fibres

Q.101 The Schwann sheath is :–
(1) A non myelinated nerve fibres
(2) Associated with myelin sheath
(3) A connective tissue cell
(4) None of the above

Q.102 The function of an axon is :–
(1) Transformation of nerve inpulse
(2) Reception of stimuli from neurons
(3) Reception of external stimuli
(4) Conduction of nerve impulse

Q.103 The interstitial tissue of nervous tissue is :–
(1) Satellite cells (2) Schwann cells
(3) Neuroglia (4) All the above

Q.104 Leptomenix of brain is formed by the joining of–
(1) Piamatter and arachnoid layer
(2) Piamater and duramater
(3) Duramatter and arachnoid layer
(4) Grey matter and white matter

Q.105 Filum terminal has only :–
(1) Piamater (2) Duramater
(3) Arachnoid (4) All of the above

Q.106 The conduction of nerve impulse is an example of :–

(1) Biophysiological process or bioelectric chemical process

(2) Biochemical process

(3) Physical process

(4) Electro-chemical process

Q.107 Reflex action in rabbit is shown :–

(1) By motor nerve

(2) By sensory nerves

(3) As autonomic & involuntary action

(4) As autonomic & voluntary action

Q.108 In rabbit hippocampal lobes are the parts of :–

(1) Olfactory lobes (2) Cerebrum

(3) Cerebellum (4) Medulla Oblongata

Q.109 A ramus communicans consists of :–

(1) White ramus only (2) Grey ramus only

(3) Both of the above (4) None of the above

Q.110 Which one of the following menix is present only in mammalian brain :–

(1) Duramater (2) Arachnoid

(3) Piamater (4) None of them

Q.111 Find out the correct sequence of a simple reflex are–

(1) Brain-spinal cord-nerves-effector

(2) Effector-CNS-sensory nerves-receptor

(3) Muscles-spinal cord-brain-receptor

(4) Receptor-sensory nerves-CNS-effector

Q.112 Lateral branches of neurons is called :–

(1) Axons (2) Cyton

(3) Collatereals (4) All the above

Q.113 Weight of brain in adult man is :–

(1) 250 gm. (2) 750 gm.

(3) 1400 gm. (4) 2500 gm.

Q.114 The autonomic nervous system does not regulate:–

(1) Excretion

(2) Respiration

(3) Learning and memory

(4) Blood circulation

Q.115 Which of the following spinal nerves does not found in man :–

(1) Caudal nerves (2) Sacral nerves

(3) Cervical nerves (4) Lumber nerves

Q.116 Opticoel cavity found in brain of :–

(1) Rabbit (2) Man

(3) Frog (4) None of these

Q.117 Resting membrane potential in neurons is :–

(1) + 30 mv (2) – 30 mv

(3) –70 to – 85 mv (4) + 70 to + 85 mv

Q.118 Bipolar neurons occurs in :–

(1) Retina of eye (2) Cochlea of ear

(3) Nasal epithelium (4) All the above

Q.119 Which cell-organelle synthesises acetyl choline:–

(1) Golgi complex (2) Ribosome

(3) Mitochondria (4) Lysosome

Q.120 Smallest cavity in brain is called :–

(1) Rhinocoel (2) Paracoel

(3) Diocoel (4) Metacoel

Q.121 Length of spinal cord in man :–

(1) 100 cm. (2) 75 cm.

(3) 45 cm. (4) 30 cm.

Q.122 Synapse name proposed by :–

(1) Charles sherrington (2) Marshall hall

(3) Pavlov (4) None of above

Q.123 Through which aperture the spinal cord passes out of skull–

(1) Foramen of monro

(2) Foramen of paninze

(3) Foramen of magnum

(4) None of the above

Q.124 Cholinergic nerves at synapses secrete :–

(1) Acetyl cholin (2) Adrenaline

(3) Nor adrenaline (4) Sodium ions

Q.125 Which one of the following types of neurons are most numerous in the body :–

(1) Unipolar (2) Multipolar

(3) Bipolar (4) Pseudounipolar

Q.126 Gasserian ganglia are present in which cranial nerce–

(1) X^{th} (2) VII^{th}

(3) V^{th} (4) IX^{th}

Q.127 The ventricles of olfactory lobes are called :–

(1) First and second ventricles

(2) Rhinocoel

(3) Diocoel

(4) Metacoel

Q.128 Habenular commissure connects :–

(1) Two optic thalami

(2) Two optic lobes

(3) Two cerebral hemisphere

(4) Two lateral lobes of cerebellum

Q.129 Cerebellum is a part of :–

(1) Fore brain (2) Mid brain

(3) Hind brain (4) None of the above

Q.130 Most of the involuntary action are controlled by:–

(1) Medulla oblongata (2) Cerebrum

(3) Cerebellum (4) Both 1 & 2

Q.131 The function of cerebrospinal fluid-

(1) Protect the brain from external jerks

(2) Provide nourishment and O_2 to the brain O_2

(3) Take away unwanted substance from the brain

(4) All of the above

Q.132 Septum lucidum is part on the :–

(1) Pseudocoel (2) Metacoel

(3) Diocoel (4) Rhinocoel

Q.133 Small, solid and four optic lobes called corpora quadrigemina are found in :–

(1) Mammals (2) Amphibians

(3) Aves (4) Reptiles

Q.134 Vermis, lateral lobes and floccular lobes constitute–

(1) Cerebrum (2) Cerebellum

(3) Medulla oblongata (4) Diencephalon

Q.135 The nerve cells are :–

(1) Unipolar and bipolar

(2) Always unipolar

(3) Unipolar, bipolar & multipolar

(4) With many axans

Q.136 Hypothalamus is situated on the :–

(1) Dorsal side of diencephalon

(2) Ventral side of diencephalon

(3) Ventral side of optic lobes

(4) Dorsal side of optic lobes

Q.137 Epithalamus is situated on the :–

(1) Dorsal side of diencephalon

(2) Ventral side of diencephalon

(3) Dorsal side of optic lobes

(4) Ventral side of optic lobes

Q.138 When the axons membrane is positively charged outside and negatively charged in side, then the condition is known as :–

(1) Action potential (2) Resting potential

(3) Active potential (4) Differential potential

Q.139 The grey matter differs from white matter in the:–

(1) Absence of axons

(2) Absence of neurilemma

(3) Presence of myelin sheath

(4) Absence of myelin sheath

Q.140 The rate at which a nerve impulse travels along a nerve fibers is dependent up on :–

(1) Length of the nerve fibres

(2) Diameter of the nerve fibre

(3) Presence of connective tissue sheath

(4) None of the above

Q.141 Sheath of Schwann cells found on :–

(1) Neurons (2) Axons

(3) Dendrons (4) Neuroglia

Q.142 Grey matter is situated on the :–

(1) Outer surface of brain

(2) Inner surface of brain

(3) In the middle of brain

(4) Uniformly present

Q.143 Find out the correct statement :–

(1) Axons receives nourishment from the dendrite

(2) Both axons & dendrites receive nourishment from the cell body of neuron

(3) Dendrite receive nourishment from axons

(4) The cell body of a neuron receives nourishment from both axon and dendron

Q.144 Which of the following statement about nerve cell is false :–

(1) Nervous activity controls body functions

(2) Nervous system is constantly active

(3) Dead nerve cell are replaced by new cell

(4) No fresh nerve cell are produced after birth

Q.145 Which cell-organella absent in neurous :–

(1) Mitochondria

(2) Ribosome

(3) Centriole

(4) Nucleus

Q.146 The nodes of renvier refer to :–

(1) A synapse

(2) A synaptic knob

(3) Breaking point of myelin sheath

(4) A synaptic vesicle

Q.147 The cranial and spinal nerves are included under:–

(1) Autonomic nervous system

(2) Peripheral nervous system

(3) Central nervous system

(4) Cutaneous nervous system

Q.148 The main function of acetylcholine is to :–

(1) Increase heart beat

(2) Help in synaptic transmission of nerve impulse

(3) Help in conduction of nerve impulse through axon

(4) Control reflex action

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	2	2	2	2	1	1	1	1	2	2	4	4	2	2	3	1	2	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	1	3	3	3	1	4	4	1	4	2	3	1	2	1	1	4	2	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	1	2	1	3	4	2	2	2	1	4	1	1	3	1	2	2	2	4	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	1	3	2	1	2	4	2	3	1	3	1	1	2	1	3	3	1	3	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	3	2	4	3	1	3	2	4	2	1	2	3	2	1	2	4	4	4	3
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	4	3	1	1	1	3	2	3	2	4	3	3	3	1	3	3	4	3	1
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	3	1	3	1	2	3	2	1	3	4	4	1	1	2	3	2	1	2	4	2
Ques.	141	142	143	144	145	146	147	148												
Ans.	2	1	2	3	3	3	2	2												

EXERCISE – 2

Q.1 Dorsal root ganglion is –
(1) Motor (2) Mixed
(3) Sensory (4) None of the above

Q.2 CNS is mostly made of –
(1) Motor neurons and sensory neurons
(2) Sensory neurons and association neurons
(3) Association neurons
(4) Motor neurons and association neurons

Q.3 The nerve fibres in lateral funiculus of spinal cord are –
(1) Only sensory
(2) Only motor
(3) Both sensory and motor
(4) Not differentiated

Q.4 Two additional cranial nerves present in rabbit are –
(1) Laryngeal and vagus
(2) Spinal accessory and hypoglossal
(3) Trigeminal and glossopharyngeal
(4) Hypoglossal and laryngeal

Q.5 Nerve impulse for hearing originates in –
(1) Ear drum (2) Auditory nerve
(3) Ear ossicles (4) Cochlear

Q.6 Acetylcholine is –
(1) Toxin
(2) Vitamin
(3) Enzyme
(4) Chemical transmitter

Q.7 Ventral root of spinal nerve is composed of –
(1) Somatic motor and vesceral sensory fibres
(2) Somatic sensory and visceral sensory fibres
(3) Somatic motor and visceral motor fibres
(4) Somatic sensory and visceral motor fibres

Q.8 Nervous band connecting the two cerebral hemispheres is –
(1) Corpus albicans
(2) Corpus callosum
(3) Corpus striatum
(4) Corpus spongiosum

Q.9 Subarachnoid space occurs
(1) Above piamater (2) Above durameter
(3) Inside blastocoele (4) None of the above

Q.10 Hypothalamus is –
(1) Helpful in sleep
(2) Has centres for thirst and hunger
(3) Controls body temperature
(4) All the above

Q.11 Third, sixth and eleventh cranial are –
(1) Oculomotor, Abducens and Accessory spinal
(2) Oculomotor, Trigeminal and Accessory spinal
(3) Optic, Facial and Accessory spinal
(4) Trochlear, Abducens and Vagus

Q.12 What is the effect of parasympathetic nervous system –
(1) Originates heart beat
(2) Decrease heart beat
(3) Increases heart beart
(4) No effect on heart beat

Q.13 Fifth cranial nerve is –
(1) Optic (2) Trigeminal
(3) Abducens (4) Facial

Q.14 Brain ventricles are lined by –
(1) Neurons (2) Schwann cells
(3) Neuroglia (4) Ependymal cells

Q.15 Alcohol affects –
(1) Medulla oblongata (2) Cerebellum
(3) Cerebral cortex (4) Thalamus

Q.16 Meninges form outer envelope in –
(1) Cartilage (2) Muscle
(3) Brain (4) Kidney

Q.17 Brain originates from –
(1) Endoderm (2) Mesoderm
(3) Ectoderm (4) Ectomesoderm

Q.18 Hypophyseal portal system occurs in –
(1) Brain (2) Kidney
(3) Liver (4) Heart

Q.19 Nissl granules of neuron are madeup of –
(1) Proteins (2) Mitochondria
(3) RNA (4) DNA

Q.20 The nerve secreting epinephrine or norepinephrine is called –
(1) Adrenergic (2) Cholinergic
(3) Ammonelic (4) None of them

Q.21 Cranial nerves supplying eyes are –
(1) 3, 4, 5 (2) 4, 6, 7
(3) 4, 5, 6 (4) 3, 4, 6

Q.22 Cerebrospinal fluid is formed by –
(1) Ependymal cells (2) Choroid plexus
(3) Neurons (4) Neuroglial cells

Q.23 Respiration, heart beat and peristalsis are controlled by –
(1) Medulla oblongata
(2) Medulla oblongata and cerebellum
(3) Medulla oblongata and cerebrum
(4) Cerebellum

Q.24 Cytons of both central and autonomic sensory fibres occurs in –
(1) Spinal ganglia
(2) Dorsal part of spinal cord
(3) Ventral part of spinal cord
(4) Autonomic ganglia

Q.25 Vasomotor nerves are –
(1) Sympathetic (2) Parasympathetic
(3) Both 1 and 2 (4) None of the above

Q.26 Which cells do not divide after birth –
(1) Nerve cells (2) Germ cells
(3) Muscle cells (4) Osteocytes

Q.27 Nerve impulse travels as –
(1) Chemical impulse
(2) Electrical impulse
(3) Electrochemical impulse
(4) Physical impulse

Q.28 Simple two-neuron reflex consist of –
(1) Sensory neuron
(2) Effector neuron
(3) Both 1 and 2
(4) Sensory neuron, effector neuron and spinal cord

Q.29 Which one is a slow neuro-transmitter-
(1) GABA (2) Adrenaline
(3) Epinephrine (4) Acetylcholine

Q.30 Which one is the spinal nerve-
(1) Trigeminal (2) Hypoglossal
(3) Olfactory (4) None of the above

Q.31 Sympathetic nerves in mammals develop from –
(1) Sacral region
(2) Cervical region
(3) Thoracico-lumbar region
(4) 3rd, 7th, 9th and 10th cranial nerves

Q.32 Arbor vitae is composed of –
(1) Grey matter (2) White matter
(3) Neuroglia cells (4) All the above

Q.33 Cell bodies of motor nerve fibres occur in –
(1) Dorsal root of spinal nerve
(2) Dorsal horn of spinal cord
(3) Ventro-lateral horn of spinal cord
(4) Ventral root of spinal cord

Q.34 Slow neurotransmission is mediated by –
(1) Adrenalin
(2) Gamma amino butyric acid (GABA)
(3) Acetylcholine
(4) Glutamate

Q.35 Which two extra cranial nerves are present amniotes –
(1) Laryngeal and hypoglossal
(2) Spinal accessory and hypoglossal
(3) Hypoglossal and facial
(4) Trigeminal and glossopharyngeal

Q.36 Blood pressure and activity of non-striated muscles are dependent on the hormone secretion of –
(1) Anterior lobe of pituitary gland
(2) Middle lobe of pituitary gland
(3) Posterior lobe of pituitary gland
(4) Adrenal cortex

Q.37 Cell body (soma) of motor nerves is situated in –
(1) Dorsal root of spinal cord
(2) Dorsal horn of spinal cord
(3) Ventral and lateral horn of spinal cord
(4) Ventral root of spinal nerve

Q.38 Progesteron is a :-
(1) Carbohydrate (2) Steroid
(3) Protein (4) Sterol

Q.39 Fourth cranial nerve is-
(1) Trigeminal (2) Abducens
(3) Trochlear (4) Optic

Q.40 Sympathetic nervous system increases-
(1) Heart beat
(2) Secretion of saliva
(3) Secretion of digestive juices
(4) All the above

Q.41 Main function of cerebellum is-
(1) Balancing (2) Sight
(3) Hearing (4) Remembering

Q.42 Centre for sense of smell is –
(1) Cerebellum (2) Olfactory lobes
(3) Cerebrum (4) Midbrain

Q.43 Nerve related to diaphragm is –
(1) Vagus (2) Phrenic
(3) Trigeminal (4) Glossopharyngeal

Q.44 Which of the following is the largest nerve –
(1) Vagus (2) Olfactory
(3) Hypoglossal (4) Glossopharyngeal

Q.45 In an axon, nerve impulse travels –
(1) Away from ctyon
(2) Towards cyton
(3) Both away and towards cyton
(4) Not known

Q.46 Match the column

Column-I	**Column-II**
a. Bowman's capsule	p. Spinal cord
b. A.V. valves	q. Brain
c. Cerebellum	r. Kidney
d. Alveoli	s. Heart
	t. Lungs

(1) a – r, b – s, c – t, d – q
(2) a – r, b – t, c – s, d – q
(3) a – r, b – s, c – q, d – t
(4) a–p, b – q, c – s, d – t

Q.47 Main function of cerebrum is –
(1) To see (2) To hear
(3) Balancing (4) Remembering

Q.48 The vagus nerve is the cranial nerve numbering–
(1) 9 (2) 10
(3) 5 (4) 7

Q.49 Which of the following is regarded unit of nervous system-
(1) Dendrites (2) Axon
(3) Neuron (4) Myelin sheath

Q.50 The junction between axon of one neuron and dendrites of the next neuron is called-
(1) junction point (2) A joint
(3) A synapse (4) Constant

Q.51 Number of dead brain cells at the age of 70 years constitute –
(1) 40% (2) 30%
(3) 20% (4) 10%

Q.52 The respiratory centre controlling inspiration and expiration are located in –
(1) Medulla oblongata (2) Cerebellum
(3) Diencephalon (4) Spinal cord

Q.53 Which cranial nerve has highest number of branches–
(1) Facial (2) Vagus
(3) Trigeminal (4) None of these

Q.54 Brain depends on blood for the supply of –
(1) Oxygen and glucose
(2) ATP and glucose
(3) Oxygen and ATP
(4) Oxygen and electrolytes

Q.55 In motor neuron the impluse following in which direction ?
(1) In two direction (2) In one direction
(3) In all direction (4) None of these

Q.56 Medulla-oblongata is controls of :
(1) blood pressure (2) smell or odour
(3) high temperature (4) low temperature

Q.57 Origin of nervous system from :
(1) meso-endoderm (2) mesoderm
(3) endoderm (4) ectoderm

Q.58 Snake felt sound from :
(1) tympanum (2) body
(3) internal ear (4) earth

Q.59 Which nerves arise from spinal cord are?
(1) Mixed nerves (2) Motor
(3) Sensory (4) None of these

Q.60 Arachnoid-
(1) Corvers cranium
(2) Surrounds piamater
(3) Surrounds durameter
(4) Surrounds heart

Q.61 During development of action potential in a nerve fibres, positive and negative charges on outer and inner side of axon membrane are reversed due to-
(1) Extension of all K^+ ions
(2) More K^+ ions enter than Na^+ ions leave than axon
(3) More Na^+ ions enter the axon than K^+ ions leaves the same
(4) All Na^+ ions enter the axon

Q.62 Nerve axon takes part in –
(1) Receiving impulse
(2) Transformation of energy
(3) Conduction of impulse
(4) Providing energy for impulse transmission

Q.63 Which is not a reflex action –
(1) Food swallowing
(2) Closing of eyes in bright light
(3) Convulsion in winter seasion
(4) Salivation on tasting food

Q.64 Which one occurs in mesencephalon/midbrin –
(1) Cerebellum (2) Inferior colliculus
(3) Thalamus (4) Mammilary body

Q.65 Neurotrasmitter between neuron and a muscle cell is –
(1) Dopamine (2) Serotinin
(3) Endorphin (4) Acetylcholine

Q.66 Medulla oblongata encloses –
(1) Fourth ventricle (2) Third ventricle
(3) Second ventricle (4) Optic lobes

Q.67 At resting stage nerve cells has –
(1) Low K^+ outside and high Na^+ inside
(2) High K^+ inside and high Na^+ outside
(3) High K^+ inside and low Na^+ outside
(4) High K^+ outside and low Na^+ inside

Q.68 In a human being number of cranial nerves are –
(1) 10 pairs (2) 20 pairs
(3) 6 pairs (4) 12 pairs

Q.69 Depolarization of nerve impulse involves –
(1) Entry of Na^+ only
(2) Entry of K+ only
(3) Entry of Na^+ and exit of K^+
(4) Entry of K^+ and exit of Na^+

Q.70 Corpus callosum is found in the brain of –
(1) Pigeon (2) Crocodile
(3) Frog (4) Elephant

Q.71 Node of Ranvier is found in –
(1) Muscle bundles (2) Dendrite
(3) Axon (4) Right auricle

Q.72 A thin vascular membrane of brain is –
(1) Arachnoid (2) Piameter
(3) Durameter (4) Epineurium

Q.73 In Rabbit what is the number of spinal nerves ?
(1) 37 (2) 30 (3) 32 (4) 38

Q.74 Which of the following nerve innervates upper jaw of frog ?
(1) Maxillary (2) Pathetic
(3) Palatine (4) Occulomotor

Q.75 Structure connected with vision in Rabbit is –
(1) Corpus callosum
(2) Corpora quadrigemina
(3) Corpus albicans
(4) Hippocampus

Q.76 The main cause of paralysis is –
(1) Some defect in muscles
(2) Complete destruction of sensory nerve
(3) Complete destruction of motor nerve
(4) None of the above

Q.77 Which of the following nerve in rabbit enters in geniculate ganglion –
(1) Glossopharyngeal (2) Facial
(3) Hypoglossal (4) Vagus

Q.78 Which of the following is sensory –
(1) Ramus ventralis
(2) Ramus dorsalis
(3) Ramus dorsalis and ramus communicans
(4) Ramus ventralis and ramus communicans

Q.79 The part of the brain which is most developed in higher primates is :
(1) cerebellum (2) cerebrum
(3) medulla oblongata (4) olfactory lobes

Q.80 The cerebellum is concerned with :
(1) memory (2) perception
(3) intelligence
(4) coordination of muscular movement

Q.81 A mass of cytons is called as :
(1) synapse (2) ganglion
(3) motor nerve (4) nerve fibre

Q.82 The pathway of reflex arc as :
(1) sense organ, spinal cord, motor neuron, sensory nerve, muscle
(2) sense organ, sensory, neuron, motor neuron spinal cord, muscle
(3) sense organ, motor neuron, spinal cord, sensory neuron, muscle
(4) sense organ, motor neuron, spinal cord, sensory neuron, muscle

Q.83 The sense of balance maintained with the help of :
(1) hammer (2) strirrup
(3) semicircular canals (4) cochlea

Q.84 The small canal leading from pinna into the head in mammals is :
(1) Haversian canal (2) Ext. auditory maetus
(3) inguinal canal (4) eustachian tube

Q.85 Energy transformation in nervous system is –
(1) Chemical to radiant
(2) Chemical to mechanical
(3) Chemical to electrical
(4) Chemical to osmotic

Q.86 Which of the following is mismatched –
(1) Cerebrum-Memory
(2) Cerebellum-Equilibrium of body
(3) Olfactory lobes - Smell
(4) Medulla - Temperature

Q.87 Name of cranial nerves of human being viz. II, VII, VIII, IX
(1) Optic, auditory, facial, hypoglossal
(2) Oculomotor, auditory, abducens, hypoglossal
(3) Optic, facial, auditory, glossopharyngeal
(4) Optic, facial, abducens, glossopharyngeal

Q.88 Which of the following is not correctly matched?
(1) Rhinoncephalon-olfactory
(2) Hypothalamus-pituitary
(3) Cerebellum-balance
(4) Medulla oblongata-temperature regulation

Q.89 Which of the following nerve supplies organ of corti ?
(1) Auditory (2) Olfactory
(3) Trochlear (4) Vagus

Q.90 Which one of the following is chemical transmitter for neuro impulse conduction-
(1) Glycine (2) GABA
(3) Adrenalin (4) Acetylcholine

Q.91 Nerve impulse initiates with the movements of –
(1) K^+ (2) Na^+ (3) Ca^+ (4) Mg^+

Q.92 Sympathetic nervous system induces-
(1) Heart beat (2) Secretion of semen
(3) Secretion of saliva (4) None

Q.93 Which is not a part of hindbrain-
(1) Thalamus (2) Cerebellum
(3) Pons (4) Medulla

Q.94 Corti's organ is present in-
(1) Reisner's membrane
(2) Scala vestibuli
(3) Basilar's membrane
(4) Middle lamella

Q.95 Reflex action in controlled by-
(1) SANS (2) PANS
(3) CNS (4) PNS

Q.96 IInd cranial nerve goes up to-
(1) Retina (2) Retina & Iris
(3) Ciliary muscle (4) None

Q.97 Parkinson's disease (characterized by tremors and progressive rigidity of limbs) is caused by degeneration of brain neurons that involved in movement control and make use of neurotransmitter-
(1) Acetylcholine (2) Norepincphrine
(3) Dopamine (4) GABA

Q.98 In a man abducens nerve is injured. Which one of the following functions will be affected-
(1) Movement of the eye ball
(2) Movement of the tongue
(3) Swallowing
(4) Movement of the neck

Q.99 One of the following examples of the action of the autonomous nervous system is-
(1) Swallowing of food
(2) Pupillary reflex
(3) Peristalsis of the intestine
(4) Knee-jerk response

Q.100 Left and right part of brain are connected to each other by-
(1) Pons (2) Medulla oblongata
(3) Corpus callosum (4) Cerebrum

Q.101 Which one of the following does not act as a neurotransmitter?
(1) Cortisone (2) Acetylcholine
(3) Epinephrine (4) Norepinephrine

Q.102 Number of cranial nerves in Columba is-
(1) 9 pairs (2) 10 pairs
(3) 11 pairs (4) 12 pairs

Q.103 Nervous system consists of -
(1) Neuron (2) Nephron
(3) Perineocyte (4) None

Q.104 GABA (gama amino butyric acid) is a –
(1) Inhibitory neurohormone
(2) Transmittery neuro humor
(3) Anti co-agulant
(4) None

Q.105 Nissl's bodies found in neurons are –
(1) Made of DNA
(2) Masses of ribosome and RER
(3) Help in formation of neurofibrils
(4) Masses of mitochondria

Q.106 Chemical transmission of nerve impulses from one neuron to another at a synapse is by –
(1) Cholesterol (2) Acetylcholine
(3) Cholecystokinin (4) ATP

Q.107 "Nodes of Ranviers" are found in –
(1) Brain (2) Heart
(3) Axon (4) Eye

Q.108 Afferent nerve fibre conducts impulse from –
(1) C.N.S. to effector
(2) Receptor to C.N.S.
(3) Receptor to effector
(4) Effector to receptor

Q.109 Saltatory conduction occurs in –
(1) Non-myelinated fibers
(2) Myelinated fibers
(3) Both of them
(4) None of these

Q.110 Chemical substance which take part in synaptic transmission is –
(1) Adrenaline (2) Epinephrine
(3) Colchicine (4) Acetylcholine

Q.111 Nissl granules occur in which part and what is their function –
(1) Neurons and help in nutrition & increase metabolic activity of neuron
(2) Blood and help in nutrition and excretion
(3) Sarcoplasm and help in contraction
(4) Cell and secrete mucous

Q.112 When a nerve fibers is stimulated the inside of the membrane becomes –
(1) Filled with acetyl choline
(2) Negatively charged
(3) Positively charged
(4) Neutral

Q.113 The parts of the neurons that perform basic cellular functions such as protein synthesis etc. –
(1) Axons (2) Dendrites
(3) Synaptic knobs (4) Soma

Q.114 The nerves leading to the central nervous system are called
(1) Afferent (2) Efferent
(3) Motor (4) None

Q.115 "Jumping of the action potential" at the nodes of ranvier is known as –
(1) Saltatory conduction
(2) Neuro transmission
(3) Recovery phase
(4) Active phase

Q.116 Nerve impulses are initiated by nerve fibers only when the membrane shall become more permeable to –
(1) Adrenaline (2) Phosphorus
(3) Sodium ions (4) Potassium ions

Q.117 Power of regeneration is lowest in –
(1) Brain cell (2) Liver cell
(3) Bone cell (4) Muscle cell

Q.118 Unit of nervous system –
(1) Neuron (2) Neuroglia
(3) Axon (4) Cyton

Q.119 Speed of impulse on nerves in mammals is –
(1) 1 meter/sec.
(2) 100 meter/sec.
(3) 1000 meter/sec.
(4) None of these

Q.120 The functional connection between two neurons is called –
(1) Synapse (2) Synapsis
(3) Chiasma (4) Chiasmata

Q.121 Conduction of nerve impulse is –
(1) Faster in none-myelinated fibres
(2) Faster in myelinated fibres
(3) No difference in the rate of conduction in myelinated & non myelinated fibres
(4) None of the above

Q.122 Enzyme acetyl cholinesterase is concerned with–
(1) Digestion of protein
(2) Synthesis of protein
(3) Digestion of polypeptide
(4) Conduction of nerve impulse

Q.123 Integrative system in the body are –
(1) Endocrine system
(2) Nervous system
(3) Blood vascular system
(4) Both 1 & 2

Q.124 During refractory period –
(1) Nerve transmits impulse very slowly
(2) Nerve can not transmit impulse
(3) Nerve transmits impulses very rapidly
(4) None of the above

Q.125 The schwann sheath is –
(1) A non myelinated nerve fibres
(2) Associated with myelin sheath
(3) A connective tissue cell
(4) Associated with myelinated & non myelinated nerve fibre

Q.126 The function of an axon is –
(1) Transformation of nerve impulse
(2) Reception of stimuli from neurons
(3) Reception of external stimuli
(4) Conduction of nerve impulse

Q.127 A short period during which a nerve is unable to conduct nerve impulse is called
(1) Synaptic delay (2) Refractory period
(3) Resting potential (4) Critical period

Q.128 Rapid integration of the function activities in human is acheieved by –
(1) Nervous system (2) Endocrine system
(3) Blood (4) Muscular system

Q.129 Which cell-organelle synthesises acetyl choline–
(1) Golgi complex (2) Ribosome
(3) Mitochondria (4) Lysosome

Q.130 Synapse name proposed by –
(1) Charles sherrington (2) Marshall hall
(3) Pavlov (4) None of the above

Q.131 Which one of the following types of neurons are most numerous in the body –
(1) Unipolar (2) Multipolar
(3) Bipolar (4) Pseudounipolar

Q.132 When the axons membrane is positively charged outside and negatively charged in side, then the condition is known as –
(1) Action potential (2) Resting potential
(3) Active potential (4) Differential potential

Q.133 The rate at which a nerve impulse travels along a nerve fibers is dependent up on –
(1) Length of the nerve fibre
(2) Diameter of the nerve fibre
(3) Presence of connective tissue sheath
(4) None of the above

Q.134 Sheath of schwann occurs on –
(1) Neurons (2) Axons
(3) Dendrons (4) Neuroglia

Q.135 Which cell-organellae absent in neurons –
(1) Mitochondira (2) Ribosome
(3) Centriole (4) Nucleus

Q.136 Nerve fibres are surrounded by an insulating fatty layer called –
(1) Adipose sheath (2) Myelin sheath
(3) Hyaline sheath (4) Peritoneum

Q.137 The main function of acetylcholine is to –
(1) Increase heart beat
(2) Help in synaptic transmission of nerve impulse
(3) Help in conduction of nerve impulse through axon
(4) Control reflex action

Q.138 Ions needed for nerve conduction –
(1) Na+ (2) Ca++
(3) Mg++ (4) None

Q.139 Myelogenesis (Myelin formation) process occur in C.N.S. (central nervous system) –
(1) By schwann cells (2) By oligodendrocytes
(3) By Axolemma (4) By neurolemma

Q.140 Repolarisation of Neuron is occured due to –
(1) Influx of Na+ (2) Influx of K+
(3) Efflux of Na+ (4) Efflux of K+

Q.141 If GABA is released at synapse area then what will happens –
(1) Depolarization of neuron
(2) Repolarization of neuron
(3) Hyperpolarization of neuron
(4) No effect

Q.142 Non Myelinated axons differ from myelinated in that they –
(1) Are more excitable
(2) Lack nodes of Ranvier
(3) Are not capable of regeneration
(4) Are not associated with schwann cells

Q.143 If myelin sheath is continue in myelinated nerve fibre than what will happens in neuronal conduction –

(1) Velocity is increased

(2) Conduction is slow

(3) Conduction is stopped

(4) No effect

Q.144 Posterior choroids plexus in brain is found in the–

(1) Diencephalon

(2) Cerebrum

(3) Cerebellum

(4) Space b/w pons & medulla (anteriorly) & cerebellum (Posteriorly)

Q.145 Menings surrounding the brain of Human from outside to inside are –

(1) Duramater, arachnoid, piamater

(2) Piamater, arachnoid, duramater

(3) Duramater, piamater, arachnoid

(4) Piamater, duramater, arachnoid

Q.146 Corpus callosum connects –

(1) Two cerebral hemisphere

(2) Two optic lobes

(3) Two olfactory lobes

(4) Optic chiasma

Q.147 Outer most covering of brain is called –

(1) Choroid (2) Duramater

(3) Piamater (4) Arachnoid

Q.148 The membrane which cover the brain and the spinal cord is –

(1) White matter (2) Grey matter

(3) Peritonium (4) Menix

Q.149 Cerebellum is concerned with –

(1) Co-ordination of muscular movement

(2) Memory

(3) Vision

(4) Reflex action

Q.150 Crura cerebri is located in –

(1) Fore brain (2) Hind brain

(3) Mid brain (4) None

Q.151 Arbor vitae is present in –

(1) Cerebellum (2) Cerebrum

(3) Diencephalon (4) Optocoel

Q.152 How many lobes are present in cerebellum –

(1) 1 (2) 3 (3) 5 (4) 7

Q.153 Piamater is –

(1) Inner most meninge

(2) Middle meninge

(3) Outer meninge

(4) None

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	3	3	2	4	4	3	2	1	4	1	2	2	4	2	3	3	1	3	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	2	1	2	3	1	3	4	1	4	3	4	4	3	2	3	3	2	3	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	2	1	1	3	4	2	3	3	3	1	2	1	2	1	4	3	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	3	1	2	4	1	2	4	3	4	3	2	1	1	2	3	2	2	2	4
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	2	3	2	3	4	3	4	1	4	2	1	1	1	3	1	3	1	3	3
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	4	1	1	2	2	3	2	2	4	1	3	4	1	1	3	1	1	2	1
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	4	4	2	4	4	2	1	3	1	2	2	2	2	3	2	2	1	2	4
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153							
Ans.	3	2	3	4	1	3	2	4	1	3	1	2	1							

EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Nissl's granules are found in - **[UTTARANCHAL-2005]**

(1) liver cells (2) nerve cells

(3) kidney (4) heart

Q.2 Main function of cerebellum is - **[UTTARANCHAL-2005]**

(1) Balancing (2) Sight

(3) Hearing (4) Memory

Q.3 The correct sequence of meninges from inner to outer side is - **[UTTARANCHAL-2006]**

(1) arachnoid → duramater → piamater

(2) arachnoid → piamater → duramater

(3) piamater → duramater → arachnoid

(4) piamater → arachnoid → duramater

Q.4 Somaethetic or post central area is responsible for - **[UTTARANCHAL-2005]**

(1) initiation of motor impulses for voluntary muscles

(2) initiation of motor impulses for involuntary muscles

(3) perception of pain, touch and temperature

(4) co-ordination of speech

Q.5 Vagus nerve is composed mainly of parasymphathetic fibres. The preganglionic fibres forms a network is known as - **[UTTARANCHAL-2005]**

(1) choroid plexus (2) nervous plexus

(3) auerbach plexus (4) brachial plexus

Q.6 Lateral rectus muscle of the eye is served by which cranial nerve? **[West Bengal - 2007]**

(1) occulomotor nerve (2) pathetic nerve

(3) abducens nerve (4) spinal accessory

Q.7 Synaptic delay last for - **[West Bengal - 2007]**

(1) 0.1 ms (2) 0.3 ms

(3) 0.4 ms (4) 0.5 ms

Q.8 During nerve impulse transmission permeability of membrane is greater for - **[West Bengal - 2007]**

(1) Na^+ (2) K^+

(3) equal for both (1) and (2)

(4) Ca^{2+}

Q.9 Parkinson's disease is associated with - **[JHARKHAND-2002]**

(1) midbrain (2) thalamus

(3) hypothalamus (4) cerebrum

Q.10 The thermoregulatory centre in the body is- **[JHARKHAND-2004]**

(1) thalamus (2) hypothalomus

(3) pons (4)medulla oblongata

Q.11 Nissl's granules are - **[Bihar-2004]**

(1) RNA bodies (2) DNA

(3) carbohydrate (4) protein

Q.12 Which part of the brain is affected first in a drunk person - **[Bihar-2004]**

(1) Cerebrum (2) Olfactory lobe

(3) Cerebellum (4) Medulla oblongata

Q.13 In mammals, the brain centre, which regulates body temperature is situated in - **[UP-CPMT 2001]**

(1) Cerebrum (2) Olfactory lobe

(3) Cerebellum (4) Medulla oblongata

Q.14 The 3^{rd}, 6^{th} and 11^{th} cranial nerves are - **[UP-CPMT 2001]**

(1) optic, facial and spinal nerves

(2) oculomotor, trigeminal and spinal

(3) trigeminal, abducens and vagus

(4) oculomotor, abducens and spinal]

Q.15 The junction between the axon of one neuron and the dendrite of the next is called- **[UP-CPMT 2001]**

(1) a joint (2) a synapse

(3) constant bridge (4) junction point

Q.16 Which one of the following is a motor nerve? **[UP-CPMT 2001]**

(1) auditory (2) abducens

(3) optic nerve (4) trigeminal nerve

Q.17 Nissl's granules are absent in - **[UP-CPMT 2001]**

(1) axon (2) cyton

(3) dendron (4) schwann cells

Q.18 Which of the following is purely motor cranial nerve? **[UP-CPMT 2002]**

(1) Oflactory (2) Optic

(3) Abducens (4) Vagus

Q.19 Trigeminal nerve in case of frog is - **[UP-CPMT 2006]**

(1) I cranial nerve (2) II cranial nerve

(3) IV cranial nerve (4) V cranial nerve

Q.20 In human body muscular co-ordination is controlled - **[MP PMT-2005]**

(1) Spinal cord

(2) Cortex

(3) Cerebellum

(4) Cerebral hemisphare

Q.21 Sense of smell is by - **[MP PMT-2003]**

(1) cerebrum (2) cerebellum

(3) olfactory lobe (4) hypothalamus

Q.22 Third ventricle connects to lateral ventricles through - **[MP PMT-2003]**

(1) foramen magnum (2) foramen monro

(3) foramen magnedie (4) foramen luschka

Q.23 Connection between axon and dendrite is - **[MP PMT-2007]**

(1) synapse (2) synapsis

(3) desmosome (4) tight junction

Q.24 Depolarization of axolemma during nerve conduction takes place because of - **[AIPMT-2000]**

(1) Equal amount of Na^+ & K^+ move out across axolema

(2) Na^+ move inside

(3) More Na^+ outside

(4) None

Q.25 Which of the following statement is correct for node of Ranvier of nerve - **[AIPMT-2002]**

(1) Neurilemma is discontinuous

(2) Myelin sheath is discontinuous

(3) Both neurilemma & Myelein sheath are discontinuous

(4) Covered by myelein sheath

Q.26 What used to be described as Nissl granules in a nerve cell are now identified as - **[AIPMT-2003]**

(1) Cell metabolites (2) Fat granules

(3) Ribosomes (4) Mitochondira

Q.27 The ‘‘Nissle's granules’’ of nerve cells's are made up of - **[RPMT-2003]**

(1) Ribosome (2) Protein

(3) DNA (4) Mitochondria

Q.28 In the resting state of the neural membrane, diffusion due to concentration gradients, if allowed, would drive - **[AIPMT-2004]**

(1) K^+ and Na^+ out of the cell

(2) Na^+ into the cell

(3) Na^+ out of the cell

(4) K^+ into the cell

Q.29 Unidirectional transmission of a nerve impulse through nerve fibre is due to the fact that – **[AIIMS-2004]**

(1) Nerve fibre is insulated by a medullary sheath.

(2) Sodium pump starts operating only at the cyton and then continues into nerve fibre.

(3) Neurotransmitters are released by dendrites and not by axon endings.

(4) Neurotransmitters are released by the axon endings and not by dendrites.

Q.30 Nerve cells donot possess - **[MANIPAL-2005]**

(1) Neurilemma (2) Sarcolemma

(3) Dendrites (4) Axon

Q.31 Myelin sheath covers which of the following - **[MP PMT-2005]**

(1) Muscle fibre (2) Nerve fibre

(3) Collagen fiber (4) Tendons

Q.32 Dendrites are associated with which system **[MP PMT-2006]**

(1) Nervous system

(2) Digestive system

(3) Muscular system

(4) Blood vascular system

Q.33 Nerve impulse travel through nerve with the help of - **[MP PMT-2006]**

(1) Acetylcholine and sympathetin

(2) Choline and acetylcholine

(3) Adrenaline and noradrenaline

(4) None of the above

Q.34 A typical value of resting membrane potential is - **[KERALA PMT-2006]**

(1) - 40 mv (2) - 60 mv

(3) - 70 mv (4) - 80 mv

Q.35 During the transmission of nerve impulse through a nerve fiber, the potential on the inner side of the plasma membrane has which type of electric charge ? **[AIPMT-2007]**

(1) First positive, then negative and continue to be negative

(2) First negative, then positive and continue to be positive

(3) First positive, then negative and again back to positive

(4) First negative, then positive and again back to negative

Q.36 Which of the following is not a part of hind brain - **[RPMT-2004]**

(1) Medulla oblongata (2) Thalamus

(3) Cerebellum (4) Pons

Q.37 The name of nervous band connecting the cerebral hemispheres in rabbit is – **[MANIPAL-2005, MHCET-2004]**

(1) Corpus albicans

(2) Corpus callosum

(3) Corpus striatum

(4) Corpus spongiosum

Q.38 Arobor vitae is part of - **[MANIPAL-2005]**

(1) Cerebrum (2) Cerebellum

(3) Midbrain (4) Forebrain

Q.39 Which has H-shaped gray matter? **[MANIPAL-2005]**

(1) Cerebrum (2) Spinal cord

(3) Cerebellum (4) Medulla oblongata

Q.40 Human brain is covered by an extremely hard layer called - **[MPPMT-2005]**

(1) White matter (2) Duramater

(3) Piamater (4) Gray matter

Q.41 Which of the following is the part of mid brain of rabbit ? **[JIPMER-2004]**

(1) Cerebrum

(2) Diencephalon

(3) Corpora quadrigemina

(4) None of these

Q.42 The function of cerebrospinal fluid does not include - **[HPPMT-2006]**

(1) Protection of brain and spinal cord by containing antibody

(2) Protection of delicate brain and spinal cord from shock

(3) As a medium for excretion of waste product

(4) Buoyancy to brain ?

Q.43 Third ventricle lies in - **[MANIPAL-2003, MPPMT-1999]**

(1) Medulla oblongata (2) Mid brain

(3) Diencephalon (4) Cerebrum

Q.44 Ventricles of brain are lined by the cells called- **[MPPMT-2004]**

(1) Neuroglia (2) Ependymal

(3) Neurocells (4) Schwann cells

Q.45 In man the osmotic centres are situated in- **[MPPMT-2005]**

(1) Cerebrum (2) Hypothalamus

(3) Pituitary gland (4) Medulla oblongata

Q.46 Hypothalamus does not control - **[KERALA PMT-2005]**

(1) Libido (2) Osmoregulation

(3) Creative thinking and consciousness

(4) Thermoregulation

Q.47 Choroid plexus is a network of - **[KERNATAKA CET-2004]**

(1) Nerves (2) Muscle fibres

(3) Capillaries (4) Lymph vessels

Q.48 Cerebral hemisphere is not the centre of - **[RPMT-2003]**

(1) taste (2) smell

(3) balance (4) thinking

Q.49 Which part of brain is supposed to be damaged if in an accident, a person lost control of water balance, hunger and body temp. - **[RPMT-2003]**

(1) Cerebellum

(2) Hypothalamus

(3) Medula oblongata

(4) Corpora quadrigemina

Q.50 Column 'I' list the parts of human brain and column 'II' lists the function. Match the two columns and identify the correct choice from those given – **[KARNATAKE CET-2005]**

Column I	**Column II**
(A) Cerebrum	(i) Controls the pituitary
(B) Cerebellum	(ii) Controls vision and hearing
(C) Hypothalamus	(iii) Controls the rate of heart beat
(D) Midbrain	(iv) Seat of intelligence
	(v) Maintains body posture

(1) A = v, B = iv, C = ii, D = i

(2) A = iv, B = v, C = ii, D = i

(3) A = v, B = iv, C = i, D = ii

(4) A = iv, B = v, C = i, D = ii

Q.51 Which destryos the acetylcholineesterase - **[AIPMT-98]**

(1) Malathione (2) CO

(3) KCN (4) Colchicine

Q.52 Botulism affects - **[AIPMT-98]**

(1) Digestive system

(2) Blood vascular system

(3) Nervous system

(4) Respiratory system

Q.53 Which of the following nerve innervates upper jaw of fog - **[RPMT-2000]**

(1) Maxillary (2) Pathetic

(3) Palatine (4) Occulomotor

Q.54 In Rabbit, the number of spinal nerves are - **[RPMT-2000]**

(1) 30 pairs (2) 37 pairs

(3) 32 pairs (4) 38 pairs

Q.55 If parasympathetic nerve of the rabbit is cut, then heart beat - **[RPMT-2001]**

(1) Unaffected (2) Decreases

(3) Increases (4) Stop

Q.56 How many cranial nerves found in the Amniota - **[RPMT-2001]**

(1) 6 (2) 8

(3) 12 (4) 10

Q.57 In Rabbit, optic lobes are small because the eye sight is controlled by - **[RPMT-2001]**

(1) Temporal lobe

(2) Occipital lobe

(3) Frontal lobe

(4) Parietal lobe

Q.58 Norepinephrine leads to increase in -

(1) Blood pressure **[RPMT-2004]**

(2) Urine production

(3) Cellular respiration

(4) Release of epinephrine

Q.59 Injury to vagus nerve in humans is not likely to affect - **[AIPMT-2004]**

(1) Gastrointestinal movements

(2) Pancreatic secretion

(3) Cardiac movements

(4) Tongue movements

Q.60 In a man, is abducens nerve is injured. Which one of the following functions will be affected? **[AIPMT-2005]**

(1) Movement of the neck

(2) Movement of the tongue

(3) Movement of the eye ball

(4) Swallowing

Q.61 One of the examples of the action of the autonomous nervous system is - **[AIPMT-2005]**

(1) Pupillary reflex
(2) Swallowing of food
(3) Peristalsis of the intestines
(4) Knee-jerk response

Q.62 Excessive stimulation of vagus nerve in humans may lead to - **[AIIMS-2003]**

(1) Hoarse voice
(2) Peptic ulcers
(3) Efficient digestion of protein
(4) Irregular contractions of diaphragm

Q.63 Which of the following cranial nerve is not a motor nerve? **[MPPMT-2004]**

(1) II (2) III
(3) IV (4) XII

Q.64 Match the following human spinal nerves in column I with II and choose the correct options:

Column I	**Column II**
(a) Cervical nerves	(i) 5 pairs
(b) Thoracic nerves	(ii) 1 pair
(c) Lumbar nerves	(iii) 12 pairs
(d) Coccygeal nerves	(iv) 8 paris

[KERALA PMT 2005]

(1) a = ii, b = iv, c = i, d = iii
(2) a = iv, b = iii, c = i, d = ii
(3) a = iv, b = ii, c = i, d = iv
(4) a = i, b = iv, c = ii, d = iii

Q.65 9^{th} Pair of cranial nerve in frog is - **[AFMC-2005]**

(1) Vagus (2) Trigeminal
(3) Hypoglossal (4) Glossopharyngeal

Q.66 Which of the following is not under the control of vagus nerve? **[JIPMER-2005]**

(1) Gastrointestinal movement
(2) Respiratory movement
(3) Salivation
(4) None of these

Q.67 Which of the following is released by parasympathtic nervous system? **[BHU-2005]**

(1) Serotonin (2) Acetylcholine
(3) Epinephrine (4) Norepinephrine

Q.68 Facial nerve arising from medulla is - **[ORISSA JEE-2006]**

(1) Motor (2) Sensory
(3) Motor and sensory (4) None of these

Q.69 The mandibular nerve is the branch of which cranial nerve? **[JKCMEE 2006]**

(1) II (2) III
(3) V (4) VI

Q.70 Vagus nerve is composed mainly of parasympathetic fibres. The preganglionic fibres forms a network in the walls of the gut. This network is known as - **[UTTARANCHAL PMT 2006]**

(1) Choroid plexus (2) Nervous plexus
(3) Auerbach plexus (4) Brachial plexus

Q.71 Given below is a table comparing the effects of sympathetic and parasympathetic nervous system for four features (a-d). Which one feature is correctly matched? **[AIIMS 2006]**

	Feature	**Sympathetic nervous system**	**Parasympathetic nervous system**
(1)	Salivary glands	Stimulates secretion	Inhibits secretion
(2)	Pupil	Dilates	Constricts of the eye
(3)	Heart rate	Decreases	Increases
(4)	Intestinal peristalsis	Stimulates	Inhibits

Q.72 Effect of anaesthetics on body - **[AIPMT-98]**

(1) Inhibits Na-K pump
(2) Kills nerves
(3) Stops brain functions
(4) Inactivates skin cells

Q.73 Deficiency of oxygen affects mainly the - **[AIPMT-99]**

(1) Brain (2) Skin
(3) Kidney (4) Intestine

Q.74 Neuroglial cells associated with - **[AIPMT-99]**

(1) Heart (2) Kidney

(3) Brain (4) Eyes

Q.75 Adrenaline direct affect on - **[AIPMT-2002]**

(1) S.A. Node

(2) β-cells of Langerhans

(3) Dorsal root of spinal cord

(4) Epithelial cells of stomach

Q.76 In which animal, nerve cell is present but brain is absent - **[AIPMT-2002]**

(1) Sponge (2) Earthworm

(3) Cockroach (4) Hydra

Q.77 Which of the following is dominant intracellular anion - **[RPMT-2000]**

(1) Potassium (2) Chloride

(3) Phosphate (4) Calcium

Q.78 Nervous system developes from - **[RPMT-2000]**

(1) Ectoderm (2) Mesoderm

(3) Ectomesoderm (4) Endomesoderm

Q.79 Which of the following is not correctly matched - **[RPMT-2002]**

(1) Rhinon cephalon - Olfaction

(2) Hypothalamus - Pituitory

(3) Cerebellum - Balance

(4) Medulla oblongata - Temperature regulation

Q.80 Internal carotid artery supply blood to - **[RPMT-2003]**

(1) Kidney (2) Liver

(3) Heart (4) Brain

Q.81 Which one of the following characters is not typical of the class Mammalia ? **[AIPMT-2005]**

(1) Seven cervical vertebrae

(2) Thecodont dentition

(3) Alveolar lungs

(4) Ten pairs of cranial nerves

Q.82 Parkinson's disease (characterized by tremors and progressive rigidity of limbs) is caused by degeneration of brain neurons that involved in movement control and make use of neurotransmitter. **[AIPMT-2005]**

(1) acetylcholine (2) norepinephrine

(3) dopamine (4) GABA

Q.83 Which one of the following statements is correct ? **[AIPMT-2006]**

(1) Neither hormones control neural activity, nor the nervous control endocrine activity

(2) Endocrine glands regulate neural activity, but not vice versa

(3) Neurons regulate endocrine activity, but not vice versa

(4) Endocrine gland regulate neural activity, and nervous system regulates endocrine glands

Q.84 Which one of the following does not act as a neurotransmitter? **[AIPMT-2006]**

(1) Norepinephrine (2) Cortisone

(3) Acetylcholine (4) Epinephrine

Q.85 Which of the following two systems are opposite in action to each other ? **[MANIPAL-2004]**

(1) Nervous - Sensory

(2) Nervous - Endocrine

(3) Sensory - Endocrine

(4) Parasympathetic - Sympathetic

Q.86 Which of the following structures is present only in mammalian brain? **[MPPMT-2004]**

(1) Corpus luteum (2) Corpus striatum

(3) Corpus fibrosum (4) Corpus Callosum

Q.87 You are watching a horror movie and you notice your heart is beating fast and mouth is dry. It is because of - **[KERALA PMT-2005]**

(1) Flight and flight response

(2) Autonomic nervous system

(3) Sympathetic nervous system

(4) Both 1 and 3

Q.88 Tongue is under the control of - **[CPMT-2004]**

(1) Trigeminal (2) Facial

(3) Autonomic system (4) Glossopharyngeal

Q.89 Number of cranial nerves in forg is - **[CPMT-2005]**

(1) Ten (2) Twelve

(3) Ten pairs (4) Tweleve pairs

Q.90 Intercellular communication in multicellular organism occurs through - **[CPMT-2004]**

(1) Nervous system only

(2) Digestive system only

(3) Respiratory system only

(4) Both nervous and endocrine system

Q.91 Which of the following substances leads to the inhibition of central nervous system? **[CPMT-2004]**

(1) Glycine (2) GABA

(3) Norepinephrine (4) Both 1 and 2

Q.92 Which one of the following pairs of structures distinguishes a nerve cell from other types of cell ? **[AIPMT-2007]**

(1) Vacuoles and fibres

(2) Flagellum and medullary sheath

(3) Nucleus and mitochondria

(4) Perikaryon and dendrites

Q.93 5^{th} cranial nerve of frog is called - **[BHU-2006]**

(1) Optic nerve (2) Vagus

(3) Trigeminal (4) Opthalmic

Q.94 If dorsal root of spinal cord is broken down then its effect is - **[JIPMER 2006]**

(1) No effect on impulse

(2) Impulse is transmitted fast

(3) Impulse is transmitted but slowly

(4) No impulse is transmitted from receptor

Q.95 Acetylcholinesterase enzyme splits acetyl-choline into - **[Pb. PMT 2005]**

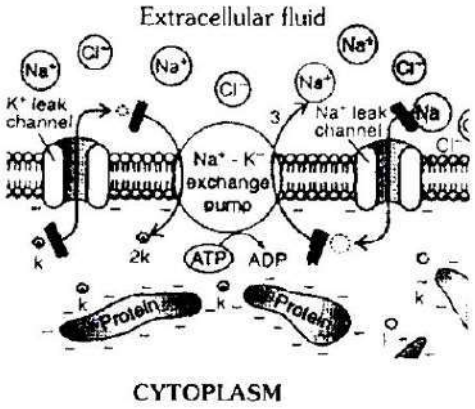
(1) Acetone and choline

(2) Acetic acid and choline

(3) Amino acid and choline

(4) Aspartic acid and acetylcholine

Q.96 In the given diagram which stage of conduction of nerve impulse through nerve fibre is observed? **[Gujrat CET 2006]**



(1) Polarization (2) Repolarization

(3) Depolarization (4) Resting potential

Q.97 Olfactory area is present in : **[MH. CET 2005]**

(1) Frontal lobe (2) Parietal lobe

(3) Temporal lobe (4) Occipital lobe

Q.98 Somesthetic or post central area is responsible for : **[Uttarakhand PMT 2006]**

(1) initiation of motor impulses for voluntary muscles

(2) initiation of motor impulses for involuntary muscles

(3) perception of pain, touch and temperature

(4) coordination of speech

Q.99 Feelings of anger, pain and pleasure are experienced through : **[Gujarat CET 2006]**

(1) Frontal lobe (2) Parietal lobe

(3) Limbic system (4) Reticular system

Q.100 The caranial nerve that supply the external rectus muscle is : **[EAMCET 2006]**

(1) II (2) III

(3) VII (4) VI

Q.101 Dilation of pupil of human eye is caused by: **[CPMT 2006]**

(1) parathormone

(2) sympathetic

(3) parasympathetic nerve

(4) autonomic nervous system

Q.102 Nerve impulse is generated when nerve cell undergoes : **[Chandigarh CET 2006]**

(1) Depolarization (2) Repolarization

(3) Hyperpolarization (4) Pseudopolarization

Q.103 Nerve impulse initiates with the movements of: **[RPMT 2006, BCECE 2007]**

(1) K^+ (2) Na^+

(3) Ca^{2+} (4) Mg^{2+}

Q.104 Which part of brain controls intellectual ability? **[DPMT 2007]**

(1) Frontal lobe (2) Parietal lobe

(3) Temporal lobe (4) Occipital lobe

Q.105 Occipital lobe is connected with : **[MH. CET 2007]**

(1) smell (2) vision

(3) speech (4) hearing

Q.106 **Assertion (A) :** The imbalance in concentration of Na^+, K^+ and proteins generates resting potential.

Reason (R) : To maintain the unequal distribution of Na^+ and K^+, the neurons use electrical energy. **[AIIMS 2007]**

(1) Both (A) and (R) are true and (R) is the correct explanation of (A)

(2) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(3) (A) is true statement but (R) is false

(4) Both (A) and (R) are false

Q.107 During the conduction of nerve impulse, the action potential is the result of movement of: **[Wardha 2007]**

(1) Na^+ from intracellular fluid to extracellular fluid

(2) Na^+ from extracellular fluid to intracellular fluid

(3) Na^+ towards both directions

(4) None of the above

Q.108 Which of the damaged cells cannot be repaired? **[JCECE 2007]**

(1) Liver cells (2) Brain cells

(3) Bone cells (4) Epidermal cells

Q.109 The IV cranial nerve is : **[DPMT 2008]**

(1) facial (2) trochlear

(3) olfactory (4) oculomotor

Q.110 Adrenaline is equivalent to which neurotransmitter ? **[Orissa JEE 2009]**

(1) GABA (2) Serotonin

(3) Epinephrine (4) Norepinephrine

Q.111 All sensory pathways to the cerebral cortex synapse at the : **[AMU 2009]**

(1) pons (2) thalamus

(3) cerebellum (4) hypothalamus

Q.112 A man is admitted to a hospital. He is suffering from an abnormally low body temperature, loss of appetite and extreme thirst. His brain scan would probably show a tumour in : **[Karnataka CET 2009]**

(1) pons (2) cerebellum

(3) hypothalamus (4) medulla oblongata

Q.113 The nerve centres which control the body temperature and the urge for eating are contained in : **[CBSE 2010]**

(1) Pons (2) Thalamus

(3) Cerebellum (4) Hypothalamus

Q.114 The optic lobes in humans are represented by the corpora : **[AMU 2010]**

(1) bigemina (2) arenacea

(3) striata (4) quadrigemina

Q.115 In a medullated nerve fibre, the conduction of impulse is faster due to the presence of : **[Orissa JEE 2010]**

(1) Pericytes

(2) Nissl's granules

(3) Endoneurium and Epineurium

(4) Myelin sheath and Node of Ranvier

Q.116 Which of the following is not an effect of sympathetic nervous system ? **[AMU 2010]**

(1) Dilation of the pupil

(2) Inhibition of peristalsis

(3) Elevation of blood pressure

(4) Stimulation of saliva secretion

Q.117 When a neuron is in resting state i.e. not conducting any inpulse, the axonal membrane is **[CBSE 2011]**

(1) Comparatively more permeable to Na^+ ions and nearly impermeable to K^+ ions

(2) Equally permeable to both Na^+ and K^+ ions

(3) Impermeable to both Na^+ and K^+ ions

(4) Comparatively more permeable to K^+ ions and nearly impermeable to Na^+ ions.

Q.118 The human hind brain comprises three parts, one of which is : **[AIPMT Pre 2012]**

(1) Corpus callosum (2) Cerebelium

(3) Hypothalamus (4) Spinal cord

ANSWER KEY

EXERCISE – 3

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	2	1	4	3	3	3	1	1	4	2	1	1	1	4	2	2	1	3	4	3
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	1	2	1	2	2	3	1	2	4	2	2	1	1	3	4	2	2	2	2	2
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	3	1	3	2	2	3	3	4	2	4	1	3	1	2	3	3	2	1	4	3
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	3	2	1	2	4	3	2	3	3	3	2	1	1	3	1	4	3	1	4	4
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	4	3	4	2	4	4	4	4	3	4	4	4	3	4	2	1	3	3	3	4
Ques.	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**		
Ans.	2	1	2	1	2	3	2	2	2	3	1	3	4	4	4	4	4	2		

EXERCISE – 4 AIIMS SPEICAL

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** All of the cranial nerves are said to be mixed nerves.

R : All cranial nerves carry both sensory and motor nerve fibres simultaneously.

Q.2 **A :** Facilities like intelligence, will power, emotions, learning, etc. are more developed in man.

R : Cerebral cortex of man has large number of gyri and sulci.

Q.3 **A :** Motor neuron terminates on a motor end plate at the neuromuscular junction.

R : Motor end plate acts as receptor for detecting changes in the muscle fibres.

Q.4 **A :** Giant squids possess very thick nerve fibres.

R : The nerve impulse travels faster in a thicker nerve fibre than in a thinner one.

Q.5 **A :** The chemicals stored in the synaptic vesicles are termed as neurotransmitters.

R : Synaptic vesicles release these chemicals in the synaptic cleft.

Q.6 **A :** Nerve impulse can never be transmitted from dendrite or cell body of one neuron to the axon of the next neuron, across a synapse.

R : This happens because of the synaptic delay at each synapse.

Q.7 **A :** Nerve impulses are conducted more rapidly in nonmyelinated nerve fibres than in myelinated ones.

R : Mylein sheath insulates the nerve fibre and prevents its depolarization.

Q.8 **A :** Salivation caused by taste of food is regarded as a conditioned reflex.

R : Conditioned reflex is evoked immediately without any previous encounter with the stimulus exciting it.

Q.9 **A :** Nervous system serves its coordinating role in several ways.

R : Neuron conducts nerve impulses.

Q.10 **A :** White matter is present in the brain.

R : Whiteness of white matter is due to white pigment.

Q.11 **A :** Brain and spinal cord has a common covering.

R : Both the brain and spinal cord possess meninges.

Q.12 **A :** Cerebrospinal fluid is present throughout the central nervous system.

R : CSF has no such function.

Q.13 **A :** A person has lost most of its intelligence, memory and judgement.

R : A person has operated a tumor located in the cerebrum.

Q.14 **A :** The brain stem contains centres for controlling activities.

R : Brain stem is very sensitive.

Q.15 **A :** Spinal cord has a column of both grey and white matter.

R : Grey matter forms the central spinal canal.

Q.16 **A :** After hearing a sound, nerve impulse passes from neurons to the brain.

R : The neurons which pass nerve impulses from the body organ to the brain is called afferent neuron.

Q.17 **A :** Motor end plate is a neuromuscular junction.

R : Motor end plate is the junction between motor neuron and muscle fibre.

Q.18 **A :** Nerve conduction is the one way conduction.

R : Nerve impulse is transmitted from dendrite terminals to axon terminals.

Q.19 **A :** Nerve impulse is originated from threshold stimulus.

R : Threshold stimulus is the minimum strength of stimulus which is applied to the nerve fibre to stimulate it effectively.

Q.20 **A :** Taste of food causes salivation even in a new-born baby.

R : Food causing salivation is an unconditioned reflex.

Q.21 **A :** Corpus callosum is present in the space between the pia and arachnoid maters.

R : It serves to maintain a constant pressure inside the cranium.

Q.22 **A :** With the evolution of multicellularity, it became imperative to develop nervous system.

R : Special senses such as vision, hearing are produced by sense organs associated with the nervous system.

Q.23 **A :** The premotor area of frontal lobe of the cerebral cortex is very important for vision and hearing.

R : The premotor area contains nerve centres for visual and hearing sensations.

Q.24 **A :** All motor neurons are efferent neurons.

R : Motor neurons conduct nerve impulses from the spinal cord to the brain.

Q.25 **A :** All sensory neurons are said to be efferent in nature.

R : Sensory neurons carry nerve impulses from the peripheral tissues to the CNS.

Q.26 **A :** Some areas of the brain and spinal cord look white.

R : This because cell bodies of neurons are situated in those areas.

Q.27 **A :** Nervous system of man is formed of two types of matter-Grey and White matter.

R : In human brain, grey matter is external while white matter is internal.

ANSWER KEY

EXERCISE – 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	3	1	2	3	3	4	1	3	1	3	1	2	3	2	1	3	2	2
Ques.	21	22	23	24	25	26	27													
Ans.	4	2	4	3	3	3	3													

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A Question I am unable to solve in first attempt	COLUMN : B Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

SENSE ORGANS

Animals possess some specialised structures to perceive the different type of changes (= stimuli) occurring in their external environment. These structures are known as **sense organs**. After receiving these stimuli, sensory organs transmit these to the central nervous system through the sensory nerve fibers.

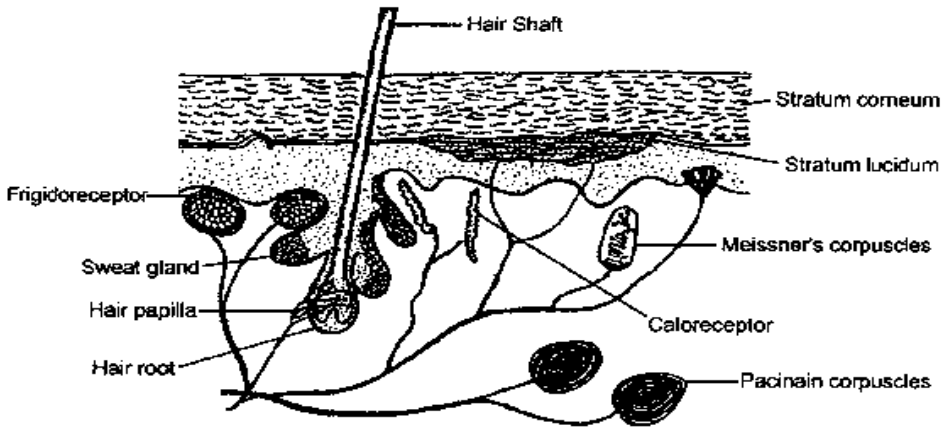
A sensory organ is only sensitive to a specific kind of stimulus to which it is specialized like temperature, chemicals, touch, light etc. Based on their location in the body sensory organs are of three. types :

1. **Exteroceptors : -** These sense organs receive stimuli from external environment because they remain in contact with the external environment. Example – nose, eyes, tongue, ears and skin.
2. **Interoceptors :** These sensory organs are associated with internal environment of body and receive the changes taking place in the internal environment. Examples – changes in the composition of blood, concentration of carbon-dioxide, hunger, thirst, asphyxia etc.
3. **Proprioceptors :** These sensory organs are present in joints, tendons, muscles and connective tissues which perceive the tension and pressure exerted during the activities of equilibrium maintenance and orientations of body.

In human body, five types of exteroceptors are found which are known as sense organs. The main sense organs include skin, eye, nose, ear and tongue.

CUTANEOUS RECEPTORS

Skin envelopes the entire body, and it is considered as tango receptor (fig.) Numerous sensory papillae are found in the dermis of skin to receive the stimuli of touch, pressure, cold, heat, temperature and pain. All these are of simple type of receptors. These sensory structures of skin receive impulses from the nerve endings in skin. These are of following types -

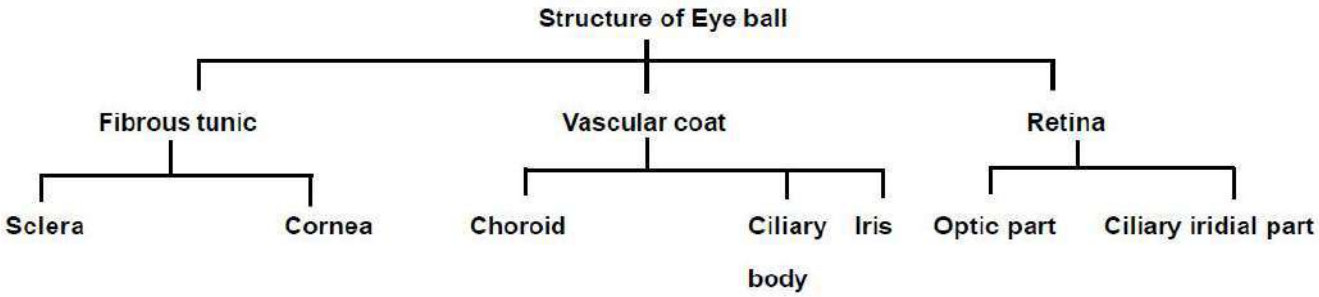


1. **Tactile Receptors : -** These receptors are present nacked endings of sensory nerve fibres on the hair follicles in the dermis of skin. These are excited when the hairs come in contact with some object.
Extensively branched (arborized) endings are of sensory nerves are found in the papillae of dermis. These endings are very small sized encapsulated structures called sensory corpuscles. Those which are cylindrical and sensitive to touch are called **Meissner's corpuscles**. Their number is much more in nipples, lips, glans penis, palm, sole and in fingers. The number of these corpuscles decreases as a person grows

older. The corpuscles sensitive to the strong and sustained contacts (pressure) and situated deep in the dermis and called as **Pacinian corpuscles**.

2. **Pain Receptors (Algesireceptors) :** Numerous branched sensory nerve fibres are scattered among the epidermis as well as dermal cells of skin. These possess nacked nerve endings. These nerve endings are sensitive to chemical, electrical, and mechanical stimuli, which cause the sensations of pain in body.
3. **Thermo Receptors :** A network of sensory nerve fibres is situated closely to the hair follicles in dermis of skin. These nerve fibres are sensitive to the stimuli related to temperature, These thermoreceptors make a person aware to stimuli of cold, heat etc. Because of this sense perception our hairs get erected during excessive cold. The sensory organs excited by cold and heat are known as **frigidoreceptors**.

EYE



- Eye and ear also called **"teleoreceptor"**, because these receive impulse from far places.

(A) Eye (Photoreceptor) : -

- These are photosensitive organs. Eye ball measures about 2.5 cm in diameter.
- Each eye is an empty ball like round structure, it is called eye ball. Each eye ball is situated in the notch of frontal bone of the skull. It is called "Eye orbit". Human eyes are situated in eye orbit lateral to nose.
- Only $1/5^{th}$ part of whole eye is seen from out side the eye orbit, called as cornea.
  Remaining $4/5^{th}$ part is in the eye orbit, called sclera.

(1) Eye lids or palpebrae : -

There are two muscular eyelids for the protection which having lashes at one side. Both the eyelids are named according to their situation i.e. upper & lower eyelids.

- Eyelids are immovable in snakes. Eyelids of fishes are absent.
- There is present one more transparent membrane on the cornea. It is called nictitating membrane or third eye lid. It is actively working in rabbit. It is found form of constricted condition at one corner of eye ball, but at the time of need, it may be expanded over entire eye ball.
- Nictitating membrane is vestigeal in human. It is also called **"Plicasemilunaris"**
- Eye lashes are found at both the eyelids.

(2) Glands : - For the cleaning and for lubrication/moisturising the exposure part of eye.
Following glands are founds in each eye.

(a) Meibomian glands : - These are present at Inner surface of eyelids. They secrete an oily substance, which spread over cornea.

- It prevent firction between two eye lid.
- It also help in frictionless movement of eyelid.

(b) Lacrimal glands : - At outer angle of each eye ball and assoicated with accessory lacrimal gland, which secrete water like substance, which moistures the cornea, eyelids and conjunctiva and cleans it. This water like subatnace is called "Tear". (Slightly alkaline contains bacteriolytic enzyme Lysozyme)

- Tear glands activate after four months of birth in human child.

(c) Gland of zeis : It is situated in margin of eye lid.

Harderian glands : - These are found inside the lower eye lids. These moisten the nictitating membrane.

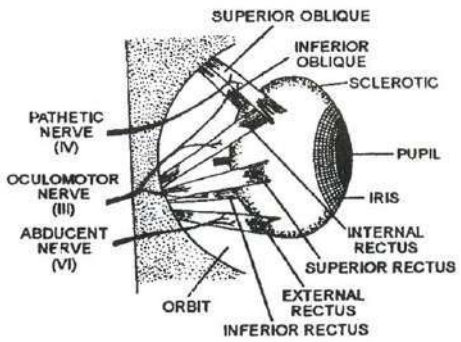
- Harderian glands are absent in rabbit & **human**.
- In place of harderian glands, in mammals, meibomian glands are present. But in some mammals e.g. rats, shrews, whales etc., these harderin glands are found.
- These glands are also found in frog and birds.

(d) Gland of moll : - These are modified sweat gland found in the eye lashes.

(3) Muscles of eye balls : -

There are present 6 voluntary muscles in the eyeball which help to rotate the eye ball into eye orbit. Out of these 4 are rectus muscles and 2 are oblique muscles. They are also called as extra occular muscles.

- Lateral or External Rectus muscle rotates the eyeball towards outside i.e. from nose to ear. Medial or Internal rectus muscle rotates the eyeball toward inside i.e. from **ear** to nose.
- Superior rectus muscle and inferior oblique muscle collectively help the eyeball to rotate upwards.
- Inferior rectus muscle and superior oblique muscle collectively help the eyeball to rotate downwards.
- Rectus and oblique muscles collectively rotate the eye ball to all the sides around its axis.



- Any defect in one of the these eyeball muscles (e.g. muscle may remain small or extra large than required) causes **strabismus** or **squint eyes**. In this defect, eye ball remains inclined to any of the one side. Eye muscles are innervated by occulomotor (III). Pathetic (IV) and Abducens (VI) Nerve.

INTERNAL STRUCTURE OF EYE BALL

The wall of remaining eye ball has three layers.

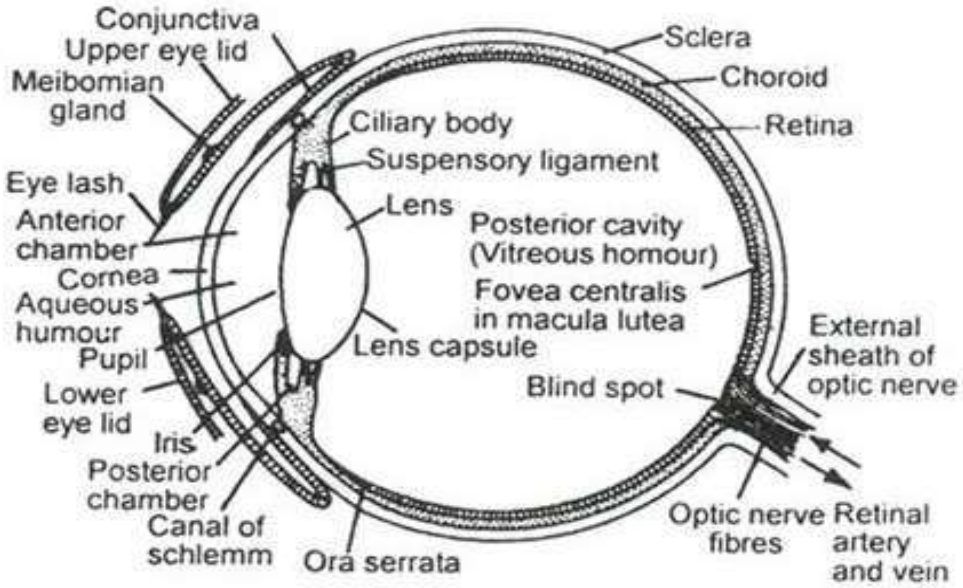
(1) Fibrous tunic : -

- It is mesodermal in origin.
- It is the outermost covering of eye ball. It is made up of hard and thick fibrous connective tissue. It is also called as sclerotic layer
- The layer is divided into 2 parts.

(a) Cornea : -

It is the outer visible part of fibrous tunic.

- The joint between cornea and sclerotic layer is called **"Limbus"** or "Sclero – corneal junction". Cornea transplantation is successful because it lacks blood vessels.



(b) Sclera : -

It is made up of white, hard, opaque thick fibrous connective tissue in mammals but in frog, it is made up of cartilage. It is the inner portion of eye ball. It is non-vascularised. This layer is of white colour, so it is also called "White of eye"

Inner layer of eyelids remain streched over anterior part of sclera (limbus) in the form of translucent membrane. It is called **conjunctiva**. It is made up of epidermis of skin. The thinnest epidermis is extend up to margin of cornea i.e. conjunctiva is the thinnest epidermis in animal body.

(2) Vascular tunic : -

- It is also mesodermal in origin.
- It is made up of network of blood capillaries.
- It is the middle layer of eyeball Due to the presence of network of blood capillaries it is highly vascularized. Melanin pigment is found in this layer. Due to the presence melanin pigment eye looks like green, blue, brown, black in colour. Eyes of rabbit are red due to red melanin pigments, and in man eyes may be brown, black, blue, green according to the melanin present in it.

This layer has three parts : -

(a) Choroid layer : -

Choroid layer is the part of vascular tunic which lie below the sclerotic layer.

It contains abundant pigment cells & blood vessels.

It is dark brown. It darkens the cavity of eyeball to prevent internal reflection of light.

It nourishes the retina.

(b) Ciliary body : -

It is the lower swollen portion below limbus.

It has ciliary processes which project into eyeball.

It has ciliary muscles (i) circular (ii) meridional.

Inner end of meridional is attached to choroid & outer end at the junction of sclera and cornea.

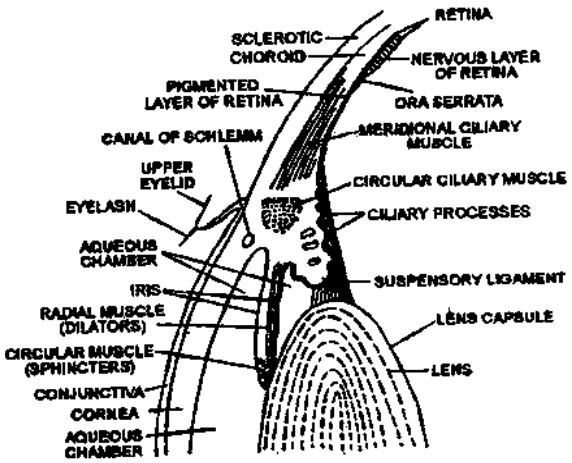
(c) IRIS : -

Choroid layer of vascular tunic separates from sclerotic layer (Just after the cornea) inclines towards inner side and forms a coloured screen, it is called **Iris**. **Muscles of Iris are ectodermal in origin.** There is present an aperture in the Centre of Iris, it is called **Pupil**. Light rays enter in the eye ball through pupil.

2 types of muscles are found with Iris.

(i) Radial dilatory muscles : -

These are outer Involuntary muscles, these are expanded in the iris breadth wise. Iris becomes thick and narrow if these muscles contract and diameter of pupil is increased at that time. It happens in dim light, it is called **Mydriasis**.



(ii) Circular sphincter muscles : -

These are scattered in inner part of iris. Due to the contraction (In bright day light or high flashes of light) of these muscles in high light, Iris expands breadth wise and diameter of pupil is decreased. It is called **miosis**.

Iris controls the intensity of light by increasing or decreasing the diameter of pupil i.e. Iris acts as diaphragm of a camera. Except muscle of iris & ciliary body all vascular tunic of eye ball is **mesodermal** in origin. The parasympathetic fibres constrict & sympathetic fibre dilate the pupil. Colour of eye like blue, gray, brown is layer of pigmented cells.

(3) Neurosensory tunic : -

- This layer is ectodermal in origin.
- It is the inner most layer of eye ball and has 3 parts : -

(a) Pars ciliaris : - This part is attached with ciliary bodies. There are present spine like projections at the surface of ciliary body, these are called **"Orra serrata:**

(b) Pars iridica : - This part lies just after the iris. It has a layer of pigmented cells.

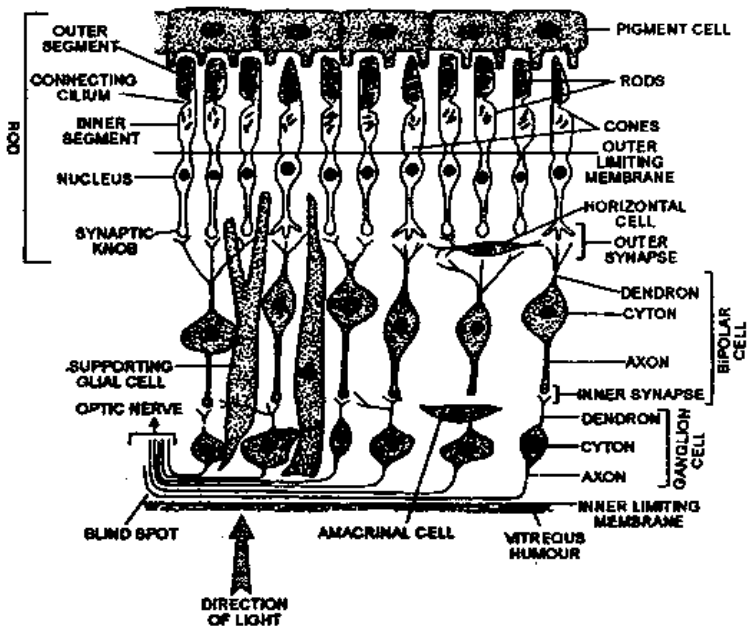
Pars iridica and pars ciliaris are made up of simple cuboidal epithelium.

(c) Pars optica : - It is also called **Retina** It is the part just below the choroid layer.
Structure of retina is complicated. It has following layers.

(i) Pigmented layer : - It is the outer most layer. In the cells of this layer, pigment is found called melanin (receptor cells.)

(ii) Sensory layer : - This layer is made up of specialized sensory cells. Rods and cones are found in this layer. Receptor cells are also known as photoreceptors/visual cells.

- Rods are long, thin, cylindrical structures/cells. These are nmerous in number. (1110 – 1125 Lacs)
- Rods are differentiates the light and dark. They are more sensitive than cones.
- A purple coloured pigment is found in rods called **Rhodopsin/Visual purple.**
- Cones are thick and small cells which differentiate among different colours in full light (65 Lacs) **Iodopsin/Visual violet** is present in cones.
- Only rods are found in the retina of owl, because it is nocturnal animal, unlike hen which has only cones in its retina.
- Cones are absent in the retina of most of the nocturnal mammals like shrews, bats etc. squirrel has only cones in its retina.
- A neurons layer is present just below the rods and cones. The synapse layer which, developes between photo sensory cells and bipolar neurons are called as outer plexiform layer.
- Each bipolar neuron has a dendron and one axon.



- Axons are jointed together by specific nerve cells, called **Amacrine cells**. Such neurons do not have nerve fibres.
- In between bipolar neurons, supporting cells are found which, are called as **Muller's cells**.

(iii) Ganglionic layer : - This layer is made up of multiple nerve. The dendrites of multipolar nerve form synapses with axons of bipolar neurons. This layer of synapse is called as inner plexiform layer.

Axons of all nerve cells combine to form optic nerve. This optic nerve penetrates the retina and goes to brain.

At the point place, at which retina is pierced by optic nerve, cones and rods are absent. So no image will be percieve at that place. This point place is known as **"Blind spot"**.

Just above the blind spot at the optical axis of eye ball, there is a place, where only cones are present. Yellow pigments is found (xanthophyll) in these cones. So this place is known as **yellow spot** or **macula lutea** or **Area centralis**.

- A groove or notch is found in area centralis, called **fovea centralis**. Fovea centralis contain only cone cells.
- Fovea centralis is most sensitive part of eye. Cones are some what obliquely placed at this place. An enlarged image of object is formed here.

Differences between Blind spot and Yellow spot

Blind spot (Optic disc)	Yellow spot (Macula lutea)
It lies a little away from the yellow spot.	It lies exactly opposite the centre of the cornea.
It contains no pigment.	It has a yellow pigment.
Optic nerve starts from this spot.	No nerve starts from this spot.
It lacks a depression.	It has a shallow depression, the fovea centrallis, at its middle.
It lacks visual receptors and is insensitive to light.	It has visual receptors and is sensitive to light.
The eye coats are absent at blind spot.	Eye coats are present at yellow spot.
No image is formed at this place.	Image is formed at this place.

Ora seratta : The function retina terminates anteriorly along an irregular border, the ora seratta.

- **Lens : -** It is ectodermal origin.
- A transparent, biconvex lens is present just after iris. In frog, lens is spherical in eyebal.
- Lens is connected by ciliary body with the help of **"Suspensory ligaments"** also called as **zonula of zinn"** or **zonules**. These ligaments are flexible and this can slide the lens and can change it's focal length. Lens ans suspensory ligament divides the cavity of eyeball into two chambers.

(a) Aqueous chamber : -

The part of eye ball which lies between cornea and lens is filled with an akaline liquid, it is called aqueous humor. It is a type of transparent tissue fluid. It's divided aqueous chamber into two parts.

(i) Anterior chamber : -

This chamber lies between cornea and iris, it is also called as Venous chamber. Veins carry CO_2, metabolic wastes outside from here.

(ii) Posterior Chamber : -

This chamber lies between iris and lens, it is also called as arterial chamber. Arteries supply O_2 and nutrients here.

(b) Vitreous chamber : - Cavity of eye ball which lies between lens and retina is called vitreous chamber. A jelly like liquid (transparent and thick like albumin) is filled in this chamber, This is called vitreous humor.

Differences between Aqueous humour and Vitreous humour

S.No.	*Aqueous humor*	*Vitreous humor*
1.	It occurs in aqueous chambers.	It occurs in vitreous chamber.
2.	It is a watery fluid	It is a jelly-like substance.
3.	It is secreted by ciliary processes.	It is apparently secreted by retina during development of eye.;
4.	It is continuously absorbed into blood and replaced.	It is not absorbed or replaced
5.	It contains most of the diffusible substances of the plasma	It consists of water (99%) protein vitrein, hyaluronic acid and collagen fibres.
6.	Obstruction in its flow may damage retina by increasing intraocular pressure.	It does not flow.

- In this liquid 99% water, some salts, a mucoprotein called vitrin and a mucopolysaccharide-Hyaluronic acid are present. Gelatinous nature of vitreous humor is depend upon fibrillar protein & hyaluronic acid. It is form during embryonic stage. In this chamber Hyalocytes cells are found.
- Aquous humor and vitreous humor both the liquids are secreted by the glands of cilliary body. Canal of Schlemm is present between limbus and ciliary body . Aqeous humor leak out by **canal of schlemm** into blood capillaries and again reach upto their veins.
- Both these liquids maintain proper pressure inside the cavity of eye ball. These check the eye ball from collapsing.
- If this canal of schlemm is blocked by any reason and fluids do not return back to veins liquid is increased in the chambers of eye.
- When amount of this humor is increased in the eye chambers then pressure is increased inside the eye ball . Thus retina pressure is increased. This is known as **glaucoma.**
- A thin **Hyaloid canal or Cloquet's or Cloquet's canal** is also found in vitreous humor from blind spot to central point of lens. It provide nourishment to the developing lens which gradually atrophied.

WORKING OF EYES

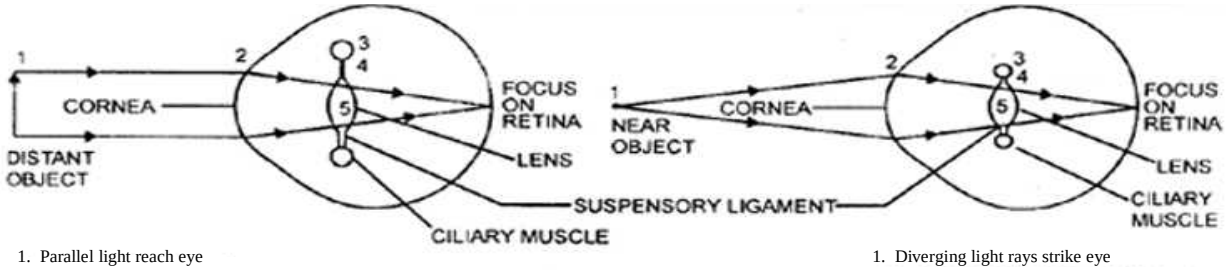
- Light ryas emitted by any object enter the eye. A small, real and inverted image of object is formed at retinal Sensory cells of retina are sensitized, and optic nerve carries this impulse to brain . At this time animal able to see the object.
- Cornea, aqueous humor biconcave lens and vitreous humor completely refract the light rays coming from ojbect. As a result of this an inverted image is formed at retina. Just like diaphragm of a camera. is Iris of eye, decreases or increases the diamter of pupil acoording to amount of light. Iris expands to decrease the pupil in high intensity of light so a small amount of light touches the retina. When light is dim, iris itself constricts to increase the diameter of pupil.

ACCOMODATION OR FOCUSSING -

The ability to change the focal length of lens by changing the curvature of lens, is called **accommodation** power.

- Only mammals and birds have this accommodation power in their eyes.

- This ability is very less in frog and it depends on the sliding of lens forward and backward to some extent.



1. Parallel light reach eye
2. Cornea refracts light rays
3. Ciliary muscle relaxed
4. Suspensory ligament under maximum tension
5. Lens flattened

1. Diverging light rays strike eye
2. Cornea refracts light rays
3. Ciliary muscle contracted
4. Suspensory ligament loose
5. Lens thickened

Diagram showing changes during accommodation

- In normal condition muscle fibres of ciliary body remain relaxed and lens is stretched by its suspensory ligaments, and due to this lens is flat. A flat lens has more focal length. As a result of this eye can see long distant objects easily.
- To see near by objects, sphincter muscles of ciliary body contract and ciliary body becomes broad, suspensory ligaments becomes loose and relaxed. As a result of this relaxation lens becomes biconvex, and now tis focal length is reduced. Now animal is able to see near by object easily.

TYPES OF VISION :

(a) Monocular vision or panoramic vision : - Most of the vertebrates have their eyes situated on the lateral sides of head and due to this animal is capable to see the large area of both the sides. It is called monocular vision.

e.g. rabbit, frog, horse (Most of the herbivorous animals have this type of vision)

(b) Binocular vision : - Most of the carnivores mammals have eyes in front of their heads and side by side, so as to focus on one object by both the eyes. It is called binocular vision e.g. Man, monkeys and apes.

(c) Stereoscopic vision : - It is three dimensional vision found in human.

(d) Telescopic vision : - This is found in birds.

- Largest eyeballs are found in horse.
- Sharpest vision is found in eagle.
- Shortest sight is found in monkeys.

Chemical explanation of vision -

Cones and rods of eye are stimulated by light rays. It is a chemical event.

- A shiny visual purple pigment is found in rods of retina called Rhodopsin. It is formed by a protien **opsin** and a coloured pigment **Retinal,** just like haemoglobin of blood.
- Opsin is also called **scotopsin.**
- In bright light. rhodopsin is decomposed into opsin protein and retinal pigments. This chemical change is sight impulse. This sight impulse is carried by optic nerve to the brain, and animal is able to see.
- In dark, rods synthesize rhodopsin again with the help of opsin, retinal and enzyme.

- This is the reason that we can not see any thing, when we move to dark place from a enlighted place (for some time only) In the same way we are unable to see in light if we are coming from dark place because it will take time to synthesize or decompose the rhodopsin **it is called adaptation of eye.**
- For resynthesis of rhodopsin, animal blinks its eyelids.
- Retinin is fomred by vitamin A so deficiency of vit A caused night blindness.
- Cones able us to differentiable among colours and bright light. Cones have a pigment called Iodopsin in place of rhodopsin of rods. It is decomposed into **photopsin** and **retinal.**
  There are three types of cones in retina : -
  (a) Erythrolab - Red cones (erythropsin – Sensitive to red)
  (b) Chlorolab - Green cones (Chloropsin – Sensitive to green)
  (c) Cynolab - Blue cones. (Cynopsin – Sensitive to blue)
- We are able to acknowledge different colours due to these three types of cones their combination.
- In moon light we cannot see colours because only rods are functioning . Due to low light level cones are not functining.
- **Red, green** and **blue ar the primary colours.**
  Dimlight vision - Scotopic vision
  Bright light vision - Photopic vison
- The eyes of some animals shine at night, because in the eyes of these animals, there is a pigment just outside the retina in the choroid layer of eyeball, which reflects the light rays coming from retina. This layer is called **Tapetum.** Due to this layer, these animals are capable to see in dark also.
- Kangaroo, hoofed mammals, elephants, whales etc. are having a silver shining layer of fibrous connective tissue called Tapetum **fibrosum.**
- In Elasmobranch fishes a reflecting colour pigment called **Guanine** is present is tapetum layer so it is called **tapetum lucidum.**
- Hunters and carnivore mammals like dogs, cats, tiger etc. have a layer in their retina called **tapetum cellulosum.**
- In the eyes of birds a comb like structure of blood vessel is present which, is called **pecten.**
- **Emmetropia : -** Normal vision of eyes is called emmetropia.

Some important defects of eyes : -

1. Hypermatropia (far sightedness) : -

- In this defect of eye, person is able to see object placed at far distance but is unable to clear see obejcts close to him or her.
- This defect is due to small size of eyeball or flatness of lens. In this defect image is formed **behind the retina.** To cure this defect person should wear convex lenses in spectacles.
- Sometimes in old age this defect may occur due to reduction in the flexibility of lens or ciliary body, then it is known as **presbyopia.**

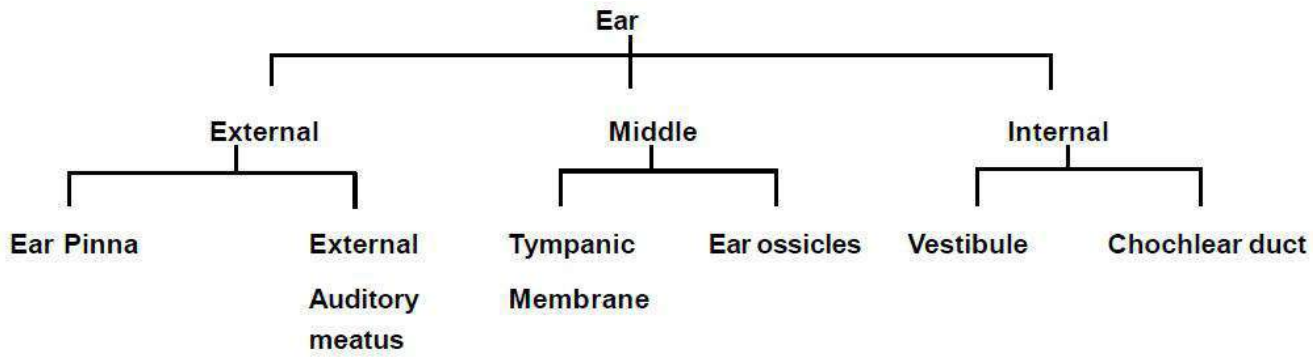
2. Myopia or Nearsightedness or short sightedness : -

- In this defect of eye, person is able to see objects near/close to him or her but is unable to see objects placed at far distance.
- This is due to enlargement of eyeball or increased convexity of lens.
- In this defects image is formed before the retina because light rays coming from distant objects converge before retina.

- To overcome this defect person should wear concave lenses in spectacles.

3. **Astimgmatism : -** In this defect curvature of cornea is changed as a result of that light rays do not focus on macula lutea but somewhere else, causing incomplete blurred vison. This defect may be cured by cylinderical lenses.
4. **Night blindness : -** This is due to deficiency of vit A. In this disorder synthesis of Rhodopsin is decreased.
5. **Xerophthalmia : -** it is due to keratinisation of cunjunctiva and cornea, and conjuctiva becomes thick. It is also due to deficeincy of vit A.
6. **Trachoma : -** In this defect of eye, a watery fluid oozes out from eyes in excess amount so eyes become red due to irritation. It is caused by a mircorbe Chlamydia trachomatis.
7. **Strabismus : -** It is due to loosening or contraction of the any of 6 voluntary muscles which give the proper position to the eye ball in its orbit. Thus eye ball inclines towards one side of orbit. It is strabismus or squint eyes. Particular muscle may be cured by operation and this defect is cured.
8. **Cataract : -** In this defect, lens becomes more solid, brown or more flat. It occurs in old age mostly. The lens becomes opaque, and reduces its power of accommodation. At this stage person can not see. A new lens is administered in place of defective lens by operation.
9. **Glaucoma : -** If the canal of schlemm is blocked in eyeball, aqueous humour can not return to veins again as a result pressure is increased in eye chambers and retina is damaged and person becomes totally blind.
10. **Photophobia : -** In this defect proper image is not formed in bright light.
11. **Colour blindness : -** It is genetic disorfer of X-chromosome. It is due to recessive gene. Colourblind persons can not different in red and green colour.
12. **Night blindness -** Also called nyctalopia. Due to defficiency of vitamin A (Retinol).
13. **Hystagmus** - Pendular movement of eye ball occurs.

EAR



SENSE ORGAN – EAR :

(B) Statoacoustic organ ear : - These are also called phonoreceptors.

- All the vertebrates have one pair of ears back to the eyes,

  There are two main functions of ears : -

(1) To receive sound waves, hearing

(2) To maintain body balance. Main function of ear is to maintain the balance of body.

Structurally ear may be divided into three parts : -

(A) External ear (B) Middle ear (C) Internal ear

(A) External ear : -

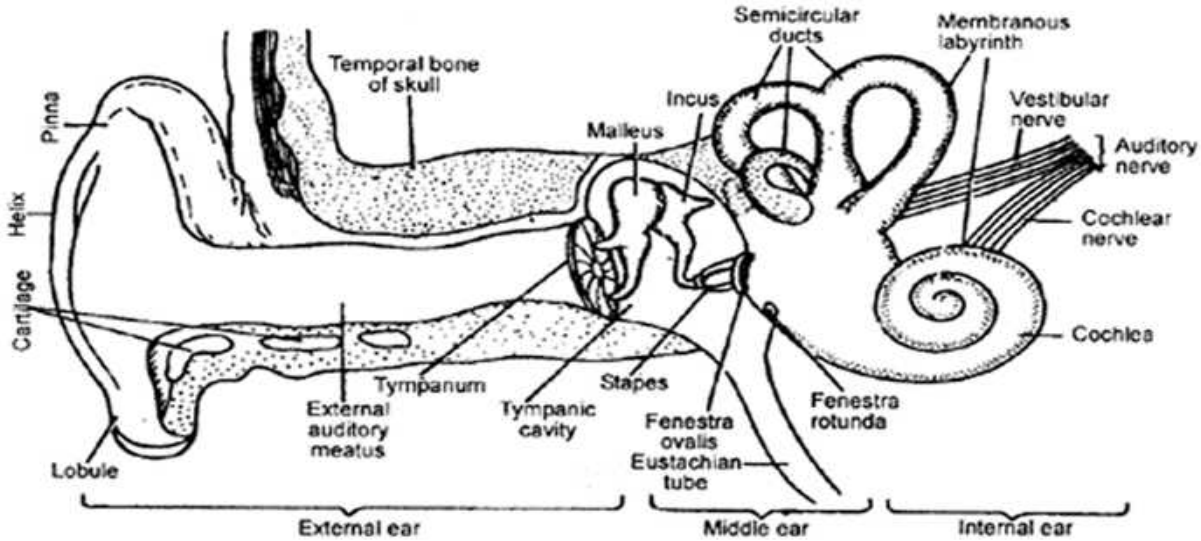
It is the outer part of ear. It is well developed in mammals only. External ear may be divided again into 2 parts :

(I) ear pinna (II) ear canal

(I) Ear pinna : - These may be small or large, **fan like** structure, important featrue of mammals, but absent in **whale, seal, *Ornithorhynchus*** etc. The skin of ear pinna in hairy. These are having yellow elastic cartilage in them. A rabbit can move its pinna accroding to its will, just like dog, cat, cow etc. But a man can not move his pinnae. Muscles of man's ear are vestigeal. Pinna covers some of the ear canal, this part is called **choncha.**

(II) Ear canal or External auditory meatus : - It is a 24 mm long canal which is expanded from base of pinna to inner side.

- Along with mammals, **birds** and **reptiles** also have ill or less developed ear canal.
- At the end of ear canal a stretched, thin obliquely placed membrane is present, it is called **ear drum** or **tympanic mmebrane**.This separates the ear canal to middle ear.
- In the wall of external auditory meatus or ear canal there are found modified sweat glands called **ceruminous glands.** These secrete **cerumen** or ear wax, which moisten the ear drum and protects it.
- Ear drum remians always in stretched position because malleus ear ossicle pulls it towards tympanic cavity by tensor tympani muscle.
- Ear drum is a part middle ear.



(B) Middle ear : - Middle ear is also called tympanic cavity. It is filled with air. This cavity is covered by a flask like bone called tympanic bulla. This bone is a part of temporal bone of skull.

- Middle ear cavity is connected by pharyngeal cavity through a canal. It is called **Eustachian duct.**
  Due to this tube, pressure at both the side of tympanic membrane remains always equal. This duct acts to maintain sound equilibrium. It exples high volume sounds through mouth, to avoid the damage of ear drum.
- Tympanic cavity is connected by internal ear cavity by two aperture.

(i) Oval aperture fenestra ovalis (oval window) and

(ii) Spherical aperture fenestra rotundus (round window). A thin and firm membrane covers each aperture.

- Three ear ossicle are present arranged in a chain with movable joints connected together in tympanic cavity.

These ear ossicles are : -

(a) Malleus : - It is situated towards outer ear. It is the largest of three and of hammer shaped malleus is formed by the modification of articular bone of jaw.

- Inner broad part of malleus is connected by incus. Malleus and incus and Joint together by synovial hinge joint.

(b) Incus : - The ossicle is **anvil** shaped. It is formed by the modification of quadrate bone of jaw. It s outer broad part is connected by malleus and inner thin part is connected by **stapes.** Incus is joint by stapes by **ball and socket joint.**

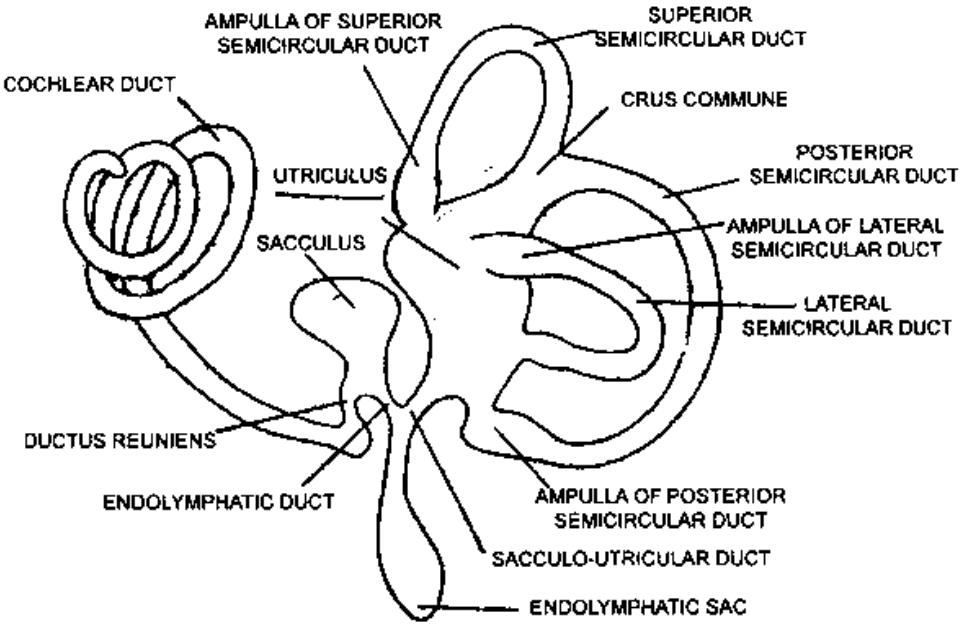
(c) Stapes : - It looks like stirrup of horse. It is formed by the modification of hyomandibular **bone of jaw.**

- It is the smallest bone of body
- Stapes is connected to incus at one side and on the other side it is connected to membrane stretched over fenestra ovalis.
- [In the tympanic cavity of frog only one ear ossicle is found it is called **columella auris.** Malleus and incus are absent here.]

All the three ear ossicles are arranged in ear cavity by ligaments. These carry sound wave from ear drum to internal ear through fenestra ovalis.

(C) Internal ear : -

It consist of (1) Bony Labyrinth (2) Membranous Labyrinth.



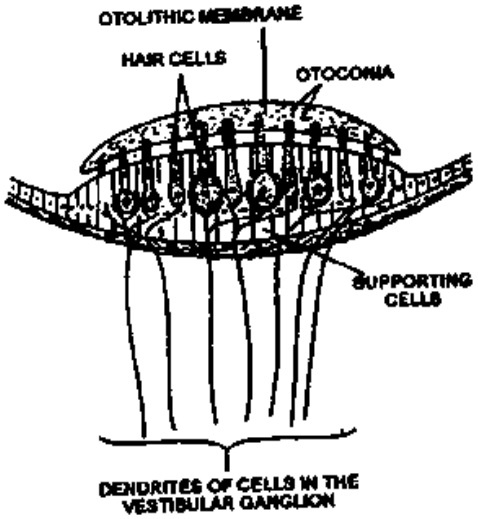
Scheme of membranous labyrinth

- Internal ear is enclosed in the petrous part temporal bone which form a bony capsule out side the internal ear it is called bony labyrinth. It is the cavity of hearing apparatus.
- Internal ear is a complex structure made up of semi transparent membrane. It is called membranous labyrinth.
- Bony labyrinth an membranous labyrinth are connected by a cavity called perilymph cavity. Perilymph liquid is filled in it.
- Endolymph is filled in membranous labyrinth.
- There are two main bag like chambers in membranous labyrinth, **utriculus and sacculus.** Both these chambers are connected together by a thin canal called **sacculo- utricular duct.**

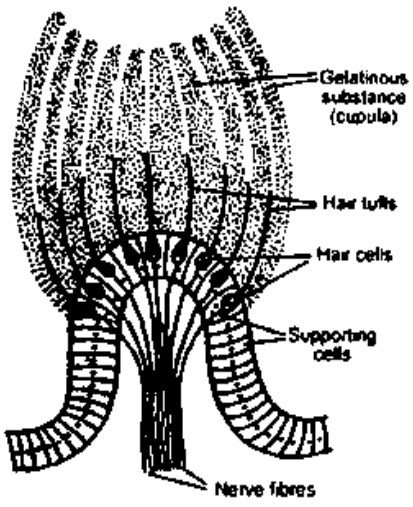
- A thin endolymphatic duct opens into sacculo-utricular duct. This endolymphatic duct opens into **endolymphatic sac** situated at back side of skull on the other side.
  Utriculus is comparatively large. Three semicircular canals arise from utriculus at 90° angle to each other and open into utriculus again these are called
  (i) Anterior or superior semicircular canal
  (ii) Posterior semicircular canal
  (iii) External or lateral or horizontal semicircular canal.
- Anterior and posterior canals arise in the form of a single canal called **''Crus commune''**
- The distal end of each semiciruclar canal is some what swollen, called **Ampulla.**
- Sacculus is smaller than utriculus. Its back side is coiled like spring. It is called **cochlear canal**. it is also known as **lagena.**
- The length of cochlear canal of human, rabbit and whale are $2\frac{3}{4}$, $2\frac{1}{2}$ and $1\frac{1}{2}$ coils respectively.
- Cochlear canal is connected by sacculus by a small duct called **ductus reuniens**.
- All the coils of cochlear canal are connected together by flexible ligaments.
- In the centre of coils of cochlea in human, there are present a pillar like structure called **modiolus.**

(D) Internal structure of inner ear : -

- The inner wall of membranous labyrinth is lined by cuboidal epithelium and outer wall is line dby connective tissue richly supplied with blood capillaries.
- Membranous labyrinth is empty inside. Its cavity is filled by endolymph which is a milky, mucilagenous fluid.
- Distal end of each semicircular canal becomes swollen called ampulla. In this ampulla, internal cuboidal epithelium form a ridge like projection called **acoustic ridge** small immovable microvilli are found at the free edges of sensory cells of acoustic ridge. These microvilli are numerous in number. These are called stereocilia, along with these there are found single movable cilium called **kinocillium.** Otoconia are absent crista of ampulla. All the microvilli of ridge are bind together like a bag and from **cupula.**
- These sensory cells situated in internal ear are in contact with small nerves. All these thin nerve combine to form **vestibular nerve (branch of auditory nerve).**
- Sensory crista and maculae are related with equilibrium of body
- Cristae control and maintain body equilibrium at the time of movement and maculae regulate this at static position.



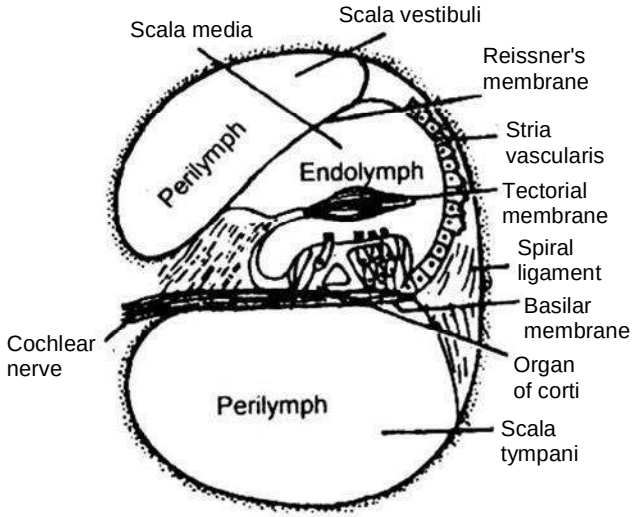
STRUCTURE OF MACULAE



STRUCTURE OF CRISTA

(E) Internal Structure of Cochlea & Cochlear canal

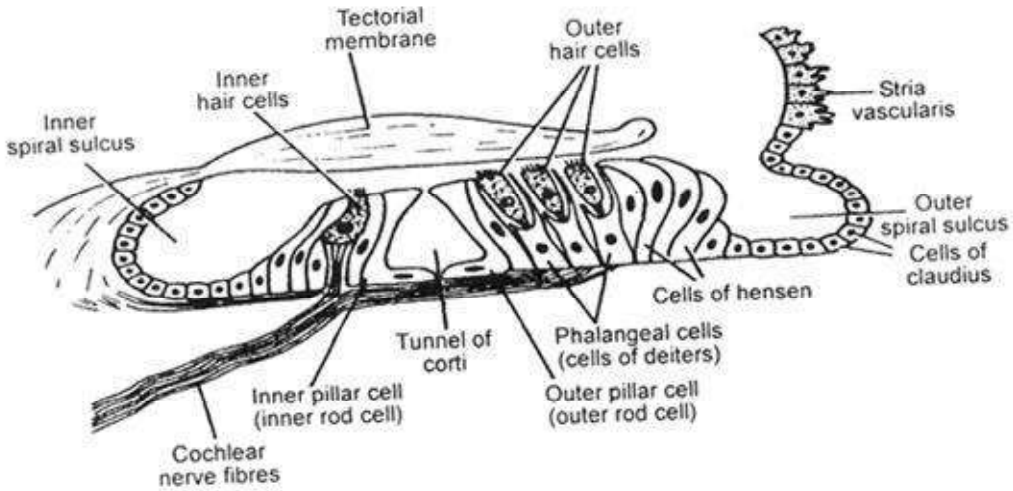
Cochlear duct is connected by bony labyrinth in such a way that it divides the cavity of labyrinth into dorsal and ventral chambers. So in a transverse section of cochlea following three chambers are seen clearly.



TRANSVERSE SECTION OF COCHLEA

(i) Scala vestibuli : - it is situated at dorsal side and is filled with perilymph.

(ii) Scala tympani : - It is situated at the ventral side below the cochlear duct. It is also filled by perilymph.



ORGAN OF CORTI

(iii) Scala media : - It is the triangular cavity of cochlear duct that is situated between scala vestibuli and scala tympani. It is filled with endolymph.

- Thin dorsal wall of cochlear duct is called vestibular membrane or Reissner's membrane.
- Ventral wall of scala media is thick it is called basilar membrane. Scala vestibuli and scala tympani are connected through a small aperture at the free edge of cochlea. This aperture is called **helicotrema.**
- Scala media is blind (closed) at its both the sides.

(F) Organ of Corti : - A sensory ridge is present at the whole of central line at epithelium lining of basilar membrane of scala media. It is called organ of corti. It has two types of cells (i) Sensory cell (ii) Supporting or suspensory cell and three type of suspensory cell

(i) Cells of Dieter's or basal cells (ii) Pillar cells or rod cells (iii) Hensen's cells or rectangular.

- In between the empty spaces of sensory and suspensory cells a lymph like fluid cortilymph is filled. This space is called tunnel of corti.
- Numerous mircrovilli called stereocilia (sensory hair) are present at the free surface of each sensory cell.
- At the ventral surface of sensory cells there are present thin fibres of auditory nerve that form cochlear branch.
- At the organ of corti a thin jelly like membrane is inclined called tectorial membrane. In this membrane, all the sensory hair's free edges are embeded.
- Main credit of hearing goes to "Organ of corti".

(G) WORKING OF EAR : -

- Ears are stato-acoustic organs of body. Thus these help the body to hear and balancing the body.

(a) Equilibrim: - The first and basic function of ears to maintain balance of body.

- This act is done by utriculus, sacculus and three semicircular canals. Equilibrium impulse/sensation is of two types : -

(i) Static balancing : - Its relation is from the point of view of gravity and position of head in static conditions of body and its changes.

- The senses of these changes (of head) are produced and carried mainly by utriculus, sacculus and their sensory cristae i.e maculae.
- Sensory hair of ridge are sensitized by **otoconia or otolith or ear dust.** These sensations or impulses are carried to brain by auditory nerve After it messages of appropriate reactions are send through motor fibres to the skeletal muscles of body.

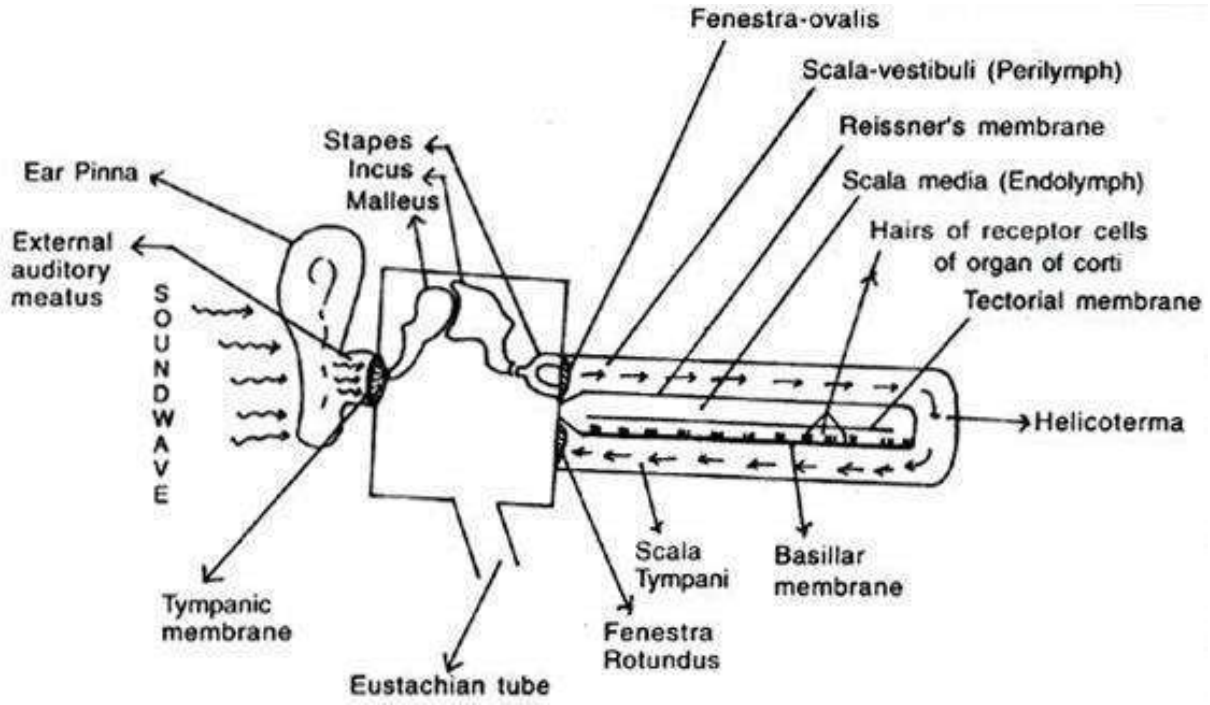
(ii) Dynamic equilibrium : -

- It is the action to maintain balance of body during movement.
- This act is done by sensory ridges of ampula of semicircular canals.
- At the time of movement the endolymph of ampula produces waves in it. Cupula of ampula are effected by these waves and sensory cells cupula are irritated. This sensation or stimulation is carried to brain by auditory nerve and proper messages are send to muscle of legs in reply. Due to this body is balanced at the time of walking.

(b) Hearing : -

- This act is done by "Organ of Corti".
- Sound waves are collected by ear pinnae. These sound waves travel through ear canal and hit the ear drum as a result of it ear drum get vibrated.
- These vibrations reach up to stretched membrane of fenestra ovalis through ear ossicles, ear ossicles work as lever.
- As a result of this travelling (from ear drum to fenestra ovalis) sound waves become more strong.
- When the membrane of fenestra ovalis starts vibrating, perilymph of scala vestibuli also starts vibrating, some vibrations reach up to scala tympani (fenestra rotundus) and its perilymph.

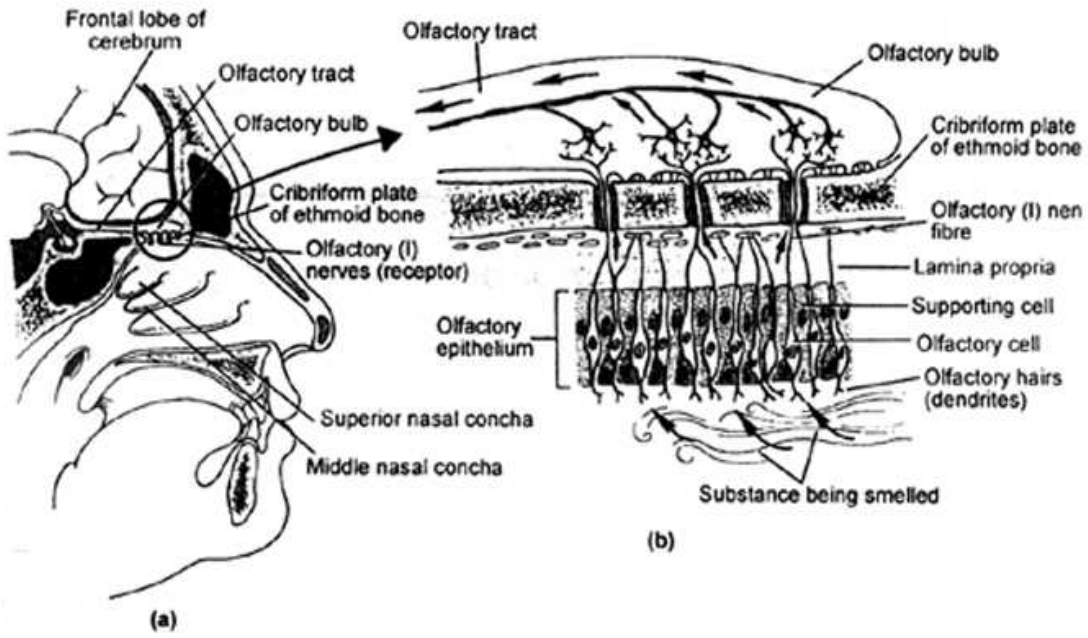
- Due to these vibrating waves, Reissner membrane and Basilar membrane of the walls of scala media also start vibrations. These vibrations travel through endolymph reach upto organ of corti. The organ of corti also starts vibrating.
- Cochlear nerve carries this impulse to brain through auditory nerve. Appropriate messages are send to receptor organs by brain accordingly.
- Vibrations /waves produced by cochlea travel through perilymph, reach up to membrane stretched at fenestra Rotundus and are destroyed.
- Some sound waves are also destroyed, when coming from helicotrema.



DIFFERENCES OF RECEPTORS BETWEEN RABBIT AND MAN

RABBIT	MAN
Eye :	
1. Monocular vision is present.	1. Bionocular vision is present.
2. Both eyes are located on the dorsal and lateral side of head.	2. Both eye are located at anterior part of face.
3. Nictitating membrane is present.	3. Nictitating membrane is vestigeal which is called as plica-semilunaris.
4. Eye is red coloured.	4. Eye is black, blue, brown coloured.
Ear :	
1. Ear pinna is funnel shaped	1. Ear pinna is kidney shaped.
2. Ear pinna is motile	2. Ear pinna is non-motile
3. No. of coiling of cochlear canal is $2\frac{1}{2}$	3. No. of coiling of cochlear canal is $2\frac{3}{4}$

NOSE



Olfactorecptors :

- Olfactoreceptors are situated in the upper part of nasal chamber in olfactory epithelium.
- This membrane is called **as schnederian membrane.**
- Olfactoreceptors are relatd with olfactory bulb. It is the extension of limbic system.
- This bulb is situated below the frontal lobe of cerebral hemisphere and aboev the ethampoid bone of nasalchamber.
- Three types of cells are found in the olfactoreceptors. These are –

(1) Bipolar olfactory nerve cells
(2) columnar epithelial cells
(3) Mucous glands

(1) Bipolar olfactory nerve cells : It is special types of nerve cells

- Sensory hair are found at the anterior end of olfactory cells. They contact with external environment in nasal chamber.
- Sensory hairs are related with dendrites of bipolar nerve cells.
- Middle part of olfactory cell is cyton.
- Posterior part of olfactory cell is axon which is nonmyleinated.

(2) Columnar epithelial cells : It is also called as supporting cells. They are present arounds the bipolar olfactory cells.

- They provides support to the olfactory cells.
- Some small conical cells are also found at the basal part of olfactoreceptor and provide base to the olfactoreceptor.
- A layer of connective tissue lies below the olfactoreceptor. It is also called as Lamina propria.

(3) Mucous glands : It is called as **Bowman's gland.** It is situated in the Lamina propria. It opens at the outer part of olfacto receptor through fine duct. Their secretory mucous substance dissolve the smell particle and carry to the sensory hair of olfactory cells. Unmyleinated axons of all olfacto sensory cells makes the synapse with dendrites of multipolar neurone of olfactory bulb. The number of receptors stimulated indicates the strength of smell.

In addition to smell receptor, a network of nerves is found in the nose, mouth and tongue.

The network formed by trigeminal nerve of V cranial nerve. It is also known as Dentist's nerve, reacts to messages of pain of teeth. It also convey the message of smell to brain. Such as ammonia, vinegar etc.

The trigeminal can protect by warning about harmful chemical in the air. Bowman's glands inside the nose release mucous fluid to get rid of the irritating susbtances.

Loss of the sense of smell is known as **anosmia.**

TONGUE OR ORGAN OF TASTE

A thick, muscular and movable organ, the tongue is found in the mouth cavity. Tongue bears four types of small papillae which are provided with taste buds. Taste buds are much numerous in the circumvallate and foliate papillae. Taste buds are formed by the transformation of epithelial cells of the tongue. A taste bud possesses two types of cells .-

1. **Supporting cells :** These cells are elongated in middle region they do not bear hairs at their free ends.
2. **Sensory cells :** These cells are alongated, buldge in middle part, they bear sensory hair at their free ends.

Each taste bud is flask or barrel shaped. It's size is 70 μm × 50 μm it's upper part opens at the epithelial surface of the tongue through a fine pore. These sensory hairs, exposed to outside through the gustatory pore are stimulated by the food substances. The sensory cells are chemoreceptor in nature and taste the food while it is dissolved in saliva. Food substances get mixed with saliva to enter into the pores of taste buds.

In human different regions of the tongue are sensitive to different taste. Anterior and free end of the tongue are sensitive to sweet and salty, lateral sides to sour taste, while the posterior part is particulary sensitive to bitter taste.

Types of receptors

- **General Senses –**

Touch	–	Tangoreceptors (Thigmoreceptor)
Temperature	–	Thermoreceptor
Heat	–	Caloreceptors
Cold	–	Frigidoreceptors
Pain	–	Algesireceptors
Current of water	–	Rheoreceptors
Electric current	–	Galvanoreceptors
Gravity	–	Georeceptors
Muscle position	–	Proprioreceptors
Equilibrium	–	Statoreceptors
Hunger, thirst etc.	–	Interoceptors
Blood pressure	–	Baroreceptors
Osmotic pressure	–	Osmoreceptors

Chemical changes	–	Chemoreceptors
Vibration	–	Vibroreceptors

- **Special Senses**

Vision	–	Photoreceptors
Hearing	–	Phonoreceptors
Smell	–	Olfactoreceptors
Taste	–	Gustatoreceptors

(1) Receptors of vision, hearing an smell receive stimuli from distance, hence called teleoreceptors.
(2) Tangoreceptors or mechanoreceptors
(i) Merkel's disc (Corpuscles) : Epidermis of non hairy (glabrous) skin, shallow cup shaped disc.
(ii) Meissner's corpulse : Dermis of skin of the finger tip, lips and nipples. Sense of touch and gentle pressure.
(iii) Pacinian corpuscle : Present in subcutaneous tissue of palm, sole of finger etc. stimulated by strong pressure contact.
(iv) Corpuscle of golgi : Sucutaneous tissue of fingers.
(v) Corpuscle of mazzoni : Sub cutaneous tissue of fingers.
(vi) Grandy's corpuscles : Beak of birds
(vii) Herbst corpuscles : Mouth part of birds
(viii) Free never ending : Present of skin, perceive the sensation of touch.

(3) Thermoreceptors
  (i) Ampullae of Lorenzini : Scoliodon (Fishes)
  (ii) Organ of ruffini : Caloreceptor - Heat
  (iii) End bulb of krause : Frigidoreceptor - cold
(4) Tactile receptors in mammals are maximum on face
(5) Current of water : Rheoreceptors lateral line sense organ in fishes and amphibian of tadpole detect the water current

POINTS TO REMEMBER :

1. Red green colour blindness is hereditory
2. Minimum distance for proper vision of eyes is **25 cm.**
3. Anterior - posterior diameter of eyeball is **17.5mm** at the time of birth normally and in adults it is **20-21mm**.
4. The best colour differentiation is found in **primates** (Advanced mammals)
5. In the retina of man's eyes there are found **110-1125 lacs rods** and **65 lacs cones.**
6. Healthy eye of a person can see clearly from **12 inch** to **20 feet.**
7. Image of object is formed on retina and it is always **inverted & real**
8. Hyalocytes cells are found in vitreous humor.
9. Cilliary body secretes aqueous humor and vitreous humor.
10. In frog and other amphibians sclerotic layer of eyeball is **Cartilaginous**
11. The largest eyes are found in **deers** in vertebrates with respect to body surface area.
12. Owls and cats see only with the help of available light from starts or moon at night
13. The lens of man's eye ball has its diameter of **11 mm.**

14. Atropine, Belladona and Cocane medicines are used to **dilate** the **pupil**
15. In a newlyborn child, eye balls are very small, i.e. babies ar always very much hypermatropic.
17. Cornea and lens of eye lack blood supply.
18. Eyes are most sensitive to the light having approx 5000 Å **wavelength.**
19. Internal or inner ear of rabbit is originated by **ectoderm** of embryo and middle ear (Bony part- mesodermal) and eustachian tube are originated by **endoderm** layer of embryo.
20. Frog's vision is **hypermatropic** in **water** and **myopic** on **land.**
21. Light sensitive organ was discovered by **Steven.**
22. Phaco-emulsification techique in cataract surgery – "Stichlesss" technique. Foldable IOL (Intra – ocular Lens) is used..
23. Gland of moll are modified sweat gland.
24. **Stye** is infection of gland of **zeis**
25. Hordeolum is inflammation sebaceous gland of eyelid
26. The relationship of receptor to bipolar cells to ganglion cells is **1 : 1 : 1** with in the fovea.
27. From the fovea to the periphery, cones dimimish and rods increase in number.
28. Electronic activity of retina is record sequence of potential change known as elctroretinogram.
29. The horizontal cells which transmit signals horizontally in the outer plexiform layer from the rods and cones to the bipolar cell dendrites.
30. The bipolar cells which transmit signals from the rods, cones and horizontal cells to the inner plexiform layer where they synapse with ganglion cell and amacrine cells.
31. The amacrine cells which transmit signals in two direction directly from bipolar cells to ganglion.
32. Lack of red cones – Protanope
33. Lack of green cones – Deuteranope
34. lack of blue cones – Tritanope
35. Unlike nerve and muscle rods and cones do not show action potential by depolarization but by electronic conduction.

Q.51 In old age farsightedness is a defect of eye in man, in which :-
(1) Eye ball becomes short
(2) Eye ball becomes elongated
(3) Lens become more concave
(4) Lens become more spherical

Q.52 Stereoscopic vision is found in :-
(1) All mammals (2) All vertebrates
(3) Primates (4) Frog

Q.53 Pigmented connective tissue in rabbit occurs in:-
(1) The eyelids (2) The choroid of eye
(3) The adipose tissue of skin
(4) The choroid & iris of eye

Q.54 Tear is a :-
(1) Secretory fluid (2) Excretory fluid
(3) Pure fluid (4) Lymphatic fluid

Q.55 Fenestra ovalis is the opening of :-
(1) Cranium (2) Tympanum
(3) Tympanic cavity (4) Brain

Q.56 In man the muscles which move the pinna are
(1) Absent (2) Vestigeal
(3) Functional more (4) Functional

Q.57 The nictitating membrane of rabbit is :-
(1) Also called third eye lid
(2) Situated in the inner corner of the eye
(3) Movable across the eye ball to clean it
(4) All of the above

Q.58 The ear ossicles of rabbit lie in the :–
(1) Auditory capsules
(2) External auditory meatus
(3) Tympanic cavity
(4) Tympanic bulla

Q.59 A small region on the retina of the eye which contains only cones is called :–
(1) Area centralis (2) Fovea centralis
(3) Blind spot (4) Ora serrata

Q.60 In rabbit the muscles which move the pinnae are
(1) Absent (2) Vestigeal
(3) Non-functional (4) Functional

Q.61 The middle ear and internal ear of mammals are enclosed in which of the following bones
(1) Mastoid (2) Ethmoid
(3) Tympanic bulla
(4) Tympanic bulla and periotic bone (temporal bone)

Q.62 Middle ear and eustachian tube of rabbit originates from
(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) All the above

Q.63 Hyalocytes cells occurs in :–
(1) Aqueous humor (2) Vitreous humor
(3) Both (4) None of them

Q.64 For the synthesis of rhodopsin, which of the following food is needed :–
(1) Mango (2) Rice
(3) Carrot (4) Tomatoes

Q.65 No image formation occurs on blind-spot of retina because :–
(1) It is not present on the optical axis of the eye
(2) Here cones and rods are absent
(3) On this part only cones are present
(4) The nerve fibres of this region do not contribute in the formation of optic chiasma

Q.66 "Telescopic vision" found in :–
(1) Amphibians (2) Mammals
(3) Birds (4) None of these

Q.67 Highly vascular and pigmented layer of Rabbit's eyes is :–
(1) Retina (2) Sclerotic
(3) Choroid (4) Ciliary body

Q.68 The part of Rabbit's eye which acts like diaphargm of camera is :–
(1) Pupil (2) Iris
(3) Lens (4) Cornea

Q.69 A circular canal which is found in limbus part of eyes is called :–
(1) Hyaloid canal (2) Canal of Schlemm
(3) Canal of Cloquet (4) Eustachian tube

Q.70 Eye and ear are the example of–
(1) Teleo receptor (2) Gustato receptor
(3) Extero receptor (4) Intero receptor

Q.71 Middle ear is filled with :–
(1) Air (2) Endolymph
(3) Perilymph (4) C.S.F.

Q.72 Dieter's cells found in :–
(1) Reissner's membrane
(2) Malleus
(3) Organ of corti (4) None

Q.73 Three layers in eye ball from inside out are-
(1) Retina, choroid, sclerotic
(2) Choroid, retina, sclerotic
(3) Sclerotic, choroid, retina
(4) Sclerotic, retina, choroid

Q.74 Aquous humor and vitreous humor are secreted by :–
(1) Iris (2) Ciliary body
(3) Lens (4) Cornea

Q.75 Pecten a comb like structure is found in the eye of :–
(1) Amphibians (2) Reptiles
(3) Birds (4) Mammals

Q.76 Lens of eye of frog is :–
(1) Oval (2) Biconcave
(3) Circular (4) None of them

Q.77 One of the following is correct :–
(1) Semicircular canal balancing
(2) Cochlea - hearing
(3) Utriculus - & sacculus - balancing & hearing
(4) All of the above

Q.78 In frog eyelids are :–
(1) Functional (2) Non - functional
(3) Absent (4) None

Q.79 In the tympanic cavity there is an aperture in which the stapes is fitted it is :–
(1) Foramen rotundus (2) Foramen triosseum
(3) Fenestra ovalis (4) Fenestra rotandus

Q.80 Colour blindness is due to :–
(1) Deficiency of Vit.A
(2) Deficiency of Vit. D
(3) Deficiency of Vit. C
(4) None of these

Q.81 Cochlea is mainly responsible for :–
(1) Balance only
(2) Hearing only
(3) Both balancing and hearing
(4) Perception of colour

Q.82 Cavity of aqueous humour is :–
(1) Behind the lens
(2) Infront of lens
(3) Between choroid and sclerotic
(4) None of these

Q.83 Ear ossicle from inner side of middle ear are –
(1) Malleus, Incus, stapes
(2) Stapes, Incus, Malleus
(3) Incus stapes & malleus
(4) Malleus, stapes, incus

Q.84 Endolymph is contains white crystals of $CaCO_3$ Called :–
(1) Otoconia (2) Otoliths
(3) Ear dust (4) All of the above

Q.85 The eye defect, Astigmatism can be corrected by using :–
(1) Convex lens (2) Concave lens
(3) Cylindrical lens (4) Surgery

Q.86 In frog's eye the selerotic is made up of :–
(1) Bone (2) Cartilage
(3) Muscles
(4) Fibrous connective tissue

Q.87 Largest eyes amongst vertebrates found in :–
(1) Elephant (2) Deer
(3) Horse (4) Man

Q.88 How many coils are present in cochlear duct of man–
(1) 1¼ (2) 2¼
(3) 2½ (4) 2¾

Q.89 Ear ossicle which present in middle ear cavity of frog's ear is :–
(1) Malleus (2) Incus
(3) Stapes (4) Columella

Q.90 Mucoprotein which found in vitreous humour is:–
(1) Albumin (2) Vitrin
(3) Globulin (4) Lysozyme

Q.91 How many coils are present in cochlear duct of Rabbit:–

(1) 2½ (2) 2¾

(3) 1½ (4) 1¼

Q.92 "Tensor tympani" & "Stapediusmuscles" are found in :–

(1) External ear (2) Middle ear

(3) Internal ear

(4) External auditory meatus

Q.93 The organ of corti is a modification of :–

(1) Tectorial membrane

(2) Reissner's membrane

(3) Basilar membrane

(4) Meissner's membrane

Q.94 Function of eustachian tube is to :–

(1) Provide air to the ear ossicles

(2) Remove dust particles from the middle ear

(3) Keep middle ear in proper shape

(4) To maintain proper air pressure in middle ear and internal ear for protecting them from damage by loud sound

Q.95 Which of the following in rabbits eyes is responsible for frictionless blinking :–

(1) Lachrymal glands (2) Meibomian gland

(3) Harderian gland (4) All of the above

Q.96 The damage to ear by sudden explosion (loud sound) is prevented by :–

(1) Eustachins tubes

(2) Tensor tympani muscles

(3) Stapedius muscles

(4) All of the above

Q.97 Which of the following glands are found in majority of mammals associated with their eyes:–

(1) Harderian and meibomian

(2) Lachrymal and sudorific

(3) Lachrymal and meibomian

(4) Harderian and Lachrymal gland

Q.98 The structure in the internal ear which resembles a "snail shell' is called :–

(1) Organ of corti

(2) Membranous labyrinth

(3) Cochlea

(4) Ear ossicles

Q.99 Serves as "harps of piano" in the ear :–

(1) Ear drum

(2) Endolymph

(3) Ear ossicles

(4) Cells of organ of corti

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	3	4	1	3	2	4	4	2	4	4	2	2	3	2	3	3	2	2	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	3	1	2	3	3	4	1	3	4	2	2	2	4	3	2	2	4	4	2
Ques.	41	42	43	44	45	46	47	48	49											
Ans.	1	2	3	4	2	1	3	3	4											

EXERCISE – 2

Q.1 Aperture of an eye can be changed by :-
(1) Aquous humour (2) Vitreous humour
(3) Ciliary muscles (4) Iris

Q.2 Which is responsible for colour detection :-
(1) Cones (2) Rods
(3) Rods and cones (4) Choroid

Q.3 Photosensitive pigment is :-
(1) Similar in all eyes
(2) Different in all eyes
(3) Similar in all vertebrate eyes
(4) Red in all eyes

Q.4 Rhodopsin is a constituent of :
(1) Cornea (2) Choriod
(3) Rods (4) Cones

Q.5 It the source of light infront of eye suddenly become bright :-
(1) Pupil contract
(2) Focus of lens changes
(3) Vitreous humor becomes liquid like
(4) Retina blood supply is cut-off

Q.6 Passage connection middle ear with pharynx is called :-
(1) Cochlear canal (2) Vestibular canal
(3) Tympanic canal (4) Eustachian canal

Q.7 Retina of the vertebrates eye consists of :-
(1) Neurons and neuroglia
(2) Rods, cones, neurons and neuroglia
(3) Rods, cones and neuroglia
(4) Rods and cones

Q.8 The focal length of the lens in eye is controlled by :-
(1) Vitreous humor (2) Ciliary muscles
(3) Iris muscles (4) Pupil

Q.9 During night when the intensity of light is low, it is detected by :-
(1) Rods (2) Cones
(3) Both (4) Crystalline lens

Q.10 To correct myopia vision one should use :-
(1) Convex lens (2) Concave lens
(3) Plane lens (4) None

Q.11 Arrangement of ear ossicles, starting from ear durm is :-
(1) Stapes, malleus,
(2) Malleus, incus, stapes
(3) Incus, stapes, malleus
(4) Stapes, incus, malleus

Q.12 Organ of corti is found in :-
(1) Kidneys (2) Heart
(3) Nasal chamber (4) Internal ear

Q.13 The fluid found in semicircular canals of internal ear of rabbit is :-
(1) Perilymph (2) Endolymph
(3) Hemolymph (4) Lymph

Q.14 Eustachian tube connects :-
(1) Left atrium with right atrium
(2) Left ventricles with right ventricle
(3) Middle ear with external ear
(4) Middle ear with pharynx

Q.15 Chief function of semicircular canals of internal ear :-
(1) Balancing and hearing
(2) To perceive sound vibrations of high frequency
(3) To maintain dynamic equilibrium of the body while the body is in balance
(4) To transmit sound vibration to the auditory nerve

Q.16 Where is the cavity of vitreous humour found
(1) Between sclerotic and choroid
(2) Infront of lens
(3) Behind lens
(4) Between choroid and retina

Q.17 The function of eustachian tube is to :-
(1) Help in vibrating tympanum
(2) Help in hearing
(3) Equalise air pressure in middle ear and external ear
(4) Equalise air pressure in middle ear and internal ear

Q.18 Function of iris is to :-
(1) Alter diameter of pupil
(2) Close eye lids
(3) Alter diameter of lens
(4) Move the lens

Q.19 The pigment found in rods is :-
(1) Retinen (2) Melanin
(3) Photopsin (4) Keratin

Q.20 Which pigment helps some noctural animal to see at night :-
(1) Haemoglobin (2) Porphyrin
(3) Guanin (4) Heparin

Q.21 Organ of corti in rabbit is concerned with the sens of-
(1) Smell (2) Hearing
(3) Taste (4) Equilibrium

Q.22 Eye is most sensitive to :-
(1) 20 Å (2) 1000 Å
(3) 5000 Å (4) 7000 Å

Q.23 Area of most active vision in eye where sharp image is formed is called :-
(1) Blind spot (2) Yellow spot
(3) Lens (4) Pupil

Q.24 Blind spot in the eye is located :-
(1) In the center of pupil
(2) In the center of lens
(3) In fovea centralis
(4) Where optic nerves leaves retina

Q.25 Lens and retina of vertebrate eye develop from-
(1) Mesoderm (2) Ectoderm
(3) Endoderm
(4) Partly from ectoderm and partly from endoderm

Q.26 The common defect of eye which develops in old age is :-
(1) Glaucoma (2) Astigmatism
(3) Presbyopia (4) Myopia

Q.27 The internal ear of rabbit in comparision to that of frog has :-
(1) Smaller cochlea
(2) Longer and coiled cochlea
(3) Fused utriculus and sacculus
(4) No sacculus

Q.28 Ciliary muscles are found in -
(1) junction of choroid and iris in eye ball
(2) Inside larynx to regulate tension in eye ball
(3) Between ribs to assist in breathing movement
(4) At base of cilia in ciliated epithelium

Q.29 Cochlea of mammalian ear is concerned with
(1) Balancing of body (2) Hearing
(3) Preception of atmospheric pressure
(4) Both (1) and (2)

Q.30 How many stimuli from a distant source fall on your eyes
(1) Light, sound and tension
(2) Light sound and odour
(3) Light and sound (4) Light only

Q.31 Myopia is a defect in human eyes in which the image is formed :-
(1) Behind retina and can be corrected by using convex lens
(2) Behind retina and can be corrected by using concave lens
(3) Infront of retina and can be corrected by using concave lens
(4) Infront of retina and can be corrected by using convex lens

Q.32 Iodopsin is related with :-
(1) Brain (2) Spinal cord
(3) Rods and cones (4) Kidney

Q.33 Convex lens is used to correct -
(1) Hyper metropia (2) Myopia
(3) Cataract (4) Glaucoma

Q.34 "Miosis" in eye refers to :–
(1) Reduction in diameter of pupil
(2) Increased diameter of pupil
(3) Reduction division in retina
(4) Shrinkage of eye ball

Q.35 Owls moves freely during night since they have-
(1) Adjustable pupil
(2) Only cones in retina
(3) Only rods in retina
(4) Vitamin A deficiency

Q.36 Our ear can hear sound waves of the frequency:-
(1) Above 20,000 Hz (2) 5-100 Hz
(3) 200-20,000 Hz (4) 20-20,000 Hz

Q.37 Which one of the following diseases in man belongs to the same catagory as haemophilia
(1) Hyper metropia (2) Rabies
(3) Night blindness (4) Colour blindness

Q.38 The eustachian tube which connects middle ear to pharynx is found in :-
(1) All the land vertebrates in general
(2) All vertabrates
(3) Amphibians only (4) Mammals only

Q.39 The fluid surrounding the membranous labyrinth of rabbit is called :-
(1) Perilymph (2) Endolymph
(3) Haemolymph (4) Cerebrospinal fluid

Q.40 Colour blindness in human being is due to :-
(1) Vitamin A deficiency
(2) Sex linked inheritance
(3) Over activity of adrenal gland
(4) Excessive drinking of alcohol

Q.41 How many oblique and rectus muscles are found to move the eye ball in various direction inside the eye orbit
(1) Two (2) Four
(3) Six (4) Eight

Q.42 Rabbit has :-
(1) Monocular vision (2) Binocular vision
(3) Mosaic vision (4) Sterioscopic vision

Q.43 Meibomian gland are associated with :–
(1) Eyes (2) Ears
(3) Reproductive organ (4) Skin

Q.44 Harderian gland occurs in :–
(1) Whale (2) Frog
(3) Birds (4) All the above

Q.45 Which of the following is not an ear ossicle :–
(1) Incus (2) Malleus
(3) Humerus (4) Stapes

Q.46 Cochlea arises from :–
(1) Utriculus (2) Sacculus
(3) Middle ear (4) Semicircular canals

Q.47 The other name of internal ear is :–
(1) Utriculus
(2) Membranous labyrinth
(3) Sacculus
(4) Ductus endolymphaticus

Q.48 External auditory meatus contains which of the following gland :–
(1) Ceruminous gland (2) Lachrymal gland
(3) Harderian gland (4) Meibomian gland

Q.49 How many semicircular canals are found in internal ear of rabbit :-
(1) Two (2) Three
(3) Four (4) One

Q.50 Otolith (otoconia) are $CaCO_3$ particles found in:-
(1) Perilymph (2) Endolymph
(3) Bones (4) Vitreous humour

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	3	3	1	4	2	2	1	2	2	4	1	4	3	3	3	1	1	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	3	2	4	2	3	2	1	2	4	3	3	1	1	3	4	4	1	1	2
Ques.	41	42	43	44	45	46	47	48	49	50										
Ans.	3	1	1	4	3	2	2	1	2	2										

EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Which regulates the amount of light falling on the lens **[JIPMER 1993]**
(1) Cornea (2) Retina
(3) Pupil (4) Ciliary body

Q.2 Space between cornea and lens is- **[AIIMS 1993]**
(1) Aqueous chamber (2) Vitreous chamber
(3) Canal of Schlemm (4) Fovea centralis

Q.3 In glaucoma- **[JIPMER 1993]**
(1) Eyeball elongates
(2) Eyeball shortened
(3) Lens becomes opaque
(4) fluid pressure increases in eye

Q.4 Meissener's corpuscles are located in – **[AIIMS 1993]**
(1) Pancreas and secrete trypsinogen
(2) Adrenal and secrete epinephrin
(3) Spleen and destroy worn out erythrocytes
(4) Skin and perceive gentle pressure

Q.5 Human eye lens is- **[JIPMER 1993]**
(1) Spherical and can be moved forward
(2) Biconvex and can not be moved forward
(3) Spherical and can not be moved forward
(4) Biconvex and can be moved forward

Q.6 Which is the correct sequence of the parts of the eye that the light rays cross in reaching the retina- **[CMC Vellore 1993]**
(1) Pupil → cornea → aqueous humour → lens → vitreous humour
(2) Lens → cornea → aqueous humour → vitreous humour → pupil
(3) Aqueous humour → vitreous humour → cornea → pupil → lens
(4) Cornea → aqueous humour → pupil → lens → vitreous humour

Q.7 Eye ball will not be moved inward on the damage of which of the following muscles- **[CMC Vellore 1993]**
(1) Internal rectus (2) External rectus
(3) Inferior oblique (4) Superior oblique

Q.8 Vitreous humour is seen in- **[CBSE 1993]**
(1) Ear (2) Eye
(3) Brain (4) Bone Marrow

Q.9 The space between the lens and the cornea of the human eye is- **[AIIMS 1993]**
(1) Vitreous chamber (2) Aqueous chamber
(3) Retina (4) Iris

Q.10 Vibrissae are associated with the function of- **[JIPMER 1993]**
(1) Thermo regulation (2) Gustation
(3) Tactile perception (4) Reproduction

Q.11 Malleus is present in the- **[CBSE 1993]**
(1) Inner ear (2) Outer ear
(3) Middle ear (4) Eye

Q.12 The movement of eye ball is brought about by the- **[Delhi PMT 1993]**
(1) Adductor muscle (2) Rectus muscle
(3) Biceps (4) Peroneus

Q.13 The cavity of the eye is divided into aqueous chamber and vitreous chamber by- **[Delhi PMT 1993]**
(1) Optic nerve (2) Retina
(3) Lens (4) Iris

Q.14 The central opening of iris is called as- **[CBSE 1993]**
(1) Pupil (2) Cornea
(3) Lens (4) Fovea centralis

Q.15 Semicircular canals occur in- **[Bihar PMT 1994]**
(1) Heart (2) Kidney
(3) Intestine (4) Ear

Q.16 Middle ear has- **[JKMCEE 1994]**
(1) Two sets of tiny bones
(2) A set of three tiny bones
(3) Two sets of large bones
(4) Three sets of large bones

Q.17 One of the following bones is found in the region of Jacobson's organ- **[CPMT 1994]**
(1) Vomer (2) Nasal
(3) Squamosal (4) Pterygoid

Q.18 Concave lens corrects - **[CPMT 1994]**
(1) Presbyopia (2) Myopia
(3) Hypermetropia (4) Cataract

Q.19 External ears are characteristic of- **[MPPMT 1994]**
(1) Mammals (2) Reptiles
(3) Amphibians (4) Pisces

Q.20 Osphradium of Pila globosa is- **[BHU 1994]**
(1) Chemoreceptor (2) Photoreceptor
(3) Thermoreceptor (4) Tangoreceptor

Q.21 Scala tympani is connected with scala vestibuli by means by- **[BHU 1994]**
(1) Stapes (2) Helicotrema
(3) Fenestra ovalis (4) Fenestra rotundus

Q.22 Which brain structure in rabbit is directly vision related- **[BHU 1994]**
(1) Hippocampal lobe (2) Corpus callosum
(3) Corpus albicans
(4) Corpora quadrigemina

Q.23 The defective condition of accommodation of the eye in which distant objects are seen distinctly but near objects are indistinct is- **[AFMC 1994]**
(1) Astigmatism (2) Presbiopia
(3) Myopia (4) Hypermetropia

Q.24 Stereoscopic vision is found in- **[JIPMER 1994]**
(1) Frog (2) Fish
(3) Man (4) Snake

Q.25 The lens in human being is- **[SKUMS 1995]**
(1) Concave (2) Biconvex
(3) Planoconvex (4) Convex

Q.26 In uncorrected myopia, the image is formed- **[Manipal M.C.E.E. 1995]**
(1) Infront of the lens
(2) At the back of the lens
(3) Infront of the retina
(4) Behind the retina

Q.27 The receptors found in the muscles, tendons and joints are- [**MPPMT 1996]**
(1) Teloreceptors (2) Proprioceptors
(3) Interoceptors (4) None of the above

Q.28 The iris of the eye is an extension of- **[PCS 1996]**
(1) Cornea (2) Sclerotic
(3) Retina (4) Choroid

Q.29 In the chemistry of vision in mammals, the photosensitive substance is called **[CBSE 1997]**
(1) Sclerotin (2) Retinol
(3) Melanin (4) Rhodopsin

Q.30 Glaucoma is caused by- **[BHU 1997]**
(1) Opacity of lens
(2) Increase in the size of eyeball
(3) blockage of canal of Schlemm
(4) Drying of vitreous humor

Q.31 Find out the right matching from the following pairs- **[PCS 1997]**
(1) Accommodation – pupil
(2) Colour perception – cones
(3) Night blindness – rods
(4) Binocular vision – iris

Q.32 The statocyst of prawn is a - **[PCS 1997]**
(1) Tangoreceptor (2) Chemoreceptor
(3) Gravity receptor (4) Sound receptor

Q.33 Vitamin A combines with a protein in the retina to produce- **[PCS 1997]**
(1) Glaucoma (2) Night blindness
(3) Rhodopsin (4) Colour blindness

Q.34 In human eye, at the blindspot- **[JIPMER 1997]**
(1) Only rods are present
(2) Only cones are present
(3) Both rods and cones are present
(4) Neither rods nor cones are present

Q.35 Jacobson's organ is- **[CPMT 1997]**
(1) Olfactory (2) Auditory
(3) Chemoreceptor (4) Algesireceptor

Q.36 Organ of Corti is found in- [**CPMT 1998]**
(1) Internal ear (2) External ear
(3) Both of these (4) None of these

Q.37 Which one of the following is not a part of ear [**RPMT 1998]**
(1) Eustachian tube (2) Cone cell
(3) Utriculus (4) Sacculus

Q.38 If eyeball is shorter and lens is thin, then probable defect would be- **[RPMT 1998]**

(1) Astigmatism (2) Presbyopia

(3) Short-sightedness (4) Long-sightedness

Q.39 The black pigment in the eye, which reduces internal reflection, is located in- **[AIIMS 1998]**

(1) Iris (2) Sclerotic

(3) Choroid (4) Cornea

Q.40 Deiter's cells (basal cells) occur in- **[AIIMS 1998]**

(1) Utriculus (2) Sebaceous glands

(3) Retina of eyes (4) Organ of Corti

Q.41 The sound reception can be interpreted by- **[RPMT-1998]**

(1) Olfactory lobe

(2) Cerebral hemisphere

(3) Cerebellum

(4) Medulla oblongata

Q.42 Too short eye ball and too flat lens produce- **[RPMT-1998]**

(1) Near sightedness (2) Far slightness

(3) Astigmatism (4) Presbyopia

Q.43 Organ of carti found in :- **[RPMT-1998]**

(1) Ear (2) Eye

(3) Nose (4) Skin

Q.44 Cortex medulla and membrane labyrinth of vertebrates is formed of- **[RPMT-1998]**

(1) Ectoderm (2) Endoderm

(3) Mesoderm (4) Both '2' and '3'

Q.45 Which part of the human eye adjusts the focal length of lens - **[RPMT-1998]**

(1) Cornea (2) Aqueous humour

(3) Conjunctive (4) Ciliary body

Q.46 The photosensitive pigments viz., erythrolobe, chlorolobe and cyanolobe are sensitive to the colours respectively- **[CPMT 1999]**

(1) Red, green and blue

(2) Blue, green and red

(3) Green, red and blue

(4) Blue, red and green

Q.47 One photon of red light contains about..... of radiant energy in the vertebrate photoreceptor cells- **[JIPMER 1999]**

(1) 686 kcal (2) 3×10^{-19} J

(3) 5×10^{-14} (4) None of these

Q.48 Suspensory ligament is part of- **[CBSE 1999]**

(1) Tongue (2) Brain

(3) Heart (4) Eye

Q.49 Iris of eye sensitive for : **[RPMT-1999]**

(1) light (2) chemical

(3) heat (4) all

Q.50 In frog, fenestra ovalis is- **[CPMT 2000]**

(1) The opening in the auditory capsule which separates the middle ear from the inner ear

(2) The communication between the pharynx and the tympanic cavity

(3) The external opening of the tympanic cavity which is covered by the tympanic membrane

(4) The air filled cavity of the middle ear

Q.51 The structure in human that provide balance are located in the - **[CPMT 2000]**

(1) external ear (2) Middle ear

(3) Internal ear (4) Eustachian tube

Q.52 Ora serrata is- **[AIIMS 1997; Har. PMT 2000]**

(1) Oral cavity of protochordates

(2) Anterior edge of sensory portion of the retina

(3) Gland present in oral cavity of frog

(4) A part of utriculus of ear

Q.53 Eustachian tube connects- **[CPMT 1991; PCS 2001; MPPMT 2001]**

(1) Pharynx to middle ear

(2) Middle ear to external ear

(3) Left ventricle to right ventricle

(4) Left atrium to right atrium

Q.54 Area of retina in human eye containing only cone cells is called- **[PCS 1996, 2001]**

(1) Macula lutea (2) Fovea centralis

(3) Pecten (4) Tapetum

Q.55 The fluid present between the lens and the cornea in the eye is : **[RPMT-2001]**
(1) aqueous humor
(2) endolymphatic fluid
(3) vitreous homor (4) perlymphatic fluid

Q.56 The eye disease hypermetropia can be cured by using : **[RPMT-2001]**
(1) concave lens (2) convex lens
(3) concave-conved lens (4) plane lens

Q.57 Only rods are present in the eyes of- **[MPPMT 2002]**
(1) Owl (2) Pigeon
(3) Fowl (4) Squirrel

Q.58 When we migrate from dark to light, we fail to see for sometimes but after a time visibility becomes normal. It is an example of- **[BSE 2002]**
(1) Mutation (2) Adaptation
(3) Photoperiodism (4) Accommodation

Q.59 A person is wearing spectales with concave lenses for correcting vision. While not using the glasses, the image of a distant object in his case wil be formed- **[AIIMS-2003]**
(1) On the blind spot (2) Behind the retina
(3) On the yellow spot
(4) In front of the retina

Q.60 Organ of Corti is found in- **[RPMT-2003]**
(1) Heart (2) Kidneys
(3) Inner ear (4) Nasal chamber

Q.61 Yellow spot is found in- **[RPMT-2004]**
(1) Muscles (2) Nerves
(3) Kidney (4) Eyes

Q.62 Corti's organ is present in- **[RPMT-2004]**
(1) Reisner's membrane
(2) Scala vestibuli
(3) Basilar's membrane
(4) Middle lamella

Q.63 The place in eye of mammals from which optic nerves and blood vessels leaves the eye ball is- **[AFMC-2004]**
(1) blind spot (2) yellow spot
(3) pars optica (4) none of these

Q.64 The muscles surrounding the pupil of rabbit's eye are : **[CPMT-2004]**
(1) striated and voluntary
(2) striated and involuntary
(3) unstriated and voluntary
(4) unstriated and involuntary

Q.65 Internal ear is filled with : **[AFMC-2005]**
(1) perilymph (2) endolymph
(3) lymph (4) both 1 and 2

Q.66 Bowman's glands are located in the: **[AIPMT - 2007]**
(1) anterior pituitary
(2) female reproductive system of cockroach
(3) olfactory epithelium of our nose
(4) proximal end of uriniferous tubules

Q.67 Lysozyme that is present in perspiration, saliva and tears, destroys- **[AIPMT - 2007]**
(1) Certain type of bacteria
(2) all viruses
(3) Most virus - infected cells
(4) Certain fungi

Q.68 Maximum refraction of light takes place at **[WEST BENGAL JEE-2007]**
(1) Cornea (2) lens
(3) iris (4) aqueous humour

Q.69 Which of the following neve supplies for organ of Corti **[JHARKHAND-2003]**
(1) Auditory (2) Olfactory
(3) Trochlear (4) Vagus

Q.70 Vitreous humor is **[BIHAR-2006]**
(1) colloid
(2) watery fluid
(3) mucoid connective tissue
(4) all of the above

Q.71 Accoustic spots in frog are present in **[UP-CPMT-2002]**
(1) ossious labyrinth
(2) carotid
(3) membranous labyrinth
(4) all of these

Q.72 In the internal ear the 'organ of Corti' which bears hairs cells, is located in…….. **[MP-PMT 2004]**
(1) Scala tympani (2) Scala media
(3) Scala vestibuli (4) Sacculus

Q.73 Ear ossicle, incus is modified from of which bone **[MP-PMT 2004]**

(1) Jugal (2) Articular

(3) Quadrate (4) Hyomandibular

Q.74 The vitreous humour, a jelly like substance which is found in posterior part of **[MP-PMT-2005]**

(1) Eye (2) Ear

(3) Nose (4) Heart

Q.75 Pharynx and middle ear are interconnected by **[MP-PMT 2001]**

(1) Tympanic canal (2) Eustachian canal

(3) Cochlear canal (4) Vestibular canal

Q.76 Only rods are present in the eyes of one of the following animals **[MP PMT-2001]**

(1) Pigeon (2) Squirrel

(3) Fowl (4) Owl

Q.77 When the intensity of light is low during night the light is detected by **[MP-PMT 2002]**

(1) Rods (2) Cones

(3) Lens

(4) Both rods and cones

Q.78 The receptors found in the muscles, tendons and joints are : **[MP-PMT-2002]**

(1) Teloreceptors (2) Proprioceptors

(3) Interoceptors (4) Thermoreceptors

Q.79 In mammals ear, a membraneous structure which separate the scala vestibule and scala media is **[MP-PMT-2003]**

(1) Basilar membrane

(2) Reissner's membrane

(3) autolith membrane

(4) Tectorial membrane

Q.80 "Organ of Corti" is found in **[MP-PMT-2003]**

(1) Scala rotundes (2) Scala media

(3) Scala vestibule (4)Scala tympani

Q.81 Merkel's disc in the skin of rabbit are **[CPMT-1992]**

(1) Tangoreceptor (2) Pain receptor

(3) Thermoreceptors (4) Vibroreceptor

Q.82 Pacinian corpuscles occur in the skin of certain parts of body. These are **[AIIMS-1998]**

(1) Pain receptor (2) Types of gland

(3) Nacked tactile receptor

(4) Encapsulate pressure receptor

Q.83 Pacinian corpuscle present in skin detect **[RPMT-1998]**

(1) Pain (2) Temperature

(3) Pressure contact (4) Movement

Q.84 A feeling of pain in one's stomach would be due **[AIIMS-1998]**

(1) Exteroceptors (2) Teloreceptor

(3) Proprioceptors (4) Interoceptors

Q.85 Thermoreceptors are **[CPMT-1992]**

(1) Organ of ruffini (2) Krause end bulb

(3) Ampallae of lorenzini

(4) All of the above

Q.86 Bowman's gland are located in the **[AIPMT-2006, 2007]**

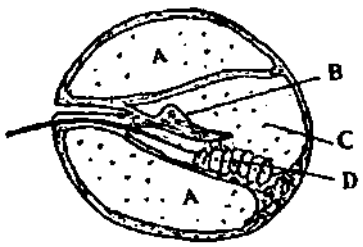
(1) Proximal end of uriniferous tubules

(2) Anterior pituitary

(3) Female reproductive system of cockroach

(4) Olfactory epithelium of our nose

Q.87 Given below is a diagrammatic cross section of a single loop of human cochlea **[AIPMT-2008]**



Which one of the following options correctly represents the names of three different parts ?

(1) D : Sensory hair cells, A : Endolymph B : Tectorial membrane

(2) A : Perilymph, B : Tectorial membrane C: Endolymph

(3) B : Tectorial membrane, C : Perilymph, D : Secretorycells

(4) C : Endolymph, D : Sensory hair cells, A : Serum

Q.88 Which one of the following is the correct difference between Rod Cells and Cone Cells of our retina ? **[AIPMT-2008]**

	Rod Cells	**Cone Cells**
(1)	Overall vision in poor function of light	Colour vision and detailed vision in bright light
(2)	distribution more retina	Evenly concentrated distributed all in centre of over retina
(3)	Visual high acuity	Low
(4)	Visual pigment contained iodopsin	Rhodopsin

Q.89 Cornea transplant in humans in almost never rejected. This is because **[AIPMT-2008]**

(1) It is composed of enucleated cells

(2) It is a non-living layer

(3) Its cells are lest penetrable by bacteria

(4) It has no blood supply

Q.90 The size of aperture of the pupil of one eye is controlled by : **[JEE 2007, DUMET 2009]**

(1) iris (2) retina

(3) cornea (4) conjunctiva

Q.91 Lateral line sense organs occur in : **[MH. CET 2004, 2005]**

(1) Salamander (2) Frog

(3) Water snake (4) *Scoliodon*

Q.92 Organs of Ruffini are receptors of : **[WB. Jee 2006, MPPMT 2007]**

(1) Heat (2) Cold

(3) Pressure (4) Touch

Q.93 Bony labyrinth contains a fluid called : **[Har. PMT 2007]**

(1) Perilymph (2) Endolymph

(3) Haemolymph (4) Lymph

Q.94 Columella auris is found in : **[Har. PMT 2007]**

(1) Rabbit (2) Frog

(3) Man (4) All of these

Q.95 Organ of Corti rests on : **[RPMT 2004]**

(1) Ressner's membrane

(2) Basilar membrane

(3) Schneiderian

(4) Robertsonian membrane

Q.96 Static equilibrium is maintained by : **[Har. PMT 2007]**

(1) Utriculus (2) Sacculus

(3) Both of these (4)Semicircular canals

Q.97 Organ of Corti is found in : **[JIPMER 2004, RPMT 2006]**

(1) Internal ear (2) External ear

(3) Both of these (4) None of these

Q.98 Organ of Corti helps in : **[AFMC 2010]**

(1) maintaining equilibrium

(2) formation of wax

(3) hearing (4) all of these

Q.99 Which of the following is correct pair ? **[RPMT 2001]**

(1) Ant. Pituitary — Synthesis of oxytocin

(2) Hearing — Organ of Corti

(3) Nephron — Endocrine organ

(4) Bipinnaria — Coelenterata

Q.100 Eustachian tube connects : **[Wardha 2008, CPMT 2009]**

(1) Pharynx to middle ear

(2) Middle ear to external ear

(3) Left ventricle to right ventricle

(4) Left atrium to right atrium

Q.101 Which organ of rabbit is concerned with equilibrium ? **[RPMT 2001]**

(1) Cochlea (2) Ear ossicles

(3) Eustachian ducts

(4) Semicircular canals

Q.102 Bowman's glands are found in : **[BHU 2002, CBSE 2006, DPMT 2008]**

(1) olfactory epithelium

(2) external auditory canal

(3) cortical nephrons only

(4) juxtamedullary

Q.103 The correct order of arrangement of ear ossicles starting from tympanum is : **[VMMC-Safdarjung 2008]**

(1) incus, malleus, stapes
(2) malleus, incus, stapes
(3) stapes, malleus, incus
(4) incus, stapes, malleus

Q.104 Taste pores are : **[St. Johns MC 2002]**

(1) ducts (2) papillae
(3) provided with lids
(4) small pores of taste buds

Q.105 Stimulation of which receptors bring about micturition in rabbit ? **[EAMCET 2002]**

(1) Stretch (2) Tango
(3) Olfactory (4) Gustatory

Q.106 The dorsal pit, present in pit vipers is sensitive to : **[PCS 2004]**

(1) Heat (2) Light
(3) Sound (4) Magnetic field

Q.107 In mammalian cochlea, the thin-walled sloping roof of the scala media is referred to as : **[IAS 2002]**

(1) Organ of Corti
(2) Scala tympani
(3) Basilar membrane
(4) Reissner's membrane

Q.108 In the following abnormalities of the eye which one is a serious condition that leads to blindness ? **[VMMC-Safdarjung 2008]**

(1) Myopia (2) Glaucoma
(3) Presbyopia (4) Astigmatism
(5) Hypermetropia

Q.109 The lens and cornea is not having blood supply. So the nutrients are supplied by : **[Kerala PMT 2003]**

(1) retina (2) eye lash
(3) blind spot (4) aqueous humor
(5) vitreous humor

Q.110 Which part of the human ear plays no role in hearing as such but is otherwise very much required ? **[AIPMT Pre 2012]**

(1) Organ of Corti
(2) Vestibular apparatus
(3) Ear ossicles
(4) Eustachian tube

ANSWER-KEY

EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	4	4	2	4	1	2	2	3	3	2	3	1	4	2	2	2	1	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	4	4	3	2	3	2	4	4	3	2	3	3	4	1	1	2	4	3	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	2	1	1	4	1	2	4	1	1	3	2	1	2	1	2	1	2	4	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	3	1	4	4	3	1	1	1	4	3	2	3	1	2	4	1	2	2	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	4	3	4	4	4	2	1	4	1	4	1	1	2	2	3	1	3	2	1
Ques.	101	102	103	104	105	106	107	108	109	110										
Ans.	4	1	2	4	1	1	4	2	4	2										

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** Dogs have an acute olfactory sense.
R : Olfactory epithelium is very extensive in dogs.

Q.2 **A :** When one applies a perfume, he soon ceases to smell it, but others approaching him can perceive its aroma.
R : The olfactory receptor cells present in the nose works as chemoreceptors.

Q.3 **A :** Sparrows possess poor night vision.
R : Sparrows eyes are made up of ommatidia.

Q.4 **A :** Auditory function of ear is restricted to external and middle ear only.
R : Internal ear bears sensory hair cells for perceiving changes concerned with posture and equilibrium.

Q.5 **A :** Vitamin A deficiency produces night blindness.
R : Photosensitive pigment rhodopsin is synthesised from vitamin A.

Q.6 **A :** The auditory ossicles help in hearing.
R : Auditory ossicles maintain the balance of air pressure between two sides of the eardrum.

Q.7 **A :** Nerve impulses are carried from gustatory cells of taste buds to the brain.
R : Taste center in brain is responsible for perceiving the taste sensation.

Q.8 **A :** Taste buds are called the sense organs for olfaction.
R : Taste buds bear olfactory receptor cells which get stimulated by certain chemical substances.

Q.9 **A :** All of the cranial nerves are said to be mixed nerves.
R : All cranial nerves carry both sensory and motor nerve fibres simultaneously.

Q.10 **A :** Taste of chillies is not a true sensation.
R : Taste of chillies is perceived only on the upper surface of the front half of the tongue.

Q.11 **A :** No taste sensation is evoked when distilled water is applied on human tongue.
R : Man does not possess taste buds for tasting water.

Q.12 **A :** Motor neuron terminates on a motor end plate at the neuromuscular junction.
R : Motor end plate acts as receptor for detecting changes in the muscle fibres.

Q.13 **A :** The chemicals stored in the synaptic vesicles are termed as neurotransmitters.
R : Synaptic vesicles release these chemicals in the synaptic cleft.

Q.14 **A :** Myopia or short sightedness can be corrected by using spectacles with biconcave lenses.
R : Biconcave lenses diverge the parallel rays before their entry into the eye.

Q.15 **A :** With the evolution of multicellularity, it became imperative to develop nervous system.
R : Special senses such as vision, hearing are produced by sense organs associated with the nervous system.

Q.16 **A :** Image focussed on the fovea is seen most accurately.
R : Fovea of retina contains numerous photoreceptor rod cells.

Q.17 **A :** Blind spot on the retina of the eye is devoid of the ability for vision.
R : The photoreceptor cone cells are absent at the blind spot.

Q.18 **A :** While reading a book, you have to move yours eyes form word to word, although the full page is in view.

R : This is because of the difference in curvature between different meridians of the cornea.

Q.19 **A :** The eye is said to have power of accommodation.

R : Ciliary muscles alters the shape of the lens for near or far vision during accommodation.

Q.20 **A :** In hypermetropia or far sightedness, the objects get focussed beyond the retina.

R : It happens due to the denaturation of lens proteins.

Q.21 **A :** Nocturnal animals are able to see in the dark.

R : Retina of eye of the nocturnal animals bears mainly rod cells as the photoreceptors.

Q.22 **A :** A red flower looks black in the evening.

R : Red pigments of flowers trun black in the evening.

ANSWER KEY

EXERCISE – 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	3	5	1	3	1	4	4	3	1	3	2	1	2	3	2	3	2	3
Ques.	21	22																		
Ans.	1	3																		

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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P. Maheshwari

LIFE CYCLE OF ANGIOSPERM

INTRODUCTION

Each and every organism can live only for a certain period of time. The period from birth to the natural death of an organism represents its life span.

Life spans are not necessarily correlated with their size or complexity of the organisms. i.e., the sizes of crows and parrots are not very different yet their life spans show a wide difference. Similarly, a mango tree has a much shorter life span as compared to a peepal tree. Whatever be the life span, the death of every individual organism is certain, i.e., no individual is immortal, except single-celled organisms.

Reproduction is defined as a biological process of self perpetuation in which an organism gives rise to young ones (offsprings) similar to itself The offspring grows, matures and in turn produces new offspring. Reproduction enables the continuity of the species, generation after generation.

TYPES OF REPRODUCTION

There is a large diversity in the biological world and each organism has evolved its own mechanism to multiply and produce offspring. Habitat and internal physiology of organism and several other factors are collectively responsible for how it reproduces. There are two types of reproduction :

(1) Asexual reproduction

(i) Offspring is produced by a single parent with or without the involvement of gamete formation.

(ii) Gametic fusion is absent.

(2) Sexual reproduction

(i) Offspring is produced by two parents (opposite sex) with the involvement of gamete formation.

(ii) Gametic fusion is present.

DIFFERENCE BETWEEN ASEXUAL AND SEXUAL REPRODUCTION

S.No.	Asexual Reproduction	Sexual Reproduction
(i)	It does not involve the formation and fusion of gametes.	It involves the formation and fusion of two gametes, generally distinguished into male and female.
(ii)	New individual develops from one cell or a part of one parent.	New individual develops from zygote or fusion product of two gametes, which may or may not be produced by two parents.
(iii)	New individuals are genetically similar to the parents.	New individuals or offsprings are generally different from either of the two parents.
(iv)	It involves only mitotic divisions.	It involves meiosis at one or the other stage. In higher plants, it occurs at the time of sporogenesis.
(v)	It does not require the formation of sex organs.	Formation of sex organs is a pre-requisite for sexual reproduction.
(vi)	It does not intorudce variability. Hence, has no evolutionary importance.	It introduces variability and is, hence of evolutionary importance.

1. Asexual Reproduction

1. A single individual (parent) is capable of producing offsprings in this reproduction. As a result, the offsprings that are produced are exact copies of each other and their parents. Such morphologically and genetically similar individuals are called clones.
2. It is common among single-celled organisms, plants and animals vvith relatively simple organisation.
3. It is also called somatogenic reproduction because propagules are formed from somatic cells of the parent.
4. It occurs by fission, budding, sporulation, fragmentation, regeneration and vegetative reproduction.

(A) Binary Fission

(i) In this process, the parent organism divides into two halves, each half forming an independent daughter organism. It means, the parent body as a whole forms the reproductive unit and the parent continues living as two daughter individuals. Therefore the organisms that undergo binary fission are said to be immortal.

(ii) It occurs in Bacteria (Moneran), Amoeba and Paramecium (Protists).

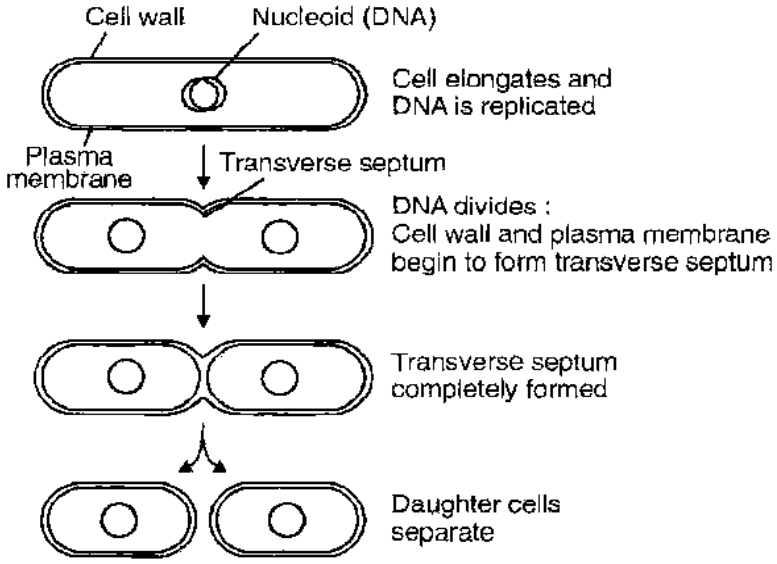


Fig. : Binary fission in bacteria

Depending upon the plane of division, binary fission is of the following types :

(i) Simple Binary Fission (Irregular Binary Fission) : Division can occur through any plane, e.g., Amoeba.

(ii) Longitudinal Binary Fission: The plane of fission passes along the longitudinal axis of the organism, e.g., *Euglena.*

(iii) Transverse Binary Fission: The plane of this division runs along the transverse axis of the individual, e.g., Bacteria, Paramecium, Diatoms.

Life span of some organisms are as follows :

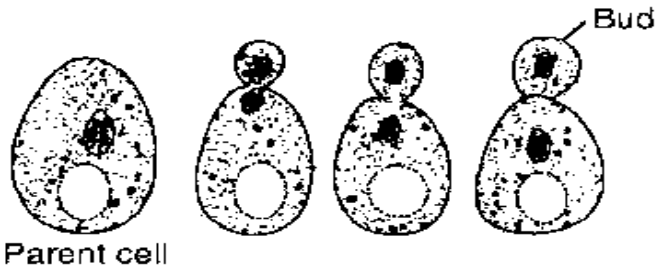
S.No.	*Plant*	*Life span*
1.	Rice	3-4 months
2.	Rose	5-7 years
3.	Banana	25 years
4.	Mango	200 years
5.	Banyan	200 - 300 years
6.	Peepal	2000-3000 years
7.	*Sequoia*	3000-4000 years
8.	*Macrozamia*	10,000-12,000 years

S.No.	*Animal*	*Life span*
1.	Mayfly	1 day
2.	Butterfly	1-2weeks
3.	Fruitfly	30 days
4.	Dog	20-30 years
5.	Crocodile	60 years
6.	Horse	60 years
7.	Elephant	60-90 years
8.	Tortoise	100-150 years

(B) Budding

(i) In yeast, the division is unequal and a small bud (protuberance) is produced that remain attached initially to the parent cell, later on the bud gets separated and mature into new yeast organisms (cells).

(ii) Budding or sporulation is also shown by oidia of *Rhizopus*.



(C) Spores

Members of the kingdom fungi and simple plants such as algae reproduce through special asexual reproductive structure. The most commonly produced structures are conidia and zoospores.

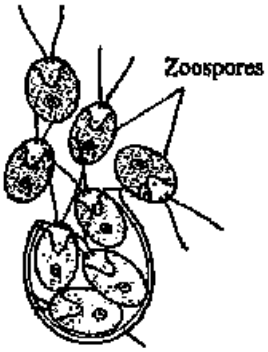
Zoospores

(i) These are motile and flagellated spores produced inside the zoosporangia under favourable conditions.

(ii) In *Chlamydomonas*(n), the protoplast of cell divides to form 8-16 zoospores. They are pyramid shaped and anteriorly biflagellated, resembling the parent cell. The parent cell wall breaks and the zoospores are liberated in water. They enlarge and behave as an adult individual.

(iii) Zoospores are also produced in the asexual life cycle of *Achlya*, *Saprolegnia*, *Phytophthora* and *Ulothrix*.

(iv) Zoospores of *Cladophora* glomerata are diploid.



Zoospores of Chlamydomonas

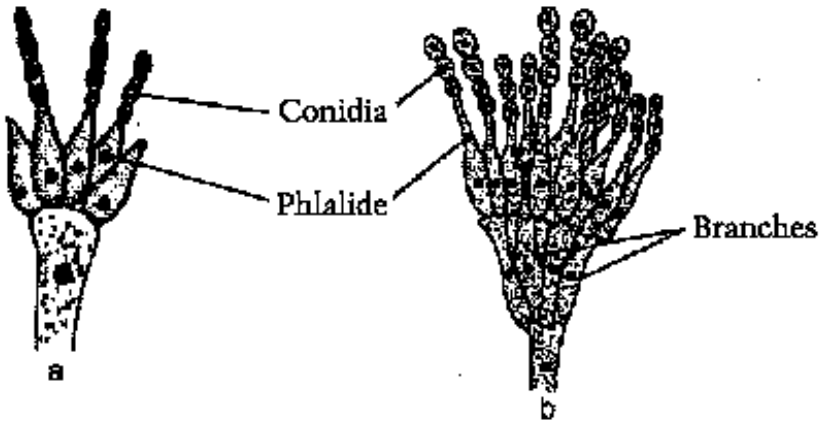
Conidia

(i) In *Penicillium*, these spores are produced at the tips of special hypha I branches, called conidiophores.

(ii) There are two types of conidiophores :

a. Unbranched/monoverticillate

b. Branched Biverticillate



Penicillium

(iii) The branches of conidiophores are called rami and branches of rami are called metulae. Each metula bears 2-6 flask shaped structures called sterigmata (phialides). Each sterigma produces a chain of conidia.

(iv) Features of Conidia:

a. Pigmented

b. Uni or multinucleated

c. The conidia in the chain are arranged in basipetal manner.

(i) Conidia are produced by the members of Ascomycetes (e.g., Aspergillus, Penicillium).

(ii) The conidiophore with its metulae, sterigmata and chain of conidia gives the appearance of a small brush/broom, technically called penicillus.

(D) Vegetative Reproduction

(a) Vegetative reproduction does not involve meiosis and fusion of gametes, therefore it is considered as a type of asexual reproduction.

(b) New plants or individuals are produced from vegetative parts of plants and newly formed individuals are genetically identical to the parent plant.

(c) It is common method of reproduction in the flowering plants.

There are two types of vegetative reproduction.

(I) Natural methods of Vegetative Reproduction :

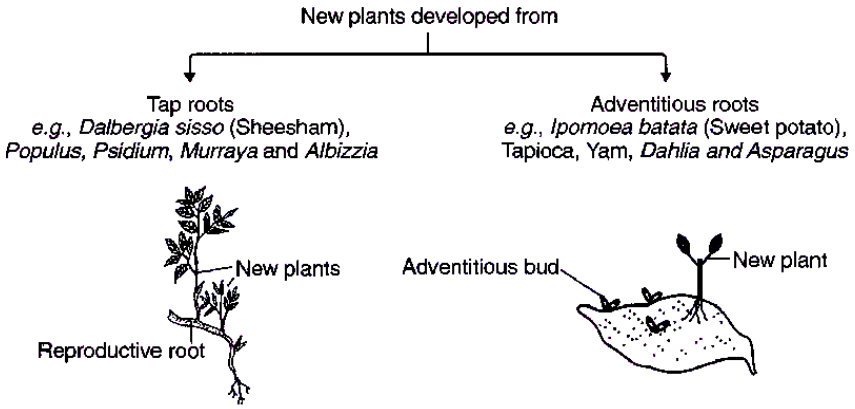
These are methods of plant multiplication occurring naturally in which a somatic part of the plant detaches from the body of the mother and develops into a new independent plant under suitable environmental conditions. The detachable somatic part that functions in vegetative propagation is called vegetative propagule. It carries one or more buds. Natural buds occur over the nodes of the stem. When placed in contact with damp soil, the buds sprout, producing roots and new plants. This potential is exploited by farmers, e.g., tubers of potato, rhizome of banana and ginger, bulbs, runners, offsets, stolons, aerial stems etc. Some propagules carry adventitious buds e.g., normal and storage roots, leaves.

It occurs by following means :

(1) Roots

(i) Both tap roots and adventitious roots takes part in vegetative reproduction due to the presence of bud, known as radicle bud.

(ii) Adventitious buds on root detaches and gives rise to new plant.



(2) Underground stems : Different types of underground stems like **tuber**, **rhizome**, **bulb** and **corm** can take part in vegetative propagation. A portion of underground stem bearing bud forms a new plant.

- **Tuber :** It is terminal portion of underground stem branch which is swollen on account of accumulation of food. e.g., Potato, Artichoke
- **Rhizome : It grows or horizontally under** soil surface. It is well branched and bears nodes, intemodes, buds and scale leaves. e.g., Banana, Turmeric, Aspidium, Adiantum

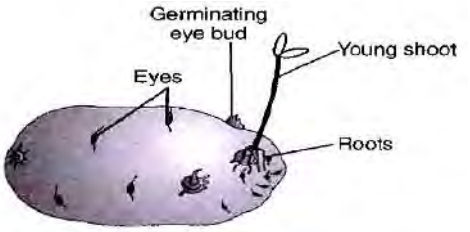


Fig. : Tuber of Potato

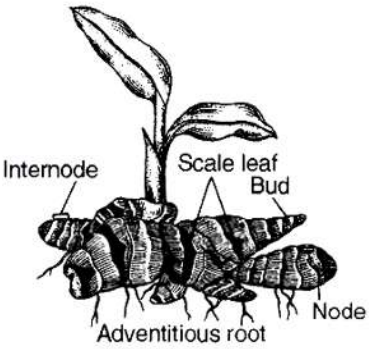


Fig. : Rhiozome of ginger

- **Bulb :** Stem is unbranched, highly reduced and disc shaped. The bud is surrounded by many concentric scale leaves. Leaf bases of inner ones are fleshy and edible and outer ones are dry. e.g., Onion, Garlic, Narcissus
- **Corm :** It grows vertically beneath soil surface. It bears nodes, internodes, buds and scale leaves. e.g., *Colocasia, Gladiolus, Freesia, Crocus*

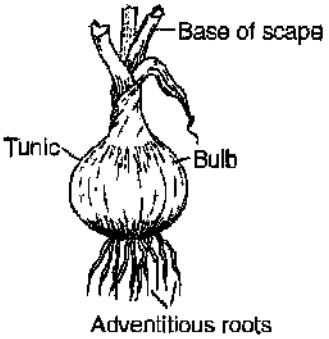


Fig. : Bulb of onion

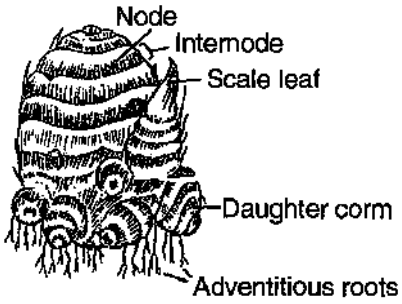


Fig. : Corm of Colocasia

(3) Creeping stems :

- **Runner :** It is elongated, prostrate, sub-aerial branch with long internodes and roots at nodes. e.g., Grasses

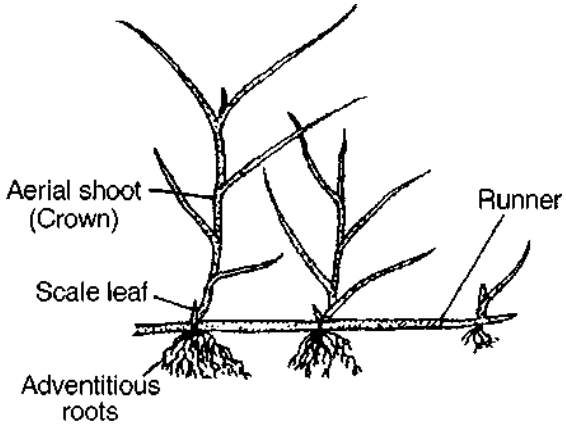


Fig. : Runner of grass

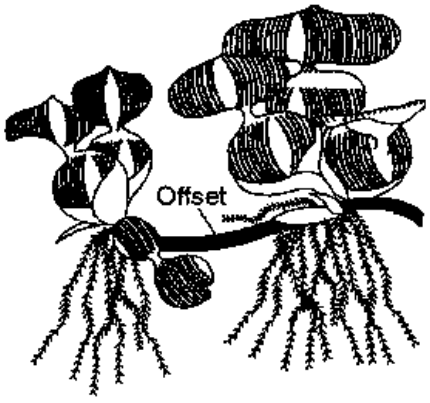


Fig. Water hyacinth

- **Offset :** Short horizontal branch producing a cluster of leaves above and the cluster of roots below is called offset. e.g., *Eichhornial* (Water hyacinth) *Pistia*

  Water hyacinth or 'terror of Bengal' was introduced in Bengal because of its beautiful flowers and shape of leaves. However, it turned out to be highly invasive aquatic weed that not only spread to all water bodies

of Bengal but also throughout India. It drains oxygen from the water, which leads to death of fishes and other animals. It is very difficult to get rid off them since it can propagate vegetatively by offset at a phenomenal rate and spread all over the water body in a short period of time.

- **Stolon :** It is subterranean long lateral branch arising from base of stem. It first grows obliquely upward and then bends down to the ground surface.
  e.g., Strawberry, Vallisneria

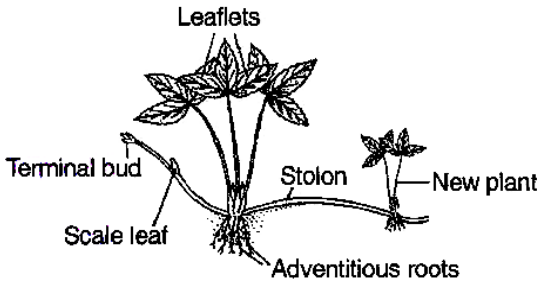


Fig. Stolon of Strawberry

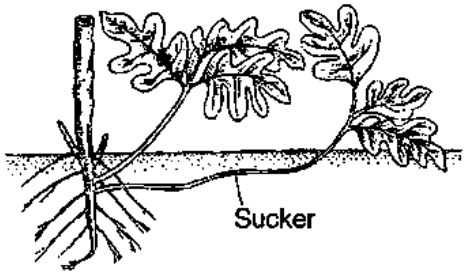


Fig. : Sucker in Chrysanthemum

- **Sucker :** It arises by axillary bud of underground part of stem. This lateral branch creeps below the soil surface and grows obliquely upward and produces new shoot.
  e.g., *Chrysanthemum*, *Pineapple*

(4) Aerial shoots :

Each segment of stem having at least one node can form a new plant. e.g., Sugarcane, Opuntia

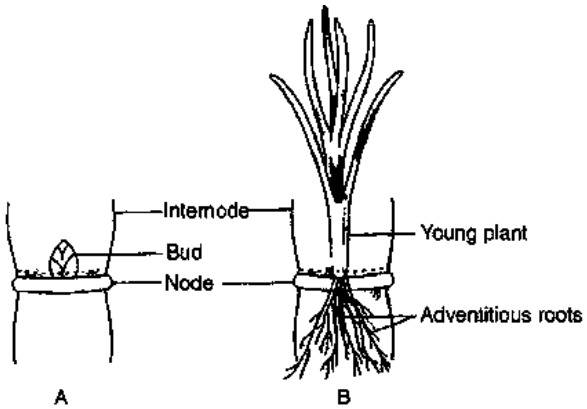


Fig. : propagation from aerial shoot in Sugarcane

(5) Leaves :

Leaves of several plants having adventitious buds help in vegetative reproduction. In Bryophyllum adventitious buds arise from the notches present at margins of leaves.
e.g., *Adiantum* (walking fern), *Begonia*, *Streptocarpus*, *Saintpaulia* and *Kalanchoe*.

Fig. : Bryophyllum

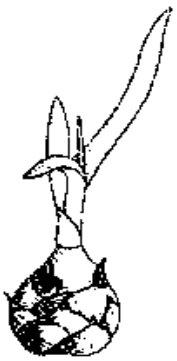


Fig. : Bulbil of Agave

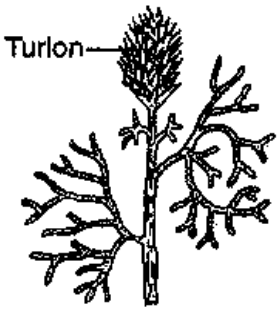


Fig. : Utricularia showing turtion

(6) Bulbils

These are fleshy buds which produce new plant.

e.g., *Agave*, *Oxalis*, *Ananas*, *Oioscorea*, *lily*, *Chlorophytum*

(7) Turions

Fleshy buds in aquatic plants e.g., *Potamogeton*, *Utricularia*.

II. Artificial Methods of Vegetative Reproduction :

Artificial methods are man-made special techniques in which, part of somatic body of a plant is made to develop into new independent plant. Artificial methods are used to propagate desired varieties according to human requirements. Rainy and spring seasons are the best periods for vegetative propagation. The various horticultural methods of vegetative propagation are as follows :

(1) Cuttings : Cuttings are cut pieces of stem, leaves and root which are planted in nurseries in natural polarised fashion. Pre-requisite to successful cutting is induction of rooting. For this, root promoting chemicals like IBA, NAA are used.

(i) Stem Cuttings :

It is a common artificial method of plant propagation. 20-30 cm long pieces of one year old stems are cut and their lower ends are dipped in dilute auxin for several minutes before planting in the soil. The lower ends develop adventitious roots. Buds present over the exposed parts sprout and form the shoot system.

e.g., Rosa, Duranta, Citrus, Clerodendron, Thea, Bougainvillea, Croton and China rose

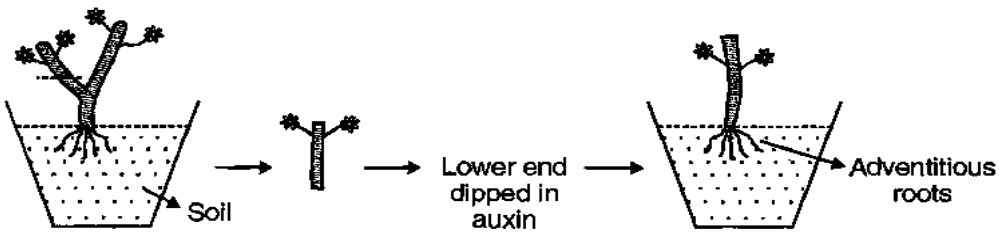


Fig. : Stem cutting

(ii) Leaf Cuttings : Snake plant (Sansevieria) can be propagated by leaf cuttings. Leaves are cut transversely into two or three parts and planted in vertical position in the soil. For successful leaf cutting, besides induction of rooting, formation of adventitious buds is also important.

(iii) Root Cuttings : They are long pieces of roots which are used to artificially propagate new plants. Ability to form adventitious roots and adventitious buds are pre-requisites. Root cuttings are used in propagation of Lemon, Tamarind, Blackberry and Raspberry.

(2) Layering :

(i) It is a type of rooting-cutting method in which adventitious roots are induced to develop on a soft stem while it is still attached to the plant.

(ii) It is carried out on one year old basal shoot branches commonly during early spring or early rainy season.

(iii) A soft basal branch is defoliated in the middle where a small injury or cut is also given, like tongueing (oblique cut), notching (V-shaped cut), ringing (removal of a ring of bark). The injured defoliated part is pegged in the soil to develop adventitious roots. The pegged down branch of the plant is called layer. Later on as the roots develop, the layer is separated and planted.

- Layering is of following types:

(a) Tip Layering :

A shoot is bent down in the soil in such a way that its basal end is slanting while the tip is upright. Soil is pressed. It induces root formation and later growth of shoot tip.

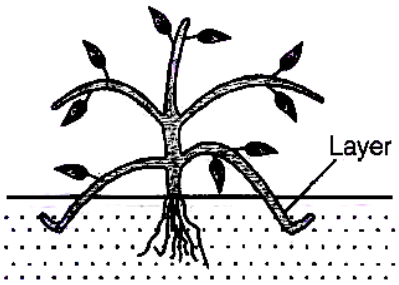


Fig. : Tip layering

e.g., Blackberry, Raspberry.

(b) Trench Layering :

The basal branch is pegged in a horizontal position in a trench made in soil. It develops a number of vertical shoots.

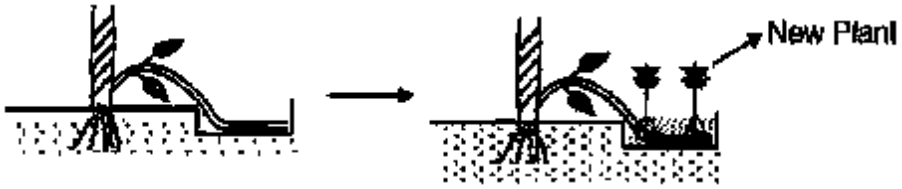


Fig. : Trench layrring

e.g., Walnut, Mulberry.

(c) Serpentine Layering

The basal branch is pegged at several places in soil at regular intervals, so as to form many plants.

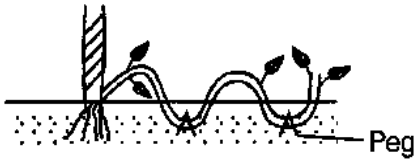


Fig. : Serpentine layering

e.g., Clematis

(d) Mound (Stool) Layering

The shoot is pruned and its lower part is covered by soil but the tip is kept outside the soil. When a number of new shoots develop, soil and saw dust are poured over the base to form a mound. Each shoot develops roots. Rooted shoots are separated and planted.

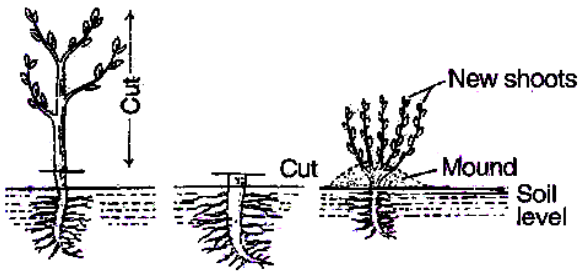


Fig. : Stages in Mound layering

e.g., Currant, Gooseberry, Apple, Pear and Jasmine

(e) Gootee (Air Layering)

(i) It is an ancient horticultural technique for propagation of tropical and subtropical trees and shrubs where soft branches do not occur near the soil.

(ii) During early monsoon rains, 3-5 cm long ring of bark is removed from the basal region of a healthy and woody branch. It is covered by a thick plaster of grafting clay. Grafting clay is made of 1 part cow dung, 1

part finely cut hay or moss and two parts clay. To it is added water and a small quantity of root promoting hormones like 1M, IBA or NAA. It is then wrapped in polythene. After 2-3 months, roots appear. The shoot is now cut below the covered part and used for planting.
e.g., Litchi, Pomegranate.

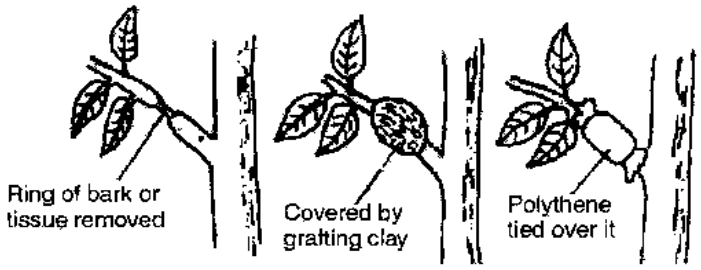
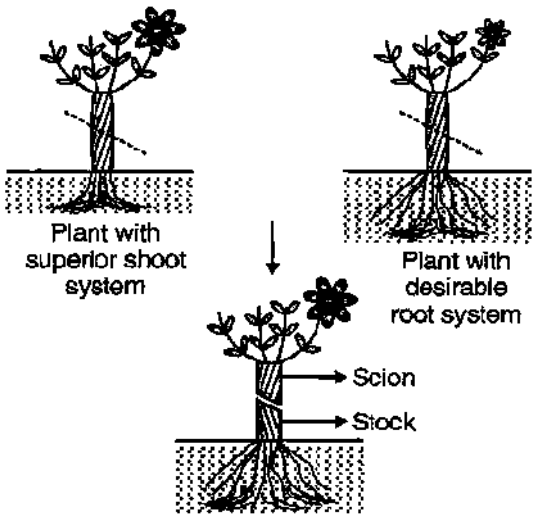


Fig. : Air layering in Rubber plant

- Soil layering was first discovered by Hartmann.
- In drop layering, a plant capable of forming several branches when it is grown in a deep soil. e.g., Dwarf Rhododendron.

(3) Grafting:

(i) Grafting is a technique of connecting two parts, usually a root system and a shoot system of two different plants in such a way that they unite and later develop as a composite plant.



(ii) It is used only in cambium containing eustelic plants.

(iii) A small shoot of plant with superior traits is employed. It is called **graft or scion**. It should have one to several buds. The root system of the other plant is allowed to remain intact. 1t is called **stock** (understock). The shoot of the stock is often cut 10-30 cm above the base of the root. Leaves and buds present over the stump of stock are removed.

(iv) In grafting, scion is fixed over the stock in a manner that cambia of the two come in contact. The union is covered with grafting wax. It is then tied with the help of a bandage, tape, rubber or nail. The buds of the stock are not allowed to sprout. They are removed as soon as they are noticed.
e.g., Mango, Apple, Pear, Citrus, Guava, Plum, Peach, Pine etc.

- The various types of grafting are as follows :

(a) Tongue (Slice or Whip) Grafting

Oblique sloping cut or notch is given to both stock and scion. The two perfectly fit upon one another. They are tied together.

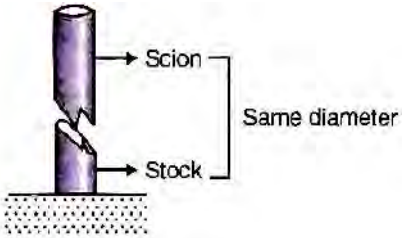


Fig. : Tongue grafting

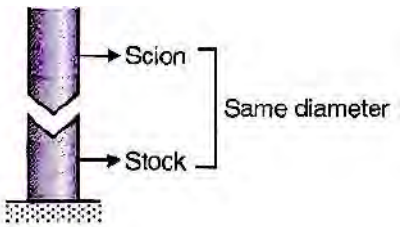


Fig. : Wedge grafting

(b) Wedge Grafting

V-shaped notch is given to stock while wedge like cut is given to scion.

(c) Crown Grafting

Many scions are selected and sl/aped at the base to form wedge. Many slits are formed on the sides of stock. Scions are inserted in the slits and are bandaged.

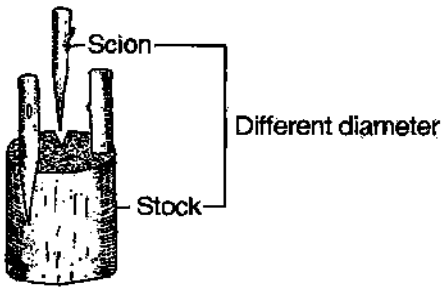


Fig. : Approach grafting

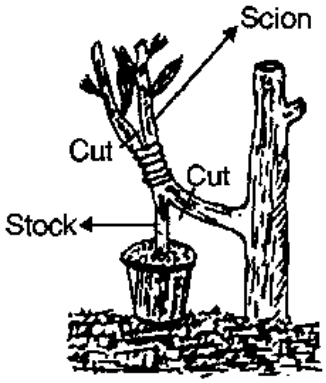


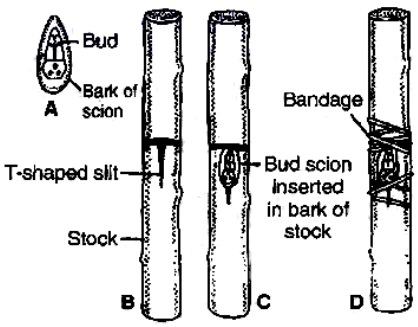
Fig. : Approach grafting

(d) Approach Grafting

Two independently growing plants are brought together. The shoots of the two are given cuts at the same level for a distance of 2.5 - 5.0 cm. The cuts are in the form of smooth slices of bark, tongue shaped cuts or deeper vertical cuts. In this grafting, the scion is cut below the graft while stock is cut above the graft after the establishment of union.

(e) Bud Grafting

Scion is a bud with a small piece of bark and cambium. Stock is given a T-shaped cut. Bark is lifted to expose cambium. Bud is inserted and the bark is allowed to come back to its original position. Only the bud is exposed. The joint is treated with grafting wax and bandaged. Bud sprouts after 3-5 weeks. Bud grafting is commonly practised in apple, peach and rose.



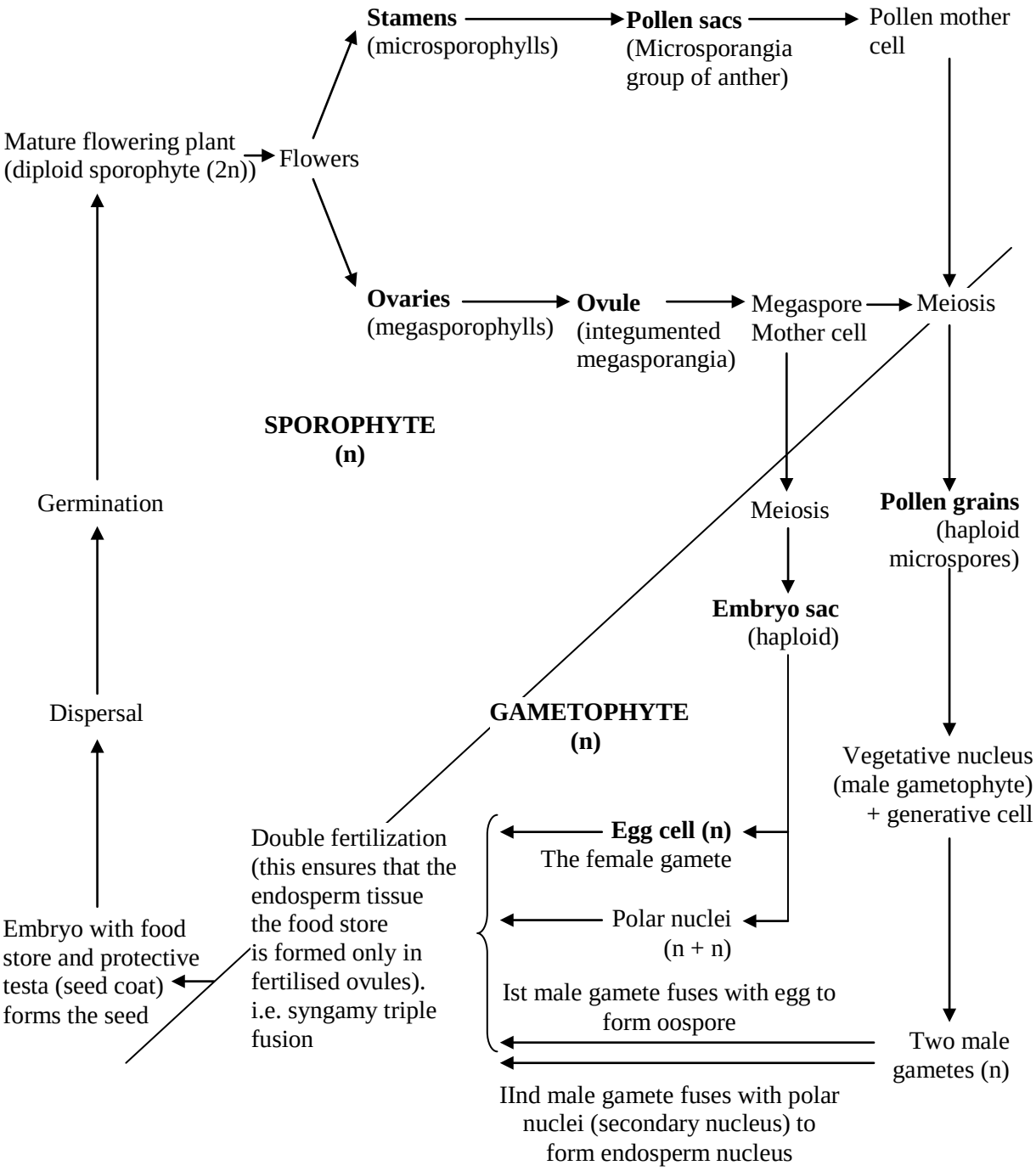
(4) Micropropagation : Micropropagation is the raising of new plants from a small plant tissue with the help of tissue culture technique. Tissue culture is the technique of maintaining and growing cells, tissues, etc. and their differentiation on artificial medium under aseptic conditions inside suitable containers.

(i) Gemmae are small, undifferentiated, multicellular green propagules which separate from parent plant and forms new plants e.g., Marchantia, Funaria.

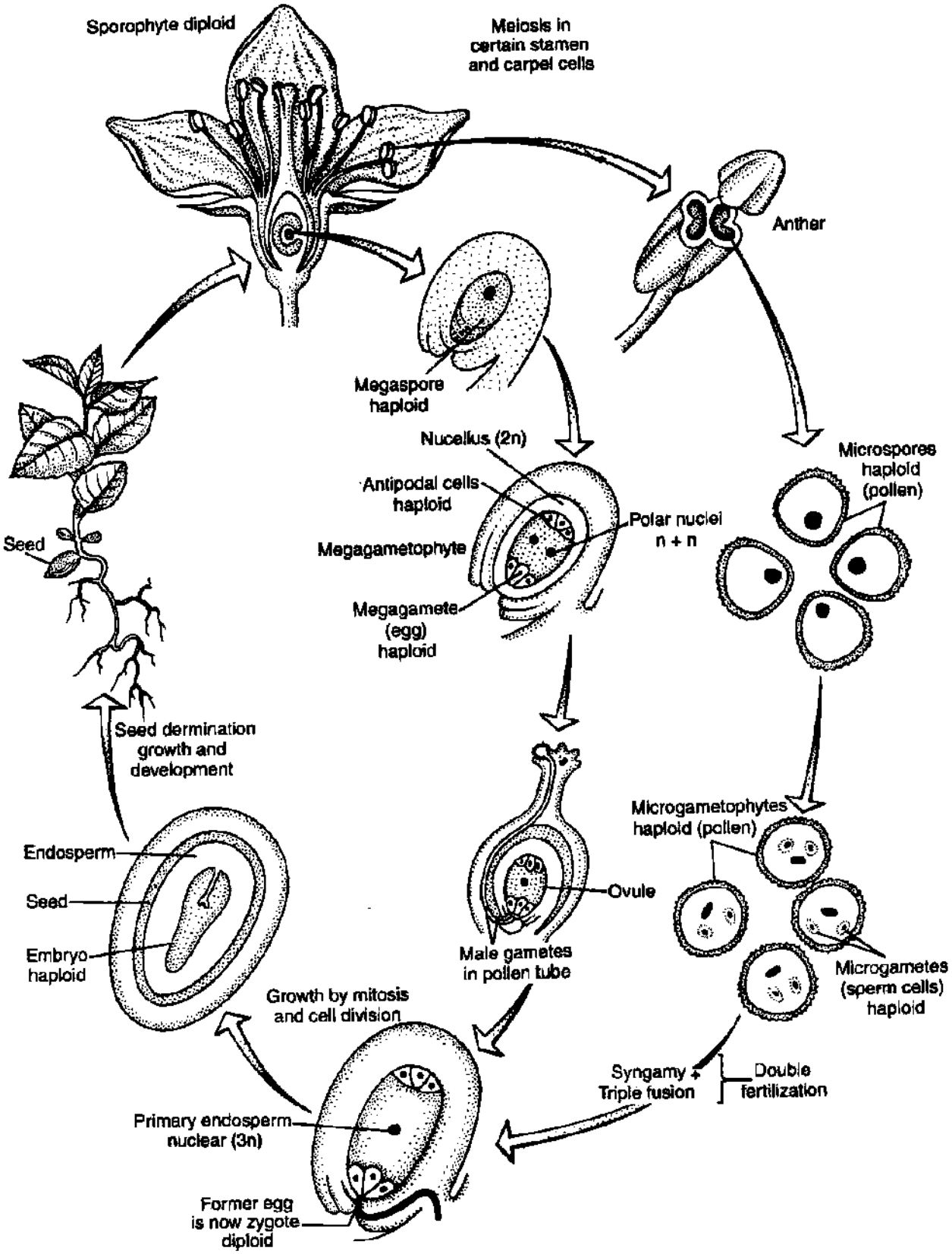
(ii) Resting buds are perennating fleshy buds, as in Selaginella subdiaphana.

SEXUAL REPRODUCTION

In Angiosperms male and female gametes are formed in male and female sex organs by the process of meiosis. Both the gametes fuse together to form a diploid zygote which gives rise embryo. It means the process in which embryo is formed by meiosis and fertilization is called Amphimixis.



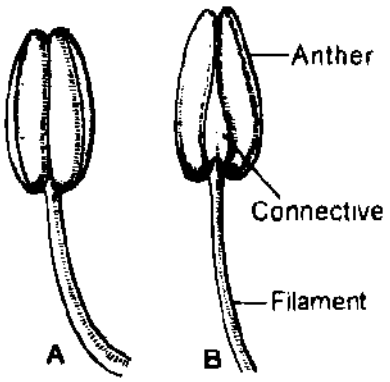
Diagrammatic representation of life history of an angiospermic plant



Life cycle of an Angiospermic plant topographic representation

MALE REPRODUCTIVE ORGAN - ANDROECIUM

Male reproductive organ is called androecium and their unit is called stamen. Stamen is also known as microsporophyll. There are 6 stamens are present in Capsella. A typical stamen is differentiates into three parts –a long, thin structure is called filament which joins the stamen to the thalamus. The free end of the filament, a swollen spore bearing structure is called anther. Anther and filament are attached together with help of small region, called connective. Connective contains vascular tissues. The main parts of the stamen is the anther.Each anther generally bilobed structure i.e. anther has two anther lobes is called dithecous.



Each lobe of anther has two chambers which are called pollen sacs or microsporangia or pollen chambers. Therefore, a typical anther has four pollen sacs is called tetrasporangiate. Pollen grains are formed inside the pollen sac through the meiotic division of pollen mother cells. At the maturity of the pollen grains, sterile tissue degenerate which are present in between the pollen sacs. Both the pollen sac fused together. Because of this reason, only one chamber appears in each anther lobe at maturity. So two chambers are seen in the mature anther at the time of dehiscence.

In *Capsella*, which is member of the cruciferae or Brassicaceae, anther are dithecous and tetrasporangiate type. But in Malvaceae, the anther of stamen has only one anther lobe. This is called monothecous and it contains only two pollen sacs called Bisporangiate. Monothecous anther are also found in Moringa, Wolffia plants. In Arceuthobium where there is only one microsporangium per anther. This condition is called Monosporangiate.

STRUCTURE OF ANTHER :

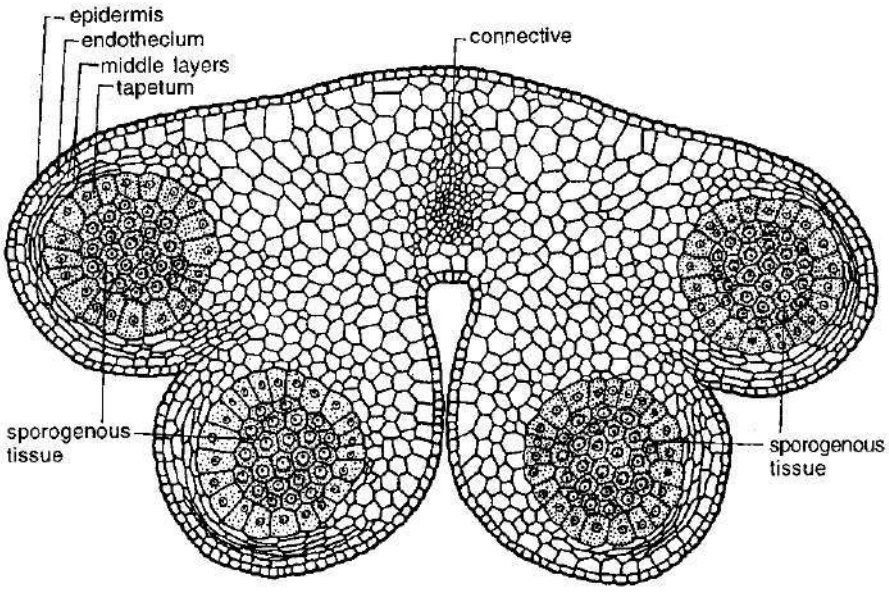
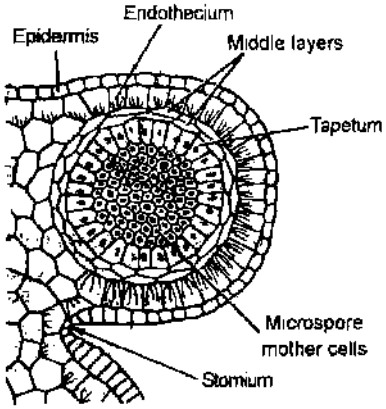


Fig. 3.1 Transverse section of a tetrasporangiate anther to show its various tissues.

The development of anther in origin is Eusporangiate type i.e. It is developed from more then one archesporial cells. In the transverse section of anther, it is seen almost spherical. The following structures are present in the anther :-

- **Epidermis :-** It is the outermost layer of anther. It is single celled thick and continuous layer but not archesporial in origin. It forms the outermost protective layer. In Arceuthobium (Smallest Parastic Angiosperm) fibrous thickening present in epidermis so it is called exothecium.
- **Endothecium :-** This layer is present below the epidermis. It is single celled thick layer. During the maturation of anther, various changes takes place in different walls of cells of endothecium. The outer wall of these cells remains thin walled, but inner walls and radial walls become thick due to thickening of α-Cellulose fibers. Callose bands are also present along the radial walls. At some places callose bands and fibrous thickening are absent. These places are called stomium. The dehiscence of anther takes palce only from these places. Endothecium becomes hygroscopic nature due to presence of fibrous thickening. So it helps in dehiscence of anther.

  Note : Hydrocharitaceae family – fibrous thickening is absent in endothecium.



T. S. of young anther showing four microsporangia and vascular bundle.

- **Middle layer :-** Middle layer is consist of parenchymatous cells. This layer is one to three celled thick structure. Food is stored by parenchymatous cells of this layer. Middle layer is ephemeral in nature and absent in a mature anther.

  In Holoptelia plant 3 to 4 called thick middle layer is present. In Najadaceae & Lemnaceae families middle layer is absent. In wolffia middle layer is absent.
- **Tapetum :-** It is the inner most layer which acts as nutritive layer. It is known as tapetum. Pollen sacs surrounded by tapetum. This is also single celled thick layer. The cells of the tapetum initially diploid but they become polyploidy due to endomitosis. It means these cells contain many chromosomes. Tapetum absorbs food from the middle layer and provide nutrition to the microspore mother cells or microspores. The cells of tapetum secrete hormones and enzymes. The tapetum layer disappears in the mature anther.

  Note : In Nicodia and Costum plants, tapetum is multilayered.
- **Pollen sacs :** Four Pollen sacs are present in the anther. Pollen sacs are also known as microsporangia. Inside the pollen sacs, microspores are formed by the meiotic divison of microspore mother cells.

TAPETUM IS OF TWO TYPES :-

Amoeboid Tapetum/Invasive Tapetum/Periplasmodial Tapetum :

It is found in primitive Angiosperm. Such type of tapetum absorb all foods from the middle layer. So middle layer immediately degenerates. In the beginning, all food materials stored by tapetum. Tapetal cells convert the absorbed food into special food granules called protoplast bodies. The innermost layer of tapetum dissolve and release its protoplast into the cavity of the microsporangium. Now inside the pollen sacs protoplast bodies are known as periplasmodium. Microspore mother cells are surrounded by periplasmodium and provides nourishment to the developing microspores. This type of tapetum provide nutrition to the microspores after degeneration.Example : *Typha, Alisma* and *Tradescantia.*

- **Glandular or Secretory Tapetum :**

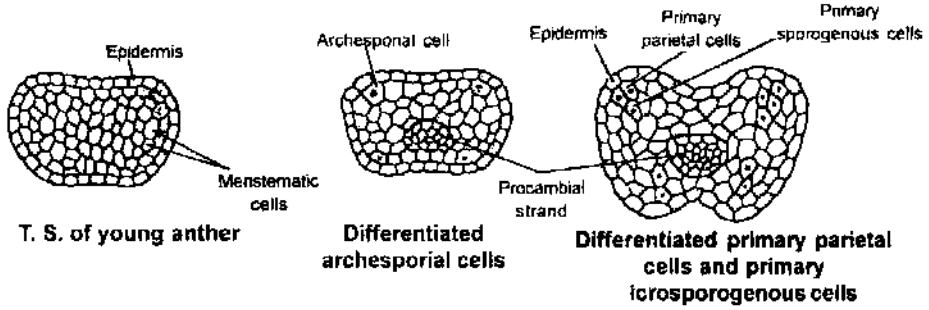
  It is developed type of tapetum. It is not degenerates quickly. It absorbs nutrients from the middle layer and secreted into the cavity of the microsporangia (Pollen sacs) and does not store it e.g. Usually it is found in most of Flowering plants (*Capsella*). Before degeneration of cells of tapetum, they form special granules called Proubisch bodies in cytoplasm. Proubisch bodies transfer between cell wall and cell membrane of tapetal cells.

Here they are surrounded by Sporopollenin. Now they are called Ubisch bodies or orbicules. At last tapetum degenerates and ubisch bodies released into pollen sacs. Generally, sporopollenin participates in the formation of outer covering (Exine) of Pollen grains. Tapetum helps in transfer of food, storage of food, formation of sporopollenin and pollenkitt materials.

MICROSPOROGENESIS :

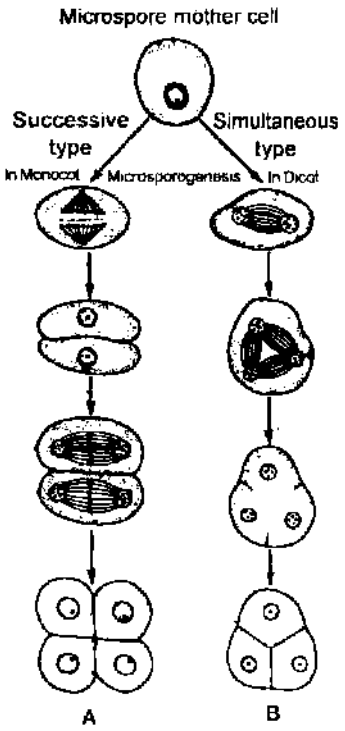
The anther appears as outgrowth like structure in the initial stage which shows spherical or oval shaped structure. At this stage, it is a mass of undifferentiated and homologous meristematic cells which is surrounded by a single cell thick outer layer. This layer is known as epidermis. First of all vascular tissue are formed in middle region Simultaneously four cells located just below the epidermis in vertical rows in the region of hypodermis at the four corners are become large has visible nucleus with dense cytoplasm. Due to this reason they are different from the rest of the cells. These cells are called archesporial cells.

These cells divide periclinally to form primary parietal cells below the epidermis and primary sporogenous cells towards the centre. Both of the cells usually undergo further divisions to form complete structure of anther except epidermis.



Primary parietal cells undergo further periclinal and anticlinal division to form a series of 3-5 layers making the walls of the anther. Out of them outer most layer of anther is formed just below the epidermis by primary parietal cells is called Endothecium or fibrous layer. The endothecium is followed by 1-3 celled thick layer is termed middle layer. The innermost layer of the anther which surrounds pollen sacs, is called tapetum. Later the tapetal cells play a significant role during the meiotic cell division in microsporogenous cells and in pollen development. The primary sporogenous cells divide twice or more than two times by mitotic division to form sporogenous cells and later sporogenous cells differentiated into microspore mother cells (MMC / PMC) during the formation of wall of pollen sac.

Each microspore mother cell divide to form four haploid microspore or pollen grain by meiotic division or reduction division. During this period spherical bodies are formed inside the tapetal cells before their disintegration. These spherical bodies are known as Ubisch-body. Ubisch body is made up of a complex substance called sporopollenin. It is polymer of carotenoids.



TWO DIFFERENT TYPE OF MEIOTIC DIVISION IN MICROSPORES MOTHER CELL.

After the formation of ubisch body, the tapetum layer degenerates. Ubisch bodes participate in the formation of exine of the microspores inside the pollen sacs. Now thick walled microspores are called pollen grains. At the initial state all four microspores are attached together with the help of callose layer. This group of microspores is called tetrad. After some time, this callose layer dissolve by callase enzyme. Which is secreted by tapetum.

Normally each microspore mother cell can form tetrad by meiotic division. But in some plant like Zostera, some microspore mother cells become sterile and provide nutrition to rest of microspore mother cells.

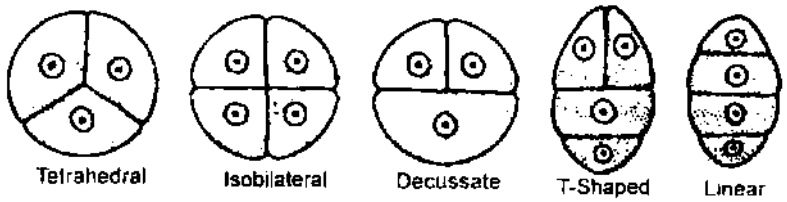
Similarly, tapetum is not well developed in Gentianaceae family so some cells of sporogenous tissue become sterile and provide nutrition to remaining sporogenous cells.

- **Types of tetrads :** The arrangement of the microspores in tetrad condition as follows :-
- **Tetrahedral tetrad :** Four haploid microspores arranged in tetrahedral form.

  Example : *Dicotyledons – (Capsella)*
- **Isobilateral tetrad :** This condition is found in **monocotyledons**. Microspores are arranged at the lateral side of each other.
- **Decussate tetrad :** In this two microspores lies at the right angle of other microspores.

  Example : *Magnolia*
- **T-Shaped tetrad :** Two microspores lie longitudinally and two microspores lie at transversly in this type of tetrad. Example : *Aristolochia* & *Butomopsis*.
- **Linear tetrad :** In this tetrad all four pollens arranged in linear order. e.g., *Halophylla, Halophia.*

  All the above type of tetrads are found in Aristolochia elegans. Most common type of tetrads is Tetrahedral.

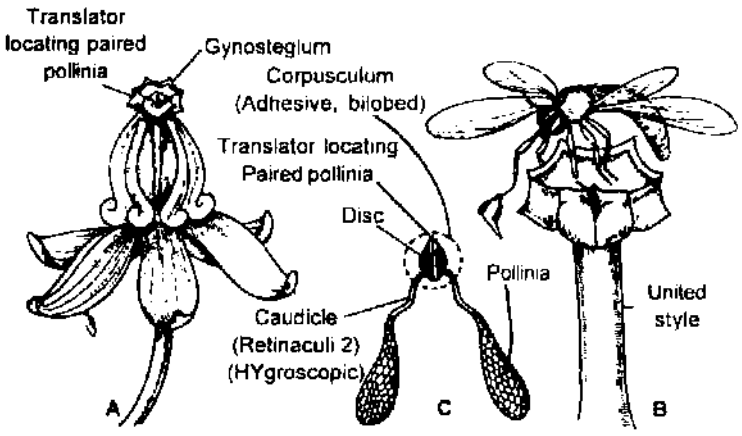


DIFFERENT TYPE TETRAD OF ANGIOSPERM

Facts about types of Pollen grains :

In Asclepiadaceae (Calotropis) and Orchidaceae family, all the pollen grains joined together to form "Pollinium".

More than four pollen grains are found in tetrad called "Polyspory" e.g. *Cuscuta.* In some plants, four pollens of tetrad join together permanently are called "Compound pollens" e.g. *Drosera, Typha, Drimys* and *Elodea.* Pollinium of Calotropis is called "Translator apparatus". Compound pollens of Mimosaceae (Mimosa) family contains 6-8 or 64 pollen grains stick together to form a small unit that is called "Massullae" e.g. *Mimosa* and *Neottia plants.*



TRANSLATOR APPARATUS

Due to the presence of sporopollenin, fossils of pollen grain are always found in good condition. The presence of fossils of pollen grains can forecast the presence of natural resources like petroleum, coals etc. in the earth. Pollen grains of some plants present in air cause allergy are called "aero allergens" e.g. chenopodium, Parthenium, Sorghum and Amaranthus. ["Hay fever" is caused by pollens of Ambrosia]. In Cyperaceae family only one pollen grain is formed from pollen mother cell e.g., *Cyperus.*

Largest pollen – Mirabilis.

Smallest pollen – Myosotis.

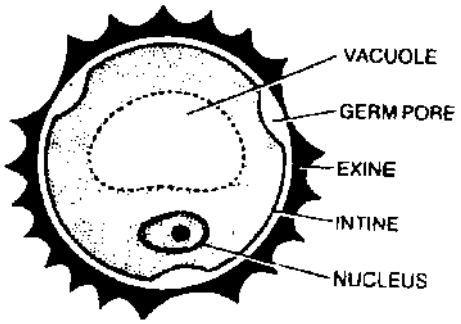
Longest pollen – Zostera (Filiform pollen)

Eight nucleated embryo sac type of pollen is found in Hyacinthus [This type of pollen grain discovered by Nemec. So it is called Nemec phenomenon]. Dumbel shaped pollens are found in Vinca herbacea. Pollen grains are rich in nutrients. It has become a fashion in recent years to use pollen tablets as food supplements in western countries. Large number of pollen products in form of tablets and syrups are available in market. Pollen consumption has been claimed to increase the performance of athletes and race horse. Pollen grains of many plant species cause severe allergies and bronchial disorders in some people leading to chronic respiratory disorders like - asthma, bronchitis. For ex. *Parthenium* (carrot / congress grass) – in India cause pollen allergy and asthma.

Viability of pollen grains is depands on temperature and humidity. In some cereals like rice and wheat – pollen grains loss viability within 30 minutes of their release. In members of Rosaceae, Leguminoseae and Solanaceae pollen grains are viable for months. Pollen grains can be stored like semen of humen being for years by cryopreservation in liquid nitrogen at –196^{o} temperature. Such pollens can be used as pollen banks similar to seed banks in crop breeding programmes.

Structure of Microspore or Pollen Grain :

Pollen grain is the first cell of a male gametophyte. Pollen grain is termed as immature male gametophyte. Usually, they are in round shape. Pollen grain surrounded by two distinct layers. The outer layer (wall) is thick, rigid and ornamented, called **exine**. This layer is formed by cutin and sporopollenin. Sporopollenin is Highly resistant material. It is nonbiodegradable. The internal layer is thin, soft and elastic in nature. It is called **intine**. It is made up of pectin and Cellulose or pecto-cellulose.



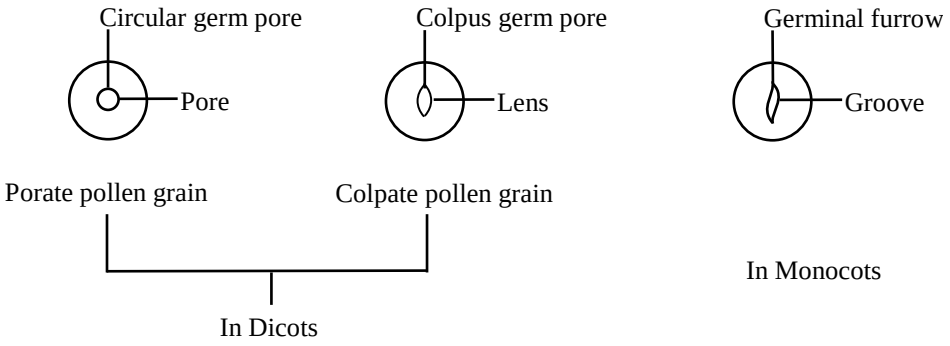
STRUCTUREOF POLLENGRAINS

Usually, at few places on outer surface exine is absent or present in the form of thin layer. These thin places are called **germ pore**. The initine comes out through any one germ pore during the germination of pollen grain in the form of pollen tube. The number of germ pore, structure and ornamentation of exine is a significant feature of taxonomy. A detail study of pollen grains is called **Palynology**. Three colpus type (slit type) of germpore are present in pollen grain of *Capsella*. This type of pollen grains are called tricopalte. Only one germ pore is present in monocots and pollen grain is called monocolpate. The plants in which pollination takes place by insects, their pollen grains having oily layer around the pollen grain. It is called **pollen kitt.** It is composed of lipids and carotenoids.

Function of pollen kitt :

This oily layer protects the pollen grain from the harmful ultraviolet rays. Its sticky surface helps to attach with the insects. Its yellow colour attracts the insects. Pollen kitt is present on the pollens of Capsella.

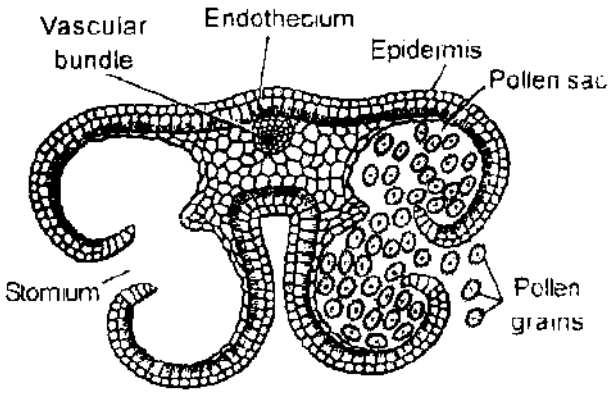
Type of Germpore :



Dehiscence of Anther :

During the maturation of anther, various changes are takes place in walls of anther.

In the begining, middle layer degenerates due to absorption of food by tapetum. When the micropores are formed inside the pollen sacs, at the same time ubisch bodies are formed in cells of tapetum, then after it degenerates. Ubisch bodies participate in the formation of exine of pollens. In this way, in a mature anther only two layers epidermis and endothecium are present in the form of outer covering.

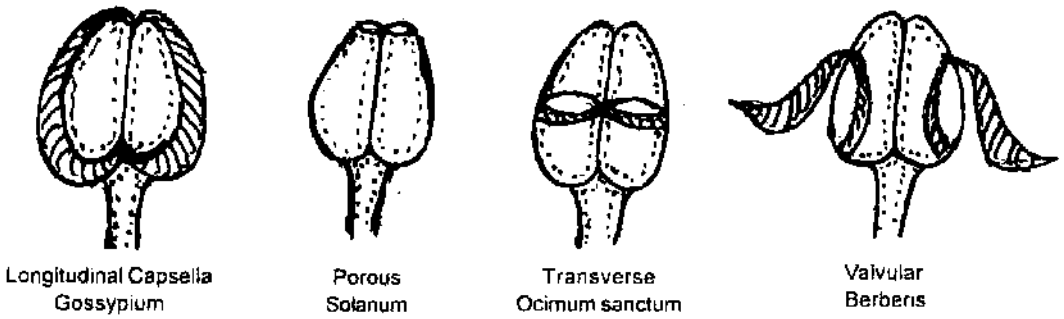


Dehiscence of Anther

The sterile tissues are present between both the pollen sacs of each anther lobe degenerate. So both pollen sacs of the each anther lobe fuse together to form single pollen sac. Therefore, in the T.S. of mature anther only two pollen sacs are present.

Dehiscence of anther takes place during the dry seson. Due to the hygroscopic nature of endothecium loss of water takes place from the cell of endothecium. Walls of endothecial cells try to contract due to the loss of water but inner and radial walls do not contract due to presence of fibrous thickening whereas outer thin walled cells of endothecium contract and become concave or incurved. Incurving of outer walls creates pulling force or tension over the entire surface of anther. Due to tension, thin walled stomial cells breaks off and dehiscence of anther takes place and pollen grains are present in pollen sacs released into the atmosphere.

Dehiscence of anther in Angiosperms either longitudinal or Apical pore or Transverse or Valvular type. Dehiscence of anther of *Capsella* is longitudinal.



MODE OF DEHISCENCE OF ANTHER

Micro-Gametogenesis or Development of Male Gametophyte :

In flowering plants, pollen grain or microspore considered as first cell of male gametophyte. Germination or development of pollen grain takes place before dehiscence of anther is called precocious development.

Development of pollen also takes place at mother place [inside pollen sac of anther] is called **In-situ development**.

Pre Pollination development :

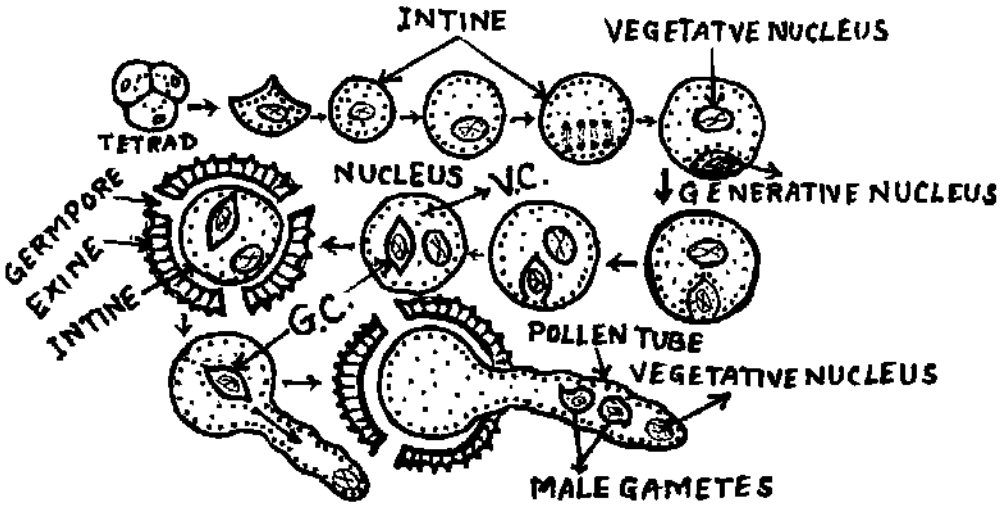
In the beginning of the process, only nucleus of pollen grain divided by unequal mitotic division, resulting two unequal size of nucleus are formed. Small nucleus present near the walls is called generative nucleus and large nucleus present inside the cytoplasm is called **tube** or **vegetative nucleus**. Both the nucleus surrounded by cytoplasm and it becomes dense, then again followed by unequal cytokinesis, resulting two unequal size of the cells are formed. Larger cell in which large nucleus is present known as Vegetative cell and smaller cell in which small nucleus is present, called **generative cell**.

Now pollen grains come in bicelled and binucleated stage. In Angiosperms pollination of pollen grains take place in bicelled and binucleated stage (60%). The development of gametophyte take place inside the pollen grain is also known as endosporic development. This stage of pollen grain is called immature or partially developed male gametophyte. Generative cell detached from the wall and changed into vermiform or spindle shaped structure and enter inside the vegetative cell.

Post Pollination development :

Rest of the further development of pollen grain [Immature male gametophyte] takes place on the stigma of carpel after pollination. Pollens absorb moisture and sugar content from the stigma. Due to this absorption volume of internal contents of cytoplasm increased. It exerts pressure on the both layers. Because of this pressure intine comes out through any one germopore in the form of tube like structure called **pollen tube**. First of all vegetative nucleus enter into the pollen tube and assumes terminal [tips] position. This spindle shaped generative cell now enter into the pollen tube.

Inside the pollen tube, generative cell divides mitotically to form two non motile male gametes. Now male gametophyte comes in three celled structure in which one vegetative cell and two male gametes are present. This three celled stage represents the mature male gametophyte of Angiosperm [*Capsella* also]. Male gametophyte is highly reduced and completely depends on sporophyte. First of all pollen tube discovered by G.B. Amici in Portulaca plant. Longest pollen tube is found in Zea mays.



Development of male gametophyte with the fomation of male gametes.

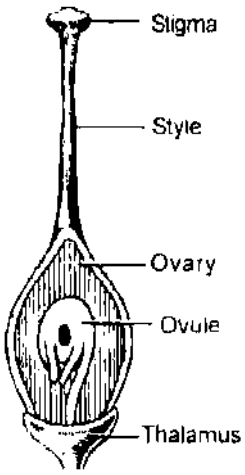
FEMALE REPRODUCTIVE ORGAN - GYNOECIUM

Gynoecium is the female reproductive organ. The free unit of gynoecium is called **pistil** or **carpel**. **Carpel** is also known as megasporophyll.

The carpel is differentiate into three distinct region -

(i) Stigma **(ii)** Style **(iii)** Ovary

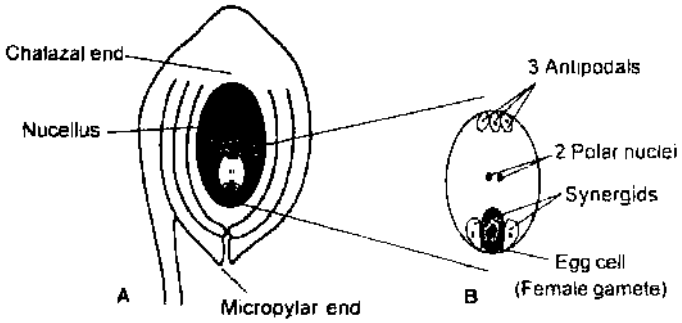
The free end of the carpel which receives pollen grains is called **stigma**. A long, narrow tubular structure is present in between the stigma and ovary called **style**. The basal swollen part of the carpel is called **ovary**. The ovule is also known as megasporangia which are borne on a cushion-like tissue called **placenta** in the ovary**.** One or more than one ovules are present inside the ovary. The gynoecium of the Capsella is bicarpellary, syncarpous, unilocular and superior. It becomes bilocular due to the formation of false septum or replum at maturity.



A typical gynoecium (= pistil)

Structure of Ovule or Megasporangium :

A ridge or stalk like out growth is formed from the placenta of the ovary on which body of ovules are present. Each ovule attached to the placenta by means of a thin stalk called **funicle** or **funiculus/Funiculum**. The point of attachment of the funicle with the ovule is called **hilum**. The main region of the ovule is composed of mass of parenchymatous cells called **nucellus**. Nucellus is the main part of ovule. The nucellus is covered by one or two coats called **integuments**.



(A) Mature ovule and (B) Mature embryosac

Difference between Egg cell and secondary nucleus

S.No.	Egg cell	Secondary nucleus
(i)	It is present near the micropyle, inside the embryo sac	It is present the middle of the embryo sac
(ii)	Generally egg is surrounded by two synergids.	It is not surrounded.
(iii)	Only single nucleus is present in it.	It is formed by fusion of two polar nuclei
(iv)	It is haploid structure.	It is diploid structure
(v)	It is fertilized with one male gamete and to form a diploid zygote (Embryo)	It is fused with one male gamete and to form a triploid primary endosperm nucleus (Endosperm)

In most of the ovule, funicle is attached to the main body of ovule for some distance (at lateral side) to form a ridge like structure known as Raphe. Vascular tissues are present inside the funiculus which supply food material from the placenta to the body of ovule.

Special Integuments :

- **Aril** – It is the type of third integuments which develops from funicle at the base of the ovule. e.g. *Myristica, Asphodelus* and *Litchi.*
- **Arillode** – It develops from the tips of the outer integument and grows downwards and surrounds the entire ovule e.g. *Pitchecolobium* (*Inga dulce*)
- **Sarcotesta** – When outer integument becomes fleshy then it is called **sarcotesta** e.g. *Mangoliaceae (Magnolia).*
- **Operculum** – It is a stopper or break like structure which is formed on the micropyle. It is formed due to the elongation of inner integuments. e.g. *Lemnaceae* family (*Lemna*).
- **Caruncle or strophiole** – It is formed due to the proliferation (out growth) of outer integuments over the micropyle. e.g. *Ricinus communis (Castor)*. It is formed by sugary contents so helps in absorption of water during germination of seeds and dispersal of seeds by ants called **myrmecochory**.
- **Coma** – In some of the plants unicellular filaments like structures are present on the seed which is formed by cells of outer surface of outer integument. Such seeds are known as "Comose seeds". e.g. *Calotropis* and *Gossypium.*

  A place from where funicle and integuments arise is called **Chalaza**. Integument is absent just opposite to the chalaza, so that a narrow passage (pore) is formed which is called **micropyle**. Micropyle in bitegmic ovule has two parts – outer region which is surrounded by outer integument is called **exostome**. The inner part of micropyle which is surrounded by inner integument called **endostome**.

  In most of the Angiosperm entire part of the nucellus is utilized by developing embryo sac but in some of the Angiosperm some part of the nucellus remain inside the ovules that part of the nucellus present inside the seed in the form of a thin layer known as perisperm. Perisperm is commonly found in Piperaceae (*Piper nigrum*) and Zingiberaceae Families (Turmeric, Ginger). Some filaments are attached with funicle [some times placenta] are known as "Obturators". The function of obturators is to guide the passage of pollen tube towards the micropyle inside the ovary.

Types of Ovule on The Basis of Integuments :

A single integumented ovule is called **unitegmic ovule** – example – members of Gamopetalae and Gymnosperm. Two integumented ovule is called **bitegmic ovule**. Example – In most of Angiosperm [Polypetalae – Capsella and Monocots]. The ovule in which integuments are absent is called **Ategmic ovule** e.g. Olax, Liriosma, Loranthus & Santalum.

Types of Ovules on The Basis of Nucellus :

- **Tenuinucellate** – The nucellus is either less developed or present in the form of single layer.
  Example : *Gamopetalae group.*
- **Crassinucellate** – The nucellus is massive type i.e., it is made up of many layers.
  Example : *Polypetalae group* and *Monocots.*

  The nucellus degenerates in plants of Compositae family and integuments becomes active to form a nucellus like tissue. This is called **endothelium or integumentary tapetum**. It is polyploidy structure.

  The nucellus dissolves in the members of Podostemaceae family to form a nutritional cavity. This is termed pseudoembryo-sac.

TYPES OF OVULES :

There are six different types of ovules are found in Angiosperms on the basis of relationship of the micropyle, chalaza, and hilum with body of the ovule and orientation on the funiculus :

Atropous or Orthotropous :

The body of ovule is upright in position. The micropyle, chalaza and hilum lie in one straight line, so that this ovule is called straight or upright ovule. Example : Betel, Piper, Polygonus and in Gymnosperms. It is the most primitive and most simple type of ovule of Angiosperms. Raphe is absent.

Hemitropous or Hemi-Anatropous ovule :

In this ovule, the body of the ovule bent on funcile at 90º angle, i.e., body of ovule present at right angle to the funiculus. This is intermediate type between ortho and anatropous ovules. This ovule is also called horizontal ovule because body of ovule present in horizontal position on the funiculus. Micropyle and chalaza are present in the same line but micropyle is situated away from hilum. Example: *Ranunculus, Primula, Golphimia.*

Campylotropous Ovule :

In this ovule, the body of ovule curved (Curvature is not effective) in this way so micropyle and chalaza do not present in straight line. The embryo sac and nucellus both are present in curved position. Micropyle comes close to the hilum. Example – *Leguminosae, Capparidaceae, Cruciferae* family [*Capsella*].

Anatropous Ovule :

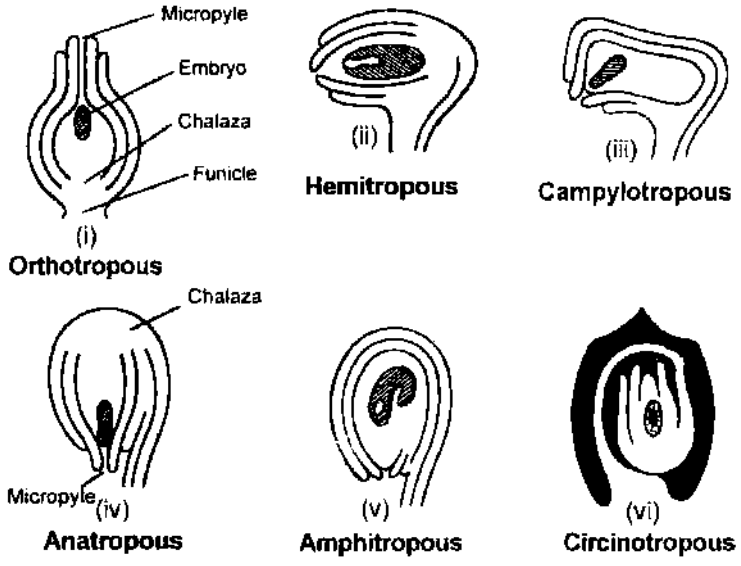
In this type, the body of the ovule completely turned at 180º angle, due to unilateral growth of funiculus, so it is also called inverted ovule. The chalaza and micropyle lie in straight line. The hilum and micropyle lie side by side very close to each other. This type of ovule is found in 80% families of Angiosperms but not in Capsella. In this ovule micropyle facing downward condition. This is the most common type of ovule so that it is considered as a "typical ovule" of Angiosperms. eg. Members of *Malvaceae, Cucurbitaceae, Solanaceae, Compositae* family. It is also called **resupinate** ovule.

Amphitropous Ovule :

In this type of ovule, curvature is more pronounced or effective in the nucellus and due to this effect of nucellus, embryo sac becomes horse shoe shaped. Micropyle comes close to the hilum. It is also called as transverse ovule. e.g. *Mirabilis, Lemna* and *Poppy, Alisma, Butomaceae* family.

Circinotropous Ovule :

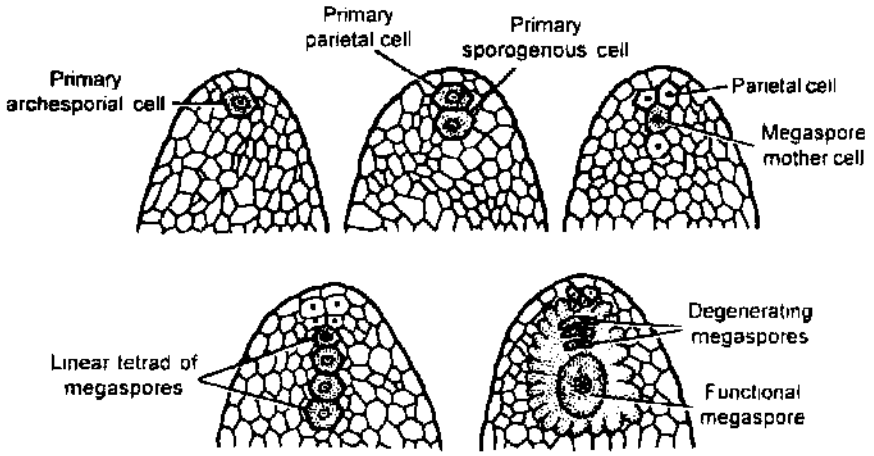
This type of ovule, first of all body of ovule inverted once and again turned into straight position due to the growth of funiculus so that body of ovule present on funicle at 360º. The entire body of ovule is surrounded by funiculus. It is also known as coiled ovule. Micropyle is situated away from hilum e.g. *Cactaceae* family-*Opuntia.*



Different type of Ovules

MEGASPOROGENESIS :

During the development of ovule, in the begining of this process, nucellus develops form the placenta in the form of a small rounded out growth like structure. At this stage, all the cells of nucellus are undifferentiated and homologous and meristematic. This mass of cells surrounded by single celled thick layer of epidermis.



Different type of Megasporogenesis

Any one hypodermal cell of nucellus is differentiated and increase in size. It becomes different from rest of the cells due to presence of distinct nucleus. It is called archesporial cell. Archesporium divides periclinally to form an outer primary parietal cell and inner Primary Sporogenous cell. Activity of primary Parietal cell depends on type of plants. If plant belongs to gamopetalae then it forms tenuinucellate type ovule and if plant belongs to polypetalae then it forms crassinucellate type of ovule is formed. The primary sporogenous cell directly act as a megaspore mother cell (MMC). It divides meiotically to form, four haploid megaspores.

The four haploid megaspores generally arranged in linear tetrad. Generally the lower most or chalazal megaspore remains functional out of tetrad of megaspores and the other three lie towards the micropyle degenerate. This functional megaspore produces female gametophyte. In most of Angiospersm (*Capsella*), Chalazal megaspore remains functional.

DEVELOPMENT OF EMBRYO SAC OR FEMALE GAMETOPHYTE :

Megagametogenesis : Megaspore is the first cell of the female gametophyte. This megaspore grows in size and obtains nutrition from the nucellus. The nucleus of megaspore divides mitotically to form a two nuclei. Each nucleus moves towards the opposite pole and reached at their respective poles. Both the nuclei lie at poles divide twice mitotically. Resulting, four-four nuclei are formed at each poles [Total 8-nuclei]. Out of the four, one-one nucleus migrates from the both poles [one nucleus from chalazal side and one nucleus from micropylar side] towards the centre. They are known as polar nuclei. Both polar nuclei are present in the centre.

Remaining three-three muclei at each pole surrounded by the cytoplasm to form cells as a result of cytokinesis. Three cells are formed towards the micropyle in which one cell is large and more distinct out of three cells. This is called egg cell and remaining two smaller cells are known as synergids. These three micropylar cells collectively known as egg-apparatus. [1 Egg cell + 2 Synergids]. The three cells are formed toward the Chalaza are called antipodal cells. Both the polar nuclei present in the central cell. But just before the process of fertilization they unite or fuse together in the centre to form secondary nucleus. It is diploid in nature [2n] and one in number.

Therefore, seven cells and eight nucleated structure is formed. This eight nucleated and seven celled structure is called female gametophyte or embryo sac of Angiosperms. This type of embryo sac is known as polygonum type because it is discovered by Strassburger in Polygonum plant. Polygonum type embryo sac is most common type in Angiosperms *[Capsella]*. Polygonum type of embryo sac develops from single megaspore so it is also known as monosporic embryo sac. Fingers like processes are produced from the outer wall of the synergids are known as filiform apparatus. With the help of these structures, synergids absorb food from the nucellus and transfer to the embryo sac. Filiform apparatus is less developed in antipodal cells. Filiform also secrete some chemicals which attracts the pollen tube.

In some plants, barrier are present either above or below the female gametophyte. These barrier are made up of thick walled cells of nucellus. They prevent the movement of embryo sac towards the chalaza or micropyle. The barrier which is present towards the chalaza is called hypostase e.g. *Umbelliferae* family, *Zostera* and *Crozophora* plants. The barrier which is present toward the micropyle is called **epistase** e.g. *Costalia* and *Costum*.

TYPE OF EMBRYO SACS :

Monosporic Embryo sac – It is of **two types –**

Polygonum type – It is **eight nucleated** and **seven celled embryo sac**.

Oenothera type – Exceptionally it is four nucleated in which only one nucleus in a central cell and three nucleus in egg apparatus. Antipodal cells are absent. [Micropylar megaspore become functional].

Bisporic Embryo sac – It is formed by two megaspores. It means it develop from two nuclear megaspores. It is of two types –

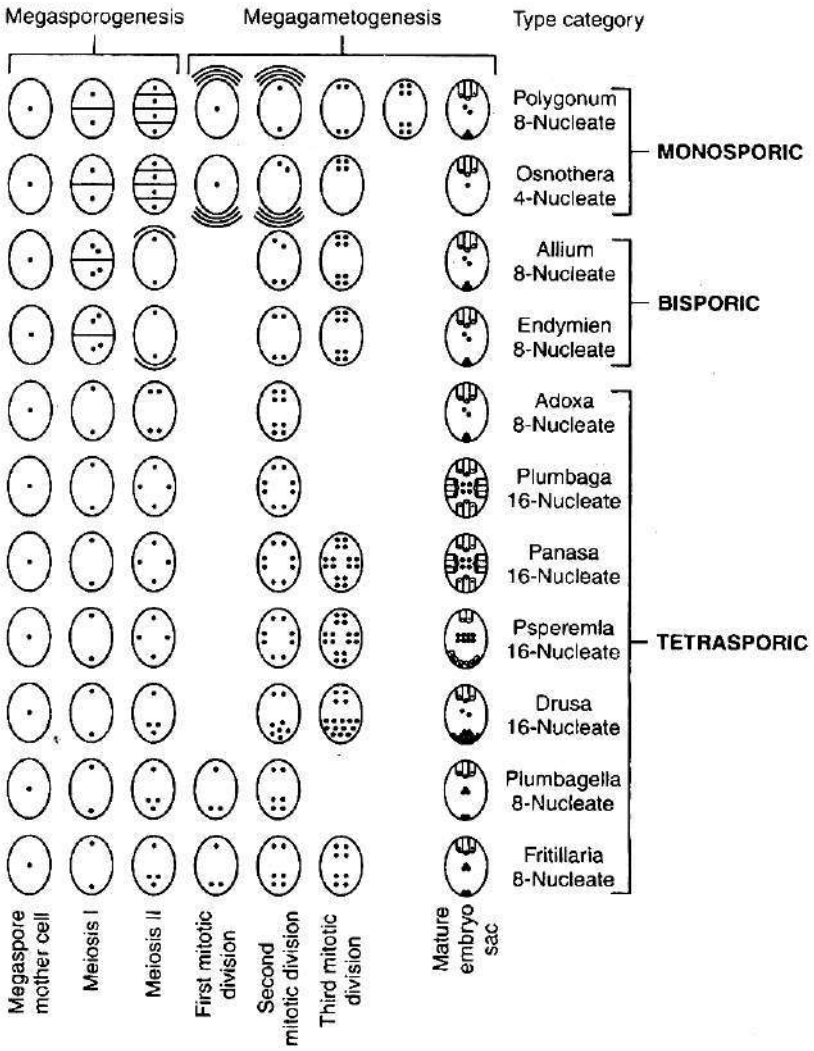
Allium type – Eight nucleated and seven celled [Chalazal megaspores].

Endymion type – Eight nucleated and seven celled [Micropylar megaspores].

Tetrasporic Embryosac – It is formed by all four megaspore nuclei because meiosis is not accompanied by cytokinesis, so that four nuclei of megaspores are formed. All four nuclei are collectively known as "Coenomegaspore".

Generally all the four nuclear megaspores take part in the formation of the seven celled and eight nucleated embryo sac but different types of embryo sacs are also formed. Arrangement of nuclei are not definite in embryo sac of Angiosperms. So that different type of embryo sacs are formed as follows :

Types of Tetrasporic Embryosac	Number of nuclei in Sec. nucleus	Ploidy of endosperm
1. **Adoxa type**	2	3n
2. **Chrysanthemum type**	3	4n
3. **Plumbago type**	4	5n
4. **Plumbagella type**	4	5n
5. **Fritillaria type**	4	5n
6. **Penaea type**	4	5n
7. **Peperomia type**	8	9n



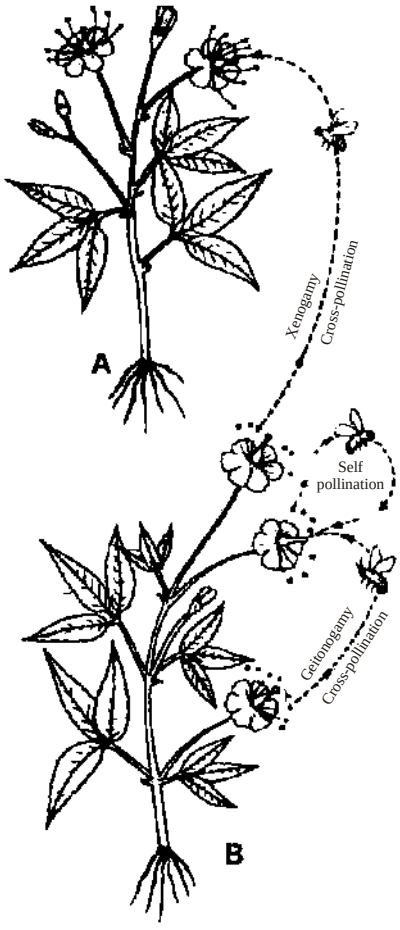
Diagrammatic representation of various types of embryo sac development

POLLINATION

"Pollination is defined as the process of transfer of pollen grains from anther to the stigma of the same flower or of different flower of the same species." The pollination in 60% of angiosperms takes place at two celled structure of pollen grains. Pollination is of two types :

1. **Self pollination or autogamy :**
   If the pollen grain are transferred from an anther to the stigma of the same flower, or other flowers of the same plant is called **self pollination or autogamy**.
2. **Cross pollination or allogamy :**
   When the pollen grains are transferred to the stigma of other flower of the same species is called **Cross pollination** or **Allogamy**. It takes place in between two different flowers.

- **Cross pollination is of two types :**
  Geitonogamy : When, pollination takes place in between the two flowers of the same plant then it is called



Pollination

geitonogamy. From the genetical point of view geitonogamy is self pollination because all flowers of the same plant are genetically identical. But ecologically, it is considerd as cross pollination.

Xenogamy : When the pollination takes place in between the two different flowers of two different plants of the same species then it is called **xenogamy**. This is real or true cross pollination. Genetically, as well as ecologically, it is cross pollination.

Difference between Self and Cross pollination

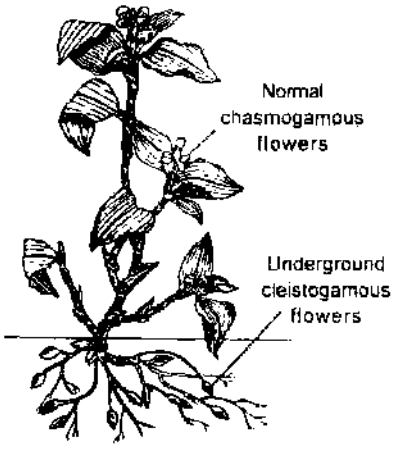
S.No.	Self pollination	Cross pollination
(i)	Pollen grains are transferred to stigma of same or genetically similar flower	Pollen grains are transferred to stigma of genetically different flower
(ii)	Anthers and stigma mature simultaneously	They mature at different time i.e. protandry and protogyny
(iii)	It occurs in open as well as closed flowers	It occurs in only open flower
(iv)	It is very economical for plants in energy point of view	It is not economical in energy point of as the plant has to produce large number of pollen grains, nectar, scent and colouration.
(v)	External agencies are not required	It is essential i.e. depends on agencies.
(vi)	Young ones are homozygous	Young ones are heterozygous.
(vii)	It produces pure lines because of the non occurrence of genetic recombination.	It produces variations due to genetic recombinations.
(viii)	It cannot eliminate harmful traits.	It can eliminate harmful traits.
(ix)	Useful characters are preserved	Not preserved
(x)	No adaptability in the changing environment.	It provides adaptability.
(xi)	It cannot introduce new traits.	It can introduce new traits
(xii)	Disease resistance is low	Disease resistance is optimum
(xiii)	There is decrease in yield.	It increase the yield
(xiv)	It does not help in the development of new species.	Helps in the development of new species.

- **Contrivances or Adaptation for Self Pollination / In breeding devices :**

Monocliny : Bisexuality it means flowers are bisexual.

Homogamy : When both the sex organs of a flower mature at the same time is called **homogamy**. So that chances for self pollination increased. e.g. *Mirabilis, Catharanthus.*

Cleistogamy : In some plants bisexual flower are formed which never opens throughout the life. Such as *Commelina, Viola.* Commelina plant have two types of flowers. One type of flowers are cleistogamous and another are chasmogamous flowers. e.g. *Oxalis, Juncus, Drosera.* A special type of cleistogamy is found in flowers of legume plant. The sex organs are closed in a structure which is formed by joining of some petals. It is called keel. This keep flower never opens. So only self pollination takes place in these plants.



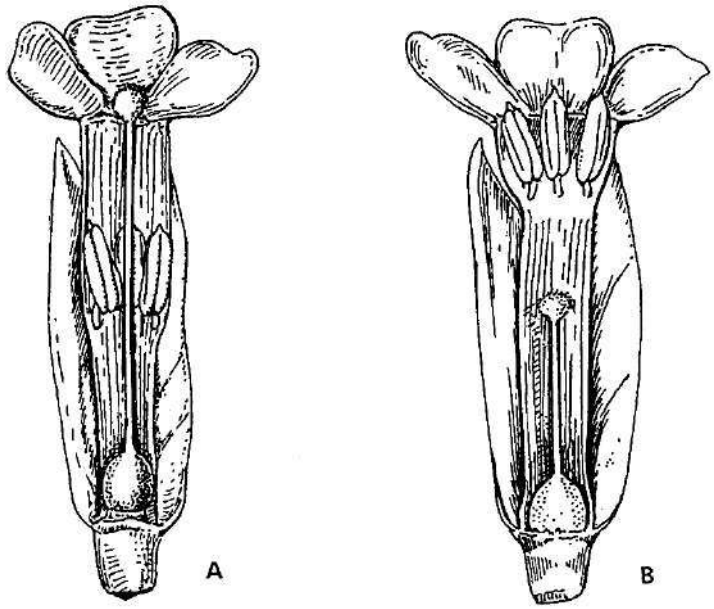
Commelina plant

Contrivances for Cross Pollination / Out Breeding Devices :

- **Dicliny :** Unisexuality of the flower confirms cross-pollination. Self pollination never takes place in these flowers. It means allogamy becomes compulsory. Examples – *Morus*, Palms, Date Palms, *Cucumber* and *Cucrurbita, Carica.*
- **Dichogamy :** In many bisexual flowers of the plants, stamens and carpels of a flower do not mature at the same time. Dichogamy is of two types .
- **Protandry :** The anther of a flower mature earlier than carpels, is called protandry. In most of the plants of Angiosperms, cross pollination only because of protandrus condition. e.g. *Salvia.*
- **Protogyny :** The carpels of the flower mature earlier than stamens. It occurs in very less no. of plants e.g. *Ficus benghalensis, Saraca indica, Ficus religiosa, Aristolochia,* most of plant of *cruciferae* and *Rosaceae* family.
- **Chasmogamy or Anthesis :** Opening [blooming] of the floral bud in the form of a flower is called **anthesis.**
- **Herkogamy :** In some plants, morphological barriers are formed in between the anther and stigma of the same flower, so self pollination can not occurs and pollen grains from the anther are unable to reach the stigma of the same flower. In this condition, only cross pollination is possible. e.g. *Gloriosa, Calotropis and caryophyllaceae* family.

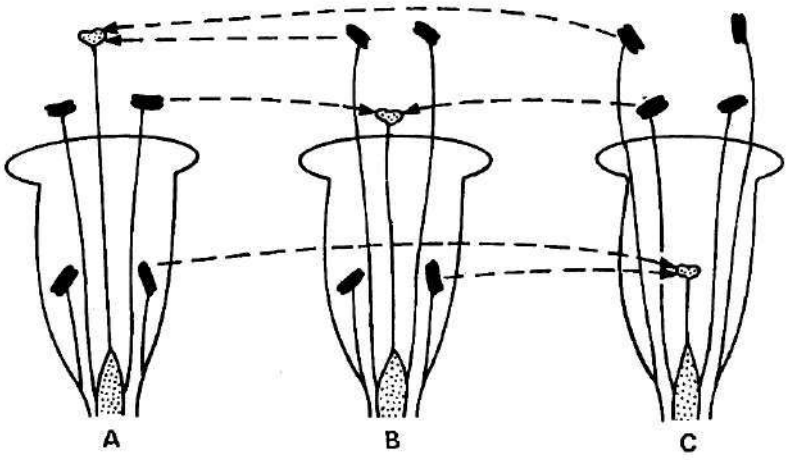
  In the members of caryophyllaceae within the same flower, the stigma projects beyond the stamen so the pollens does not fall on it. In Glorisa the anther dehisce at a distance, so that stigma is out of reach of its own pollen grains. Heterostyly There is difference in between the length of the filaments of stamens and length of style in different flowers of some plants. Some of the plants having long stamen and short style, and in some of the plants bears long style and short filament. Due to this reason, self pollination can not possible in these plants e.g. *Primrose (Primula), Lathyrum, Oxalis.* Primrose (*Primula vulgaries*) is a commonly cited example of this phenomenon. It has two types of flowers (distyly) :

  Pin-eyed or long-styled, with long style, long stigmatic papillae, short stamens and small pollen grains. Thurum-eyed or short-styled, with short style, small stigmatic papillae, long stamens and large pollen grains. The stigma in the thrum-eyed flowers is at the level of anthers in the pin-eyed flowers and vice-versa. As a rule, pollen from thrum-eyed flowers can bring about effective pollination only in pin-eyed flowers and, similarly, pollen from pin-eyed flowers can effect legitimate pollination in thrum-eyed flowers, but not in their own type.



Distyly in *Primula vulgaris.* (A) Pin-eyed flower, (B) Thrum-eyed flower

Some flowers, such as ***Lythrum*** and ***Oxalis***, show **tristyly**. They have **three types of flowers** with respect to the length of the style and stamens. Pollen from flowers of one type can effectively pollinate stigma of only the other two types of flowers and not of its own type.



Tristyly. **A.** Flower with long style, and normal and short stamens. **B.**Flower with mid-style, and long and short stamens. **C.** Flower with short style, and normal and long stamens. As shown by arrows, pollen from any one of these three types of flowers can bring about legitimate pollination in other two but not in its own type.

Self sterility or self incompatibility or intraspecific incompatibility :

In this condition the pollen grains of the flower can not germinates on the stigma of the same flower. This condition is called self sterility. This is a parental [Genetical] characteristic feature which is controlled by genes. Such as in Pitunia, Malva, Thea, Passiflora, Vitis, Apple (Malus). Incompatibility involves many complex mechanisms associated with interactions of pollen and stigmatic tissues. It leads to prevention of pollen germination, retardation of pollen tube growth, deorientation of pollen tube or even failure of nuclear fusion. It is controlled by genes with multiple alleles (s-allele).

Self incompatibility or intraspecific incompatibility :

Plants rejects the self pollens grains i.e. pollens from same flower or different flower of same plant to prevent genetic self pollination. Recognition of "self" pollen in based on genes for self incompatibility called 'S'-gene. In the gene pool of a plant population, there can be dozons of alleles of an S-gene. If a pollen grain has an allele that matches an allele of the stigma on which it land, the pollen tube fails to grow.

Depending on species, self recognition blocks pollen tube growth by one of the two molecular mechanism.

(i) Gametophytic self incompatibility (GSI)

(ii) Sporophytic self incompatibily (SSI)

Gametophytic self incompatibility :

In GSI, the S-allele in the pollen genome regulates the blocking of fertilization. For ex. An S_1 pollen grain from an S_1S_2 parental sporophyte will fail to fertilize egg of an S_1S_2 Flower but will fertilize an S_2S_3 flower. An S_2 pollen grain would not fertilize either flower. Self recognition of this type involves the enzymetic destruction of RNA within a rudimentary pollen tube RNA hydrolyzing enzymes are secreted by style of carpel which destroy pollen tube. Ex. *Liliaceae, Poaceae, Solanaceae, Trifolium.*

Sporophytic self in compatibility (SSI) :

In this system pollens of a plant behave similarly, irrespective of S-allele they carry. For ex. A plant carrying S_1S_2 alleles, the pollen carrying S_1 or S_2 allele, would behave as S_1 if S_1 is dominant or as S_2 if S_2 is dominant and $S_1 + S_2$ if no dominance. So the presence of even one of the alleles of the stylar tissue

in sporophytic tissue of male parent make the all pollen of that plant non-functional with respect to that particular style.

So this S_1S_2 plant produce pollens S_1 or S_2 are completely incompatible to plant carrying S_1S_2, S_1S_4, S_1S_5 or S_2S_3, S_2S_4, S_2S_5 but 100 percent compatible with a plant carrying S_3S_4 or S_3S_5

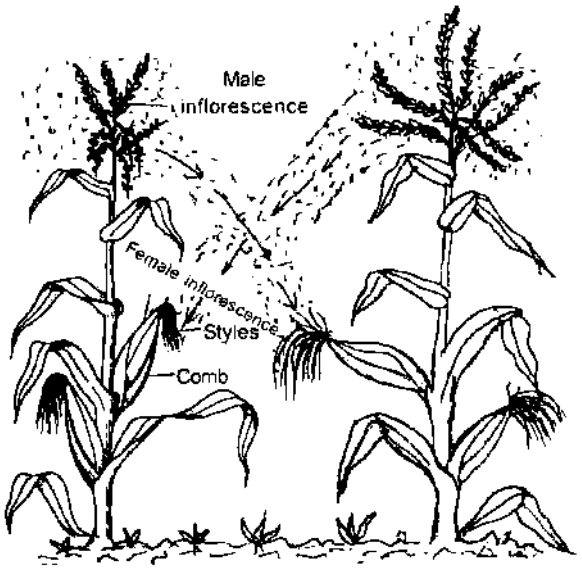
In SSI system rejection occurs on the stigma the pollen tube is destroyed as can not penetrate cuticle of stigma. Ex. *Astaraceae, Brassicaceae.*

Growth of its pollen tube of self pollinated pollen grain is very slow and growth of the pollen tube of cross pollinated pollen grain in very fast so pollen tube of cross pollinated pollen grains reach earlier inside the ovule. This is termed prepotency.

METHODS OF CROSS POLLINATION

Anemophily :

When the pollen grains are transfer from one flower to the another flower through the agency of air is called anemophily and flower is known as anemophilous flowers. Such as Cereal plants :- Maize etc. Anemophily is also found in all Gymnosperms. The anemophilous plants produce enormous amount of pollen grains. The pollen grains are very small, light weight and dry and their stigma is hairy or brushy and mucilaginous (Sticky).



Air pollination in Maize plant

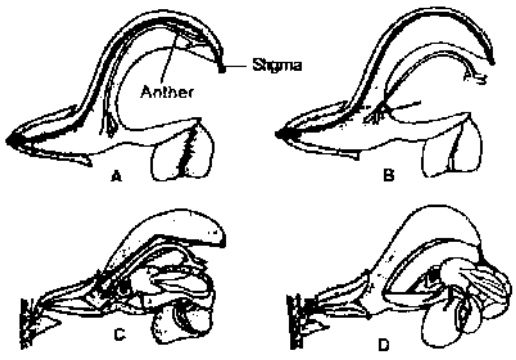
Yellow clouds are formed in the sky during the wind pollination in Pinus. These yellow clouds are formed due to the pollen grains are called **"Sulphur Showers".**

Anemophilous flowers are neither attractive nor with fragrance. They do not have nectar glands, Anemophilous flowers are generally unisexual. E.g. – *Sugar cane, Bamboo, Coconut, Cannabis, Grasses* and *Date palms, Typha, Oak, Hazel.* **Potamogeton** and **Myriophyllum** are aquatic plant but it is anemophilous. Maximum loss of pollen grains takes place in this pollination. It is completely non directional process.

Antomophily :

The pollination takes place by the agency of insects is known as entomophily. Most of insect pollination (80%) only by Honey bees. Entomophilous plant are ornamental plants.

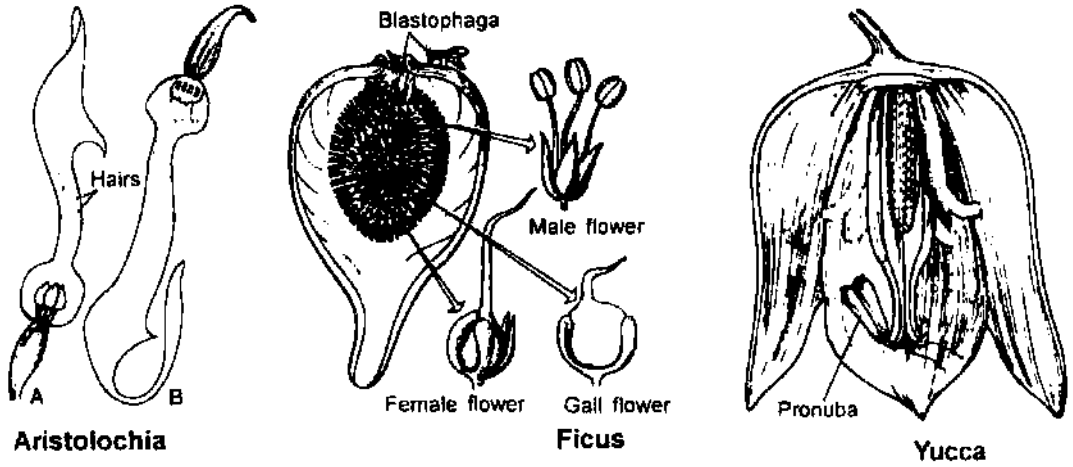
Ornamental plants utilize their maximum energy in this pollination and develops different types of adaptations for attraction of insects. These flowers are attractive in colour. They posses special fragrance. Nectar glands is also present. The pollen grains of insect pollinated flowers becomes sticky due to presence of pollen kitt. The surface of stigma of flowers is rough.



Lever mechanism in Salvia

Some of the plants develop special adaptation for insect pollination. The Lever mechanism or turn pipe mechanism is found in Salvia for pollination. The flower of Salvia have bilabiatecorollate tube. The connective of stamen is long. The anterior anther lobe of connective is fertile while posteriorly lobe is sterile. When the insect lands on the lower lip, the fertile lobe automatically brings down to touch the back of insect and thus depositing the pollen grains on the back of insect.

Some of the flowers have attractive bracts i.e. bright and coloured e.g. *Bouganvillea.* Yucca plant has develops an obligate symbiotic relationship with an insect Pronuba moth. The pollination in Yucca takes only by Pronuba moth. This insect lays eggs in the ovary of flower. Life cycle of both depend on each other.

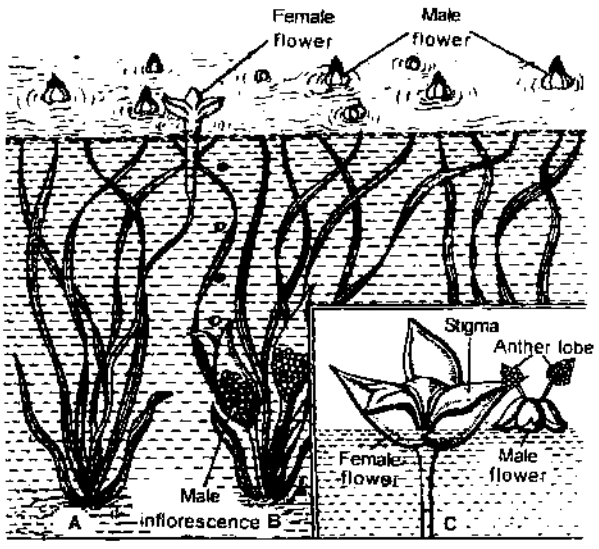


Trap door mechanism is found in species of Ficus for pollination [Blastophaga insect] because Hypanthodium type of inflorescence is present. In Aristolochia, Fly trap mechanism is found for pollination. This flower is known as "Pit fall flower". Ophrys speculum flower pollinated by Wasp [Colpa aurea] by means of pseudo-copulation. The appearance and odour of the flower like female wasp [Mimicry]. In Centaurea plant pollination takes place in piston mechanism. In Rafflesia, the pollination is brought about by Carrion flies. Nymphaea, Nelumbo and Alisma are also entomophilous plants while they are hydrophytes.

Hydrophily :

When the pollination brings by the agency of water is known as hydrophily. It is of two types -

- **Epihydrophily** : When the pollination takes place on the surface of water is called **epihydrophily**. Example – *Vallisneria* and *Ruppia.*
- **Hypohydrophily :** When the pollination takes - place inside the water is called **hypohydrophily**. Example – *Ceratophyllum, Najas, Zostera* and *Hydrilla*. Specific gravity is found in pollen grains so remains suspended in water.



Epihydrophily in Vallisneria

Zoophily :

When the pollination brings by the agency of animals is called **zoophily**. Generally in zoophillous plants, flowers are very large, attractive and maximum number of nectar glands are present (more than entomophilous).

Ornithophily :

When process of pollination is taken place by birds is known as ornithophily. Example – Sun bird or Humming bird in Bignonia plant and by Honey bird in Strelitzia plant, Callistemon (Bottle brush), Bombax [Silk cotton tree,] Butea monosperma.

Chiropterophily :

If the pollination brings through the bats is called Chiropterophily. Example by Pteropus. These flowers are big in size Example *Anthocephalus kadamba, Bauhinia, Kigelia, Adansonia plants.*

Myrmecophily :

This pollination brings about by Termites and Ants. Prosopis – kikar, Acacia (Mimosoideae family) and some members of Rubiaceae family etc.

Malacophily or Malmacophily :

This pollination brings about by Snails. Example Aspidistra lurida and Chrysanthemum plants. Erythrina (Coral tree) plant visited by Crows and squirrels. In Arisaema or Cobra Plant pollination by snake called Ophiophily. Night flowering plants are pollinated by Moths. The are highly scented. Their flower generally white coloured. Orchids are pollinated by Wasps / Snails. Favourable colour of Honey bees is yellow, but they are blind to red colour.

FERTILIZATION

The fusion of male gamete with female gamete is called **fertilization**. First of all fertilization was discovered by Strasburger (1884) in Monotrapa plant. This process is completed in the following steps-

Germination of pollen grains :

After pollination, pollen grains germinate on the stigma. They absorb moisture and sugar contents from stigma and swell up. The intine of pollen grain grows out through the any one germinal pore of exine, in the form of tube like out growth is called pollen tube. One pollen tube develops in Capsella and most of Angiospems is called monosiphonous condition, but more than one pollen tubes develops in Malvaceae and Cucurbitaceae family. It is called polysiphonous. When the pollen tube comes down from the stigma into the style, first of vegetative nucleus enter, into the pollen tube then it is followed by generative cell. The tube nucleus always occupies terminal position in pollen tube.

The vegetative nucleus controls the growth of the pollen tube. Mean while, the generative cell divide mitotically to form two male gametes. Both of the male gametes are non motile. Boron element and calcium ions (mainly Boron) are essential for the growth of pollen tube and best temperature for growth of pollen tube is 20 – 30ºC. Pollen tube shows apical growth and chemotrpic movement.

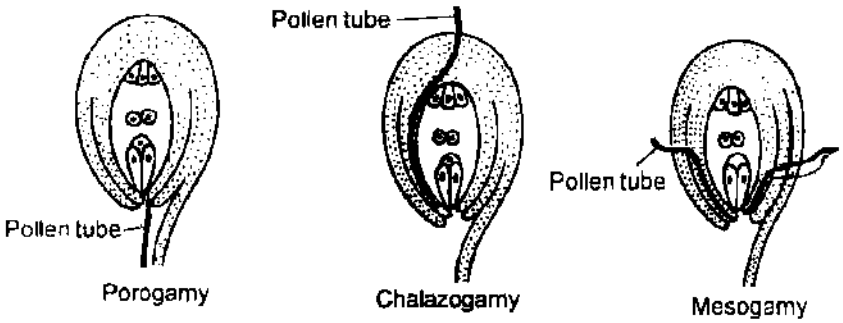
Entry of pollen tube into ovule :

Finally, then pollen tube enters in the ovary at that time, ovule becomes mature. Inside the ovary obturators guides the passage of pollen tube towards the micropyle. A mature ovule in which embryo sac also mature, has three paths for the entry of pollen tube.

Porogamy : In this, pollen tube enters into the ovule through the micropyle. It is known as porogamy. It is found in most of Angiosperms [Capsella].

Chalazogamy : In this method, the pollen tube enter into the ovule through the chalaza. This method discovered in Casuarina by Treub [1891] Example – Betula and Juglans (walnut).

Mesogamy – In this method, pollen tube enter into the ovule either through integuments – Curcurbita or through the funiculus – Pistacia and Populus.



Various methods of entry of pollen tube into the ovule

Entry of pollen tube into embryo sac :

Pollen tube can enter into the ovule thorough the any passage but inside embryo sac, only enter through the egg apparatus. After the entrance inside the ovule, it grows towards the egg apparatus because synergids cells secrete the chemical (hormones) which attracts the growth of pollen tube. It means pollen tube shows chemotropic movement in ovule. Any one synergid starts degenerating when the pollen tube comes near egg apparatus. The pollen tube enter into the embryo sac through the degenerating synergids, helped by filiform apparatus.

When tip of the pollen tube enters into the embryo sac vegetative nucleus degenerates. The tip of the pollen tube swells and burst [endosmosis] after reaching inside the embryo sac. The pollen tube release all contents including both male gametes inside the central cell of embryo sac. Two dark granules appears in the region of degenerating synergids. These are known as X-bodies. They are two in no. and both X-bodies are formed by the degenerating nucleus of tube cell and synergids.

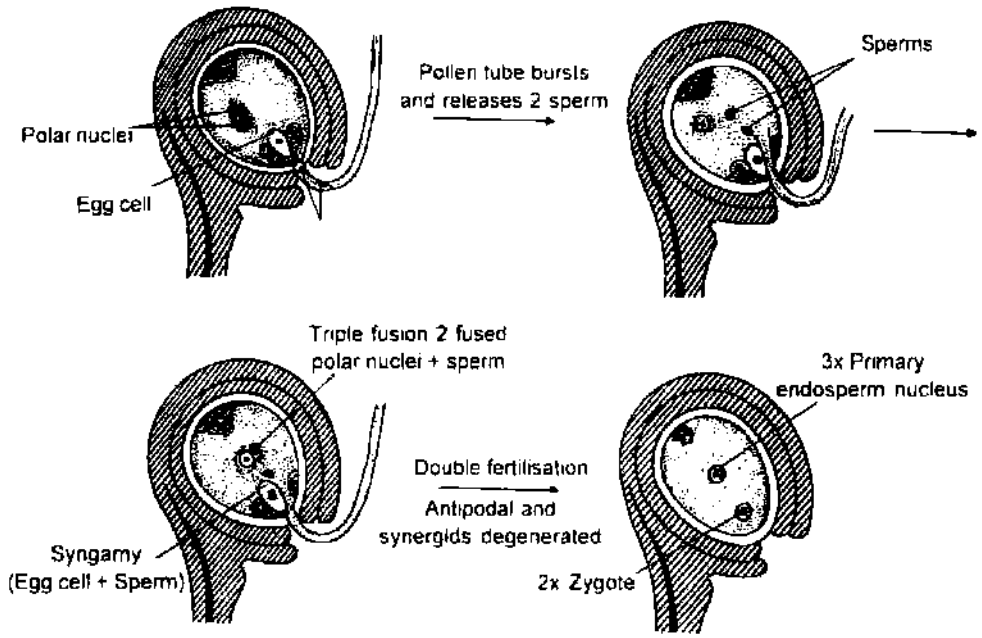
FUSION OF GAMETES :

Before or after the entrance of pollen tube into the embryo sac, both polar nuclei of the central cell fused together to form a diploid nucleus. It is known as secondary nucleus or definitive nucleus. Out of two, one male gamete fertilized with egg cell and to form a diploid zygote. This fusion is known as syngamy. This is true mechanism of fertilization process. The second male gamete fused with diploid secondary nucleus which is formed by the fusion of two polar nuclei. This fusion is known as triple fusion resulting, a triploid (3n) structure is formed. It is called primary endosperm nucleus.

Fertilization takes place twice at a time in Angiosperm is called double fertilization. Double fertilization was discovered by Nawaschin in Lillium and Fritillaria plants. Double fertilization and triple fusion is the specific or universal characteristic of Angiosperm. There are five nuclei (2 polar nuclei, 1 egg nuclei, 2 male gametes) and three gametes (2 male gametes, one egg cell) participate in double fertilization.

A zygote is formed by true fertilization (syngamy) develops into embryo. Triploid primary endosperm nucleus is formed by triple fusion develops into the endosperm which is used as nutrition for growing embryo.

All the remaining cells of embryo sac like antipodal cells, synergids degenerate excluding zygote and primary endosperm nucleus after the fertilization. At this time, zygote obtains food from degenerating synergids and antipodal cells. The fertilization in which non motile gametes are carried to female gamete through pollen tube is known as Siphonogamy. Entry of more than one pollen tube into the ovule leading to occurrence of supernumerary male gametes is called **Polyspermy**.



Release of male gametes and double fertilization

DEVELOPMENT OF ENDOSPERM

First of all endosperm develops from the primary endosperm nucleus after the fertilization which store food materials. It is utilizes by the embryo during the early development and at the time of seed germination. Food is present in the form of starch in endosperm. The endosperm is of three types on the basis of development:-

Nuclear endosperm :

This type of endosperm mostly found in Dicotyledon [Polypetalae]. Nuclear endosperm is also present in *Capsella*.

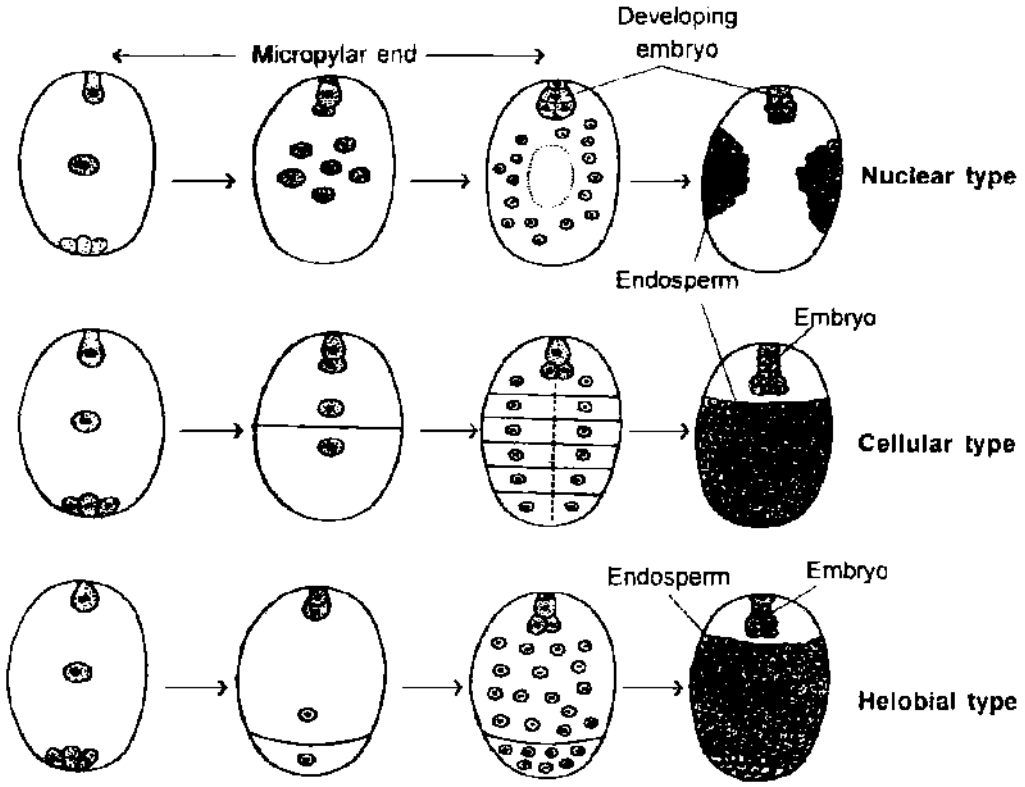
Such type of endosperm develops by free nuclear divisions of nucleus of primary endosperm nucleus, resulting multinucleated endosperm is formed. Later on cytokinesis takes place, so that multicellular endosperm is formed. This type of endosperm is the most common in Angiosperms. The milky fluid is found in green Coconut is example of nuclear endosperm, which is called liquid syncytium. In Melastoma, cytokinesis never take place so that it is always remains nuclear endosperm

Cellular endosperm :

This type of endosperm is found in Gamopetalae group. During the development, each division of primary endosperm nucleus is followed by cytokinesis. So that endosperm remains cellular from the beginning.

Helobial endosperm :

During the development of this type of endosperm, first division of primary endosperm nucleus is followed by unequal cytokinesis so that two unequal sized cells are formed (Cell towards the micropyle is large). Now free nuclear division takes place in each cells, results it becomes multinucleated. Eventually cytokinesis takes place at a time so that is changed into a cellular endosperm. This type of endosperm is found in Monocots. It is intermediate type of endosperm.



Different types of endosperms in Angiosperms

Significance of Endosperm :

Food supply to developing embryo as embryo sac has very little stored food. So zygote developes into embryo after the proper development of endosperm in most of angiosperms. Young endosperm is rich in auxins, Gibberellins and cytokinins. Zeatin is obtained from maize endosperm. Auxin-B is also obtained from maize endosperm. In mature or germinating seeds the reserve food of endosperm is utilized till the development of photosynthetic tissue.

Aleurone layer :

In cereals one or few outer most layers of endosperm become highly specialized morphologically as well as physiologically and form aleuron tissue. It is characterized by thick wall and non vacouled cytoplasm. The cells have aleuron granules or grains which are rich in protein and spherosomes and glyoxysomes. Aleuron grains have protein, phospholipids and some carbohydrates. During seed germination the reserve food in endosperm cells is digested by activity of hydrolytic enzymes like protease, amylase which are secreted by aleuron cells. Gibberellin induce the synthesis or denovo synthesis of these enzymes in aleuron cells.

After the observation of first two division of primary endosperm nucleus, endosperm can be identified whether it would be nuclear, or cellular endosperm. Endosperm is absent in some of Angiosperms e.g. in Orchidaceae, Podostemaceae and Trapaceae. Exceptionally, some of the plants have diploid endosperm instead of triploid such as in Oenothera. Maize and Tomato have mosaic endosperm in which patches of different colours are present. The endosperm in Betel nut is rough surfaced. It is known as ruminate endosperm. The drinking portion is nuclear endosperm and edible portion is cellular endosperm in Coconut.

DEVELOPMENT OF EMBRYO IN DICOT

Development of embryo in *Capsella* is first time discovered by Hanstein. In Angiosperm, Zygote undergoes in resting phase. When the endosperm is formed, development of zygote starts. In the beginning it absorb food from the endosrperm and increase in size then after a layer sectreted by itself. Now it is called Oospore.

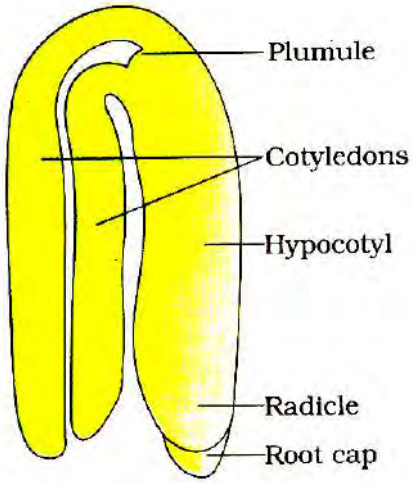


Fig. A typical dicot embryo

The first division of Oospore is transverse, results two cells are formed. The one cell lies towards micropyle is called basal cell or suspensor cell. The other cell is formed towards the Chalaza is called apical cell or terminal cell or embryonal cell. The basal cell and embryonal cell divide simultaneously.

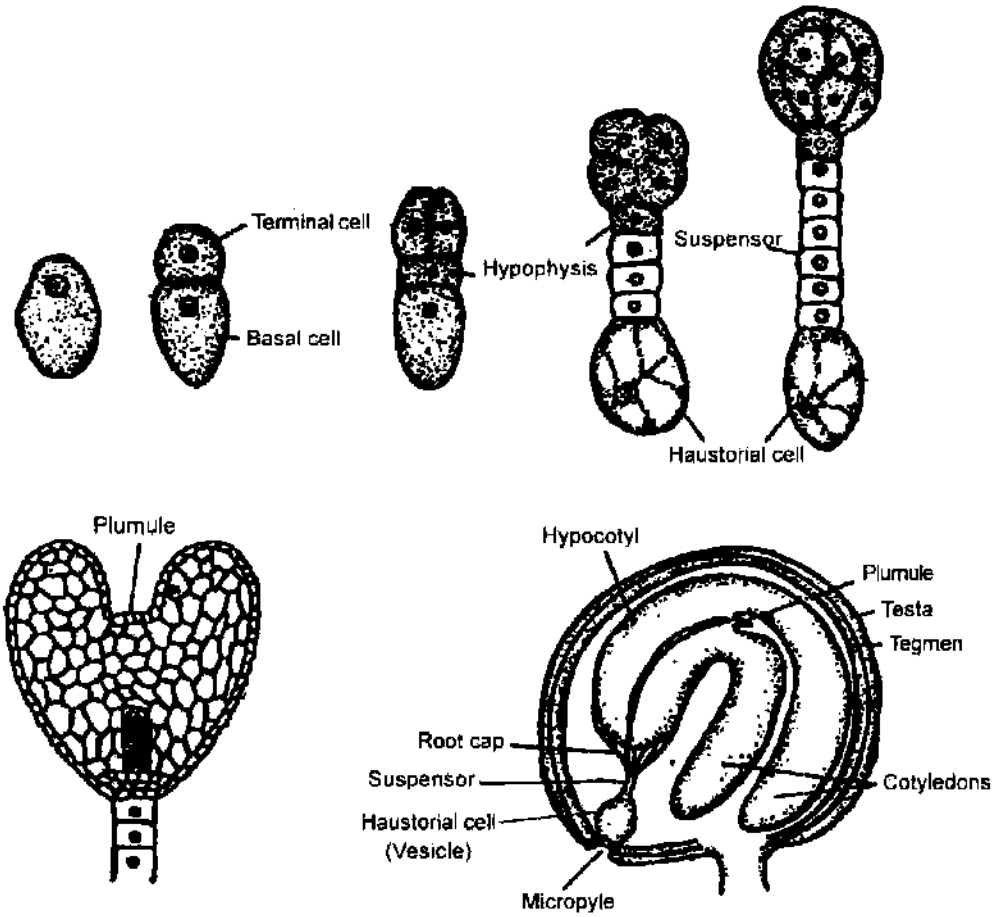
The basal cell divides transversly and apical cell divides vertically resulting, two suspensor cells and two embryonal cell are formed. This stage is made up of four cells which are arranged in 'T' Shape structure. Embryonal cells divided vertically to form four Embryonal cells. This is the quadrant state of embryo. The two suspensor cells divided by the transverse divisions forming a 6-10 celled long filament like structure called suspensor. The main function of suspensor is to push the developing embryo into food laden endosperm to provide nutrition. The micropyler cell of the suspensor swells up. This cell of suspensor is known as haustorial-cell.

The cell of suspensor lies near the embryonal cells is called hypophysis. This cell combined with radicle to form the apex of root [Root cap]. This four cell quadrent embryo further divide transversely to produce eight cells. The eight celled stage of embryo is called octant stage. The eight cells of octant are arranged in two tiers. The four cells of the octant embryo lies near the hypophysis is known as hypobasal cells and four cells present towards the chalaza termed epibasal cells. The hypobasal cells give rise to radicle and hypocotyl and epibasal cells give rise to two cotyledons and plumule of the embryo. All the cells of octant divided by periclinal division so that a 16 cells globular embryo is formed [Proembryo].

Due to fast division of embryonal cells of globular embryo, a heart shaped embryo is formed. All the cells of this embryo are meristematic. Due to the fast growth in two lobes of heart shaped embryo, they develop into two cotyledons. Both the growing cotyledons turn in downwards due to the curved position of body of ovule of Capsella. The tissues are present below the joining place of both the cotyledons are responsible to form plumule and behind it epicotyl is formed. The tissues present opposite to the plumule near the hypophysis give rise to radicle. The apex root [root cap] is formed by hypophysis. This curved position of the embryo is called Torpedo or Chordate stage.

An axis is present between plumule and radicle is called embryonal axis. It is also called Tigellum [main embryonal axis]. Both the cotyledons are present at lateral position of embryonal axis and plumule is formed in terminal position in Dicotyledon embryo. This type of development of embryo is know as Crucifer type or Onagrad type. It is the most common type of development in Dicots. Crucifer type of development is also found in Capsella, so that it is considered as typical Angiosperm for the study of embryonic development of Angiosperms. When embryo is formed, suspensor dries and degenerates so it is known as meroblastic development. Ovule modified into seed in which testa is formed by outer integument and tegmen is formed by inner integument. Only micropyle of ovule remains unchanged and also pesent in seed.

Entire ovary modified into fruit. This fruit is formed by frertilized ovary so that it is called true fruit. In some of the angiosperm fruit is formed by ovary without fertilization know as parthenocarpic fruit. In some fruit parthenocarpy is senseless (If edible part is endosperm or seed).



STAGES IN THE DEVELOPMENT OF EMBRYO IN A DICOT (*Capsella bursa-pastoris*)

DEVELOPMENT OF EMBRYO IN MONOCOTYLEDON

The Lilium type of embryonic development is found in monocotyledons. The first division is transverse division in oospore. Results two cells are formed the upper cell chalazal is called embryonal cell and lower micropylar cell is termed as basal cell. The basal cell does not divide further and later on it increases in size and form single celled vesicular suspensor. Only embryonal cell divides transversly in which terminal cell is called cotyledon cell and lower (middle) cell is known as embryonal axis cell. A transverse division takes place in embryonal axis cell to gives rise two cells.

The one cell out of two, gives rise to plumule initial and another gives rise to radicle initial. The plumule initial divides to form the plumule of the embryo. Radicle initial divide to form the radicle. In this both the initials are responsible to form embryo in lateral position. An apical cotyledon is formed by the continuous division of cotyledon cell. This apical cotyledon is known as Scutellum.

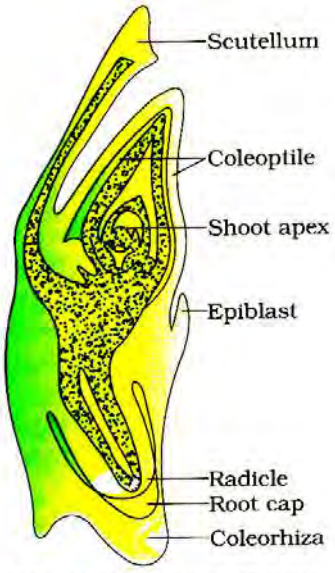
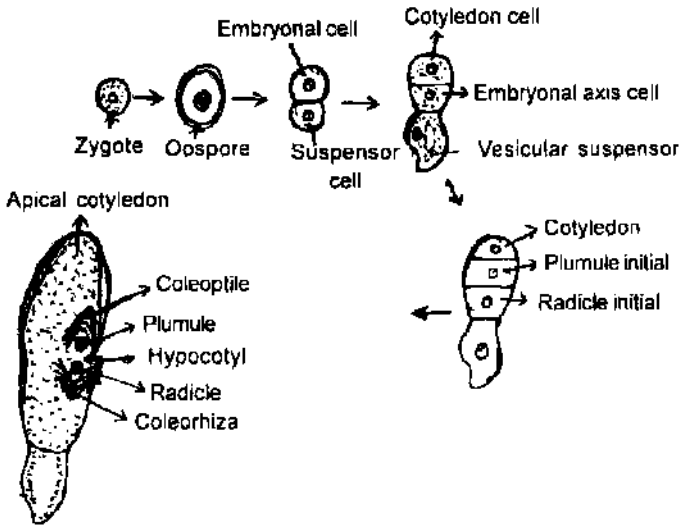


Fig. L.S. of an embryo of grass

The plumule and radicle is covered by cap like hard protective structures. The covering of plumule is called coleoptile and covering of radicle is known as coleorhiza. These structure broken during the germination. The plumule lies in lateral position and cotyledon in terminal position in monocotyledons. In angiosperm, development of embryo is meroblastic and endoscopic [towards the chalaza].



Development of Embryo in Monocotyledon

Summary of events that take place in an ovary, leading to formation of fruits and seeds.

Ovary	-	**Fruit**
Ovary wall	-	Pericarp
Ovule	-	**Seed**
Funicle	-	Stalk of seed (may be left or broken)
Hilum	-	Hilum
Nucellus	-	Usually degenerates but in some cases persists in the form of a thin layer called **perisperm**.
Outer integument	-	Testa } Seed coat
Inner integument	-	Tegmen } Seed coat
Micropyle	-	Micropyle
Embryo sac		
Synergids	-	Degenerate
Egg cell (After Fertilization)	-	Oospore – Embryo
Antipodals	-	Degenerate
Secondary nucleus	-	Endosperm
(After fusing with male gamete)		Nucleus – Endosperm

POLYEMBRYONY

Many embryos are formed inside the single seed is called polyembryony. First of all, it is observed by Leeuwenhoek in Citrus (Orange) seeds. Polyembryony is commonly found in Gymnosperm but it is also found in some of Angiospermic plants such as Orange, Lemon and Nicotiana etc. If polyembryony develops naturally then it is called spontaneous polyembryony [self], and if develops artificially is called induced polyembryony. When many embryos are formed from separate-separate embryosacs [more than one] inside the ovule is called false or pseudo polyembryony.

When many embryos are formed inside the single embryo sac of the seed is called "true poly embryony". It is either develops from –

Clevage of Zygote or **budding** – e.g. *Cymbidium, Exocarpus, Nymphaea, Nicotiana, Orchids* etc.

By the fertilization of synergids – e.g. *Anemone, Aristolochia, Sagittaria* etc.

Fertilization of antipodal cells – e.g. *Paspalum, Ulmus* etc.

Note : In Lilium all three types of polyembryony are present.

[Adventive embryony is also example of polyembryony in which additional number of embryos are formed from nucellus or integuments].

ANDROGENIC HAPLOID PLANTS

This concept was given by Haberlandt and practically proved by Steward. It is based on totipotency. Anther of the Datura plant grown on culture medium by Guha and Maheshwari. As a result of this culture, haploid and diploid two different type of plants are formed. Diploid plants developed from the wall of the anther and haploid plants developed from the pollen grains. Such type of haploid plants obtained from the tissue culture are known as androgenic plants. Fast vegetative multiplication through the tissue culture from any part [cell or tissue] of the plant in the field of Agroforestry and Horticulture is called micropropagation.

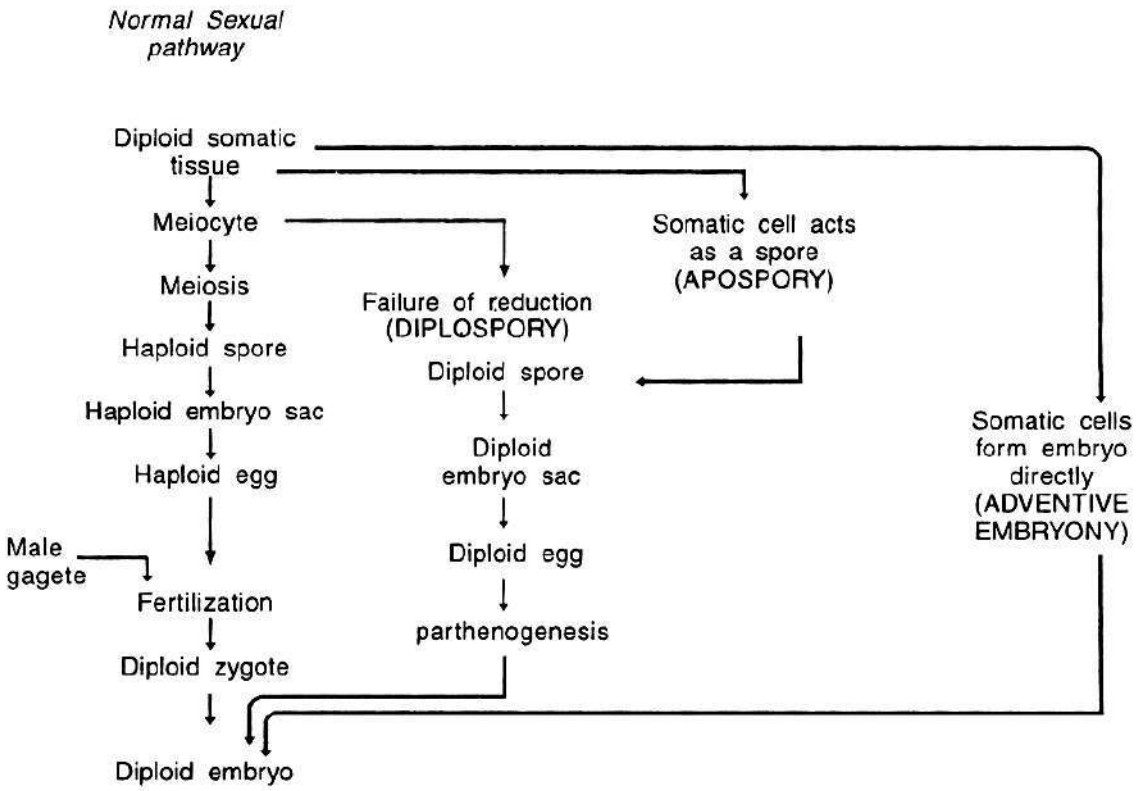
P.Maheshwari established – Research centre of Angiosperm Embryology at Delhi University. Book published by Maheshwari – An Introduction to the Embryology of Angiosperms.

APOMIXIS

In asexual reproduction, the new individual are produced by any means **other than the fusion of sex** gametes. It means a **reproduction in which new individuals are formed without meiotic division and fusion of gametes** is called **asexual reproduction.** In this way asexual reproduction is also known as **apomixis.**

[Greek – Apo = without; mixis = mixing] **Apomixis** term suggested by **Winkler**.

The Apomixis is characterized by quick multiplication and reproduction of genetically similar plants from the single parent. Such a population produced from single individual is called **clone** and each member of the clone is called **remet**.



Agamospermy :

In this type **embryo** is formed without fertilization and meiotic division is called **agamospermy**. It means plants belonging in this category propagated through **seeds** but the embryo formation does **not involve meiosis** and **syngamy**.

There are **three different type of agamospermy** -

Diplospory :

In this method **archesporium** differentiates to form a **megaspore mother cell** but this **megaspore mother cell directly gives rise to an embryo sac without meiosis.** This **embryo sac is diploid** and a diploid embryo is formed without fertilization from diploid **egg** of this embryo sac.

Diplospory is also known as **diploid parthenogenesis**.

Example : Parthenium, Taraxacum

Parthenogenesis : In this process **haploid egg cell of female gameto**phyte is responsible to **form a haploid embryo without fertilization**.

Apogamy : In this process **any haploid cell of female gametophyte except egg cell** is responsible to form a **haploid embryo without fertilization**.

Parthenogenesis and Apogamy both are not included in agamospermy.

Note : If both gametophyte and sporophyte are diploid in Parthenogenesis and apogamy then it is called diploid Parthenogenesis and diploid apogamy.

Apospory :

It is discovered by **Rosenberg** in **Heiarcium** plant. In this method **embryo sac or female gametophyte is directly formed from any diploid cell of the ovule** (nucellus/integument) **except megaspore mother cell** without meiosis is known as **apospory**. In this **gametophyte** always remains **diploid, e.g.** ***Heiracium, Ranunculus*** and ***Rubus*****.**

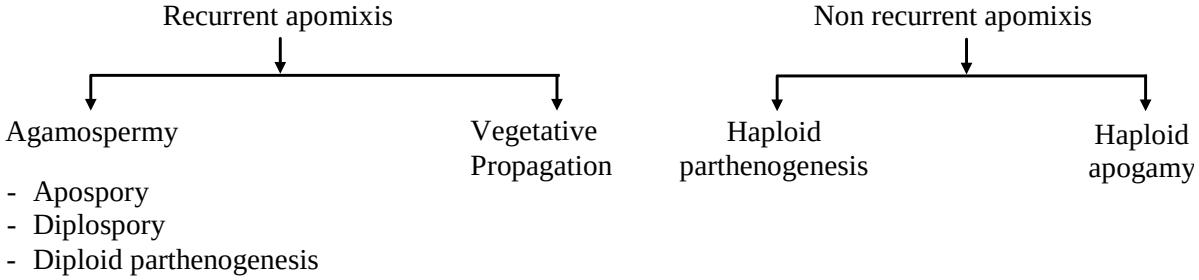
Adventive Embryony :

In this method, an embryo is formed from any **diploid cells (Nucellus or integuments)** of the **sporophyte**. This **diploid cell** behave like a **zygote and develop** (No embryo sac formation) Adventive embry.

from **Nucellus** – **Citrus, Mangifera, Opuntia, Mamillaria**

from **Integuments** – **Spiranthus australis**.

According to P. Maheshwari :



- Apospory
- Diplospory
- Diploid parthenogenesis

Significance of Apomixis over hybrid seeds -

Generally hybrid seeds are utilized in cultivation of most of crops and vegetables. The hybrid seeds have to be produced every year. If the seeds collected from hybrid are sown, the plants in the progeny will segregate and do not maintain hybrid characters. The production of hybrid seeds is costly so cost of hybrid seeds is too expensive to farmers.

So if these hybrid made into apomicts, there is no segregation of characters in the hybrid progeny. Then the farmers can keep on using the hybrid seeds to raise new crop year after year and be does not have to buy hybrid seeds every year. Because of the importance of apomixis in hybrid seed industry, active research is going on in many laboratories around the world to understand the genetics of apomixies and to transfer apomictic genes into hybrid varieties.

PARTHENOCARPY

Parthenocarpy (Gk. *parthenos*-virgin, *karpos*-friut, Noll, 1902) is the formation of fruit without fertilization. The fruit produced due to parthenogenesis does not bear seeds. e.g, pineapple, banana, apple, pear etc. In some cases the stimulus of pollination is required. The phenomenon is called **stimulative parthenocarpy**. In others parthenocarpy. Parthenocarpic fruits are generally seedless. However, technically fruits having seeds (pseudoseeds) with an asexual embryo are also parthenocarpy fruits. Parthenocarpy is of three **types-genetic, environmental** and **chemically induced**.

(1) **Genetic parthenocarpy :** Parthenocorpy is due to genetic alteration caused by mutation or hybridisation. It is also called natural parthenocorpy , e.g., navel orange, banana, pineapple, varieties of apple, grape and pear.

(2) **Environmetal parthenocarpy :** Low temperature, frost and fog have been known found to induce parthenocarpy in a number of plants, e.g., pear, olive, *Capsicum*, tomato.

(3) **Chemically induced parthenocarpy :** Spray or paste of auxins and gibberellins in low concentration of 10^{-6} - 10^{-7} M has been found to induce parthenocarpy in several plants, e.g., tomato, *Vitis*, cucurbits, *Citrus*, strawberry, blackberry, fig, etc.

Importance of parthenocapic fruits

1. They do not contain irritant seeds which have to be removed before eating fruits.

2. Fruits can be developed inside the green houses where pollinators are not available.

3. Quicker food processing.

PARTHENOGENESIS

Process of development of seeds from unfertilized female gametes. Seeds may be haploid or diploid (Gk. parthenos-virgin, genesis-descent). It is the development of a new individual from a single gamete without fusion with another gamete. In lower plants both the type of gametes can female gametes show this facility. Depending upon the haploid of the gamete, there are two types of parthenogenesis, diploid and haploid. In **haploid parthenogenesis**, the embryo sac and its egg are haploid. The egg grows to form haploid embryo. Such embryos do not survive in higher plants but in lower plants, the plant body is haploid embryos has survival value. In diploid parathenogenesis, the embryo sac as well as its egg is diploid. It undergoes parthenogenesis and forms diploid embryo. **Diploid parthenogenesis** is generally accompanied by failure of meiosis during megasporogenesis as well as direct formation of embryo sac from a nucellar cell, e.g., *Rubus*, *Poa*, apple. In apple, self pollination promotes diploid parthenogenesis.

SELF INCOMPATIBILITY : It is recognized in 66 families of angiosperms. Morphologically self in compatibility is of two types :

(A) Heteromorphic self incompatibility (B) Homomorphic self incompatibility

(A) **Heteromorphic self incompatibility** – Occurrence of two (distyly) or three (tristyly) morphologically distinct mating type within a species, which can be easily recognized without a breeding test. The difference in the mating type is generally in the relative length of stamen and style. Ex. *Primula, Lathyrum.*

(B) Homomorphic self incompatibility – In this type all the mating type within a species are morphologically similar and requires proper breeding test, for their recognization. Depending upon the origin of factors determining the mating type on pollen side it is of two types.

(i) Gametophytic self incompatibility (GSI)

(ii) Sporophytic self incompatibility (SSI)

When two pollen tubes enter in an ovule and release their contents, it is possible that the egg may be fertilized by one male gamete from one tube and triple fusion may involves participation of male gamete from another tube. This pnenomenon is called **Heterofertilization** eg. *Zea mays.* When the entry of male gamete is not accompanied by fusion. This phenomenon is called **semigamy**. The percentage of pollen germination and tube growth is better in large populations. This is called as **'population effect'** or **'crowding effect'**

B-Ca-inositol of Sugar complex acts as chemotropic agent for pollen tube growth. Highest amount of fat is found in endosperm of *Coconut.* Embryonic development of Capsella is endoscopic because it is developed towards chalazal region of the zygote. Single celled suspensor is found in *Triticum* [wheat] and *Caryophyllum.* Their seeds are caryopsis fruit. Suspensor is absent in *Sunflower* and *Marigold.* 125 meiotic divisions are essential for development of 100 grains of Wheat.

Heaviest seed (6 k.g.) is found in Lodoshia. Its fruit is 1 meter in lenth and wt. of fruit is 18 kg. Edible part of Betelnut is endosperm. Abscisic acid is the natural germination inhibitor of seed. Light induces germination in Lettuce/(*Lactuca sativa*). Smallest or minute seeds are found in Orchids which are lightest in plant kingdom and are called "Dust seeds" [wt. 20.33 µg].

Xenia (by Focke) – Effect of pollens inside Embryo sac on Endosperm (except Embryo) → Maize.

Metaxenia – Effect of pollen out side the Embryo sac on seed coat or pericarp. Datepalm – maturity time as well as size of fruits can be changed by using different pollens. The longest pollen tube is found in Maize.

The polysiphonous condition is found in families of Malvaceae and cucurbitaceae. Those plants which live immortal through the seeds are known as therophytes.The synergids are absent in the embryo sac of Plumbago.

ANGIOSPERMIC SEED

Difference between Monocotyledonous and Dicotyledonous seed

S.No.	Monocotyledonous Seeds	Dicotyledonous Seeds
(i)	Only single cotyledon is present with embryo	Two cotyledon are present with embryo
(ii)	Generally cotyledon is thin or papery	Cotyledons are thick
(iii)	Generally seeds are endospermic	Generally seeds are non endospermic, some times may be endospermic
(iv)	Cotyledon is also called scutellum	Not called by this name
(v)	In seed plumule is covered by coleoptile and radicle is covered by coleorrhiza.	Coleoptile and coleorhiza are not formed
(vi)	Plumule is in lateral position and cotyledon are is in terminal position	Plumule is in terminal position and cotyledons are present in lateral position
(vii)	Radicle degenerates after sometime and adventitious roots are formed at that place.	Radicle is responsible to form primary root.
(viii)	In some of the seeds, seed coats and cotyledon fused together e.g. Wheat etc.	Such types of seed are not found.

STRUCTURE OF SEED

The miniature plant exists in a seed. Plant is the main base of whole living world. So it can be say that seed is the most important structure. In angiosperm, after the fertilization, fertilized egg cell changed into embryo, ovary changed into fruit and ovule change into seed. Morphologically, fertilized ovule is known as seed. In other words, seed is a mature, integumented megasporangium. Seed is characteristic of Spermatophytes (Gymnosperms and Angiosperms). Typical mature seed have three main parts : (i) Seed coat (ii) Embryo (iii) Cotyledon

(i) Seed coat :

Outer, protective covering of the seed is called seed coat, which develops from integuments of ovule. The seeds which develops from bitegmic ovule, there are two distinct layers in seed coat. The outer layer is thick, hard and leathery (developing from outer integument), called testa, whereas inner layer is thin and papery or membranous (developing from inner integument), called tegmen. In seeds developing from unitegmic ovule there is single layered seed coat. The seed coat performs usual protective function.

The seed is attached to the fruit wall or pericarp by means of a stalk called funicle or funiculus. The point of attachment of funiculus to the body of mature seed is called hilum. A small opening or pore called micropyle is present just near the hilum, which is the way of entry of water into the seed. As most of the ovules in angiosperms are inverted or anatropous, so a ridge called raphe is also present is seed.

(ii) Embryo :

Embryo is the most important part of the seed, which represents mini or tiny future plant. The development of embryo occurs from fertilized egg [zygote]. The embryo having an embryonal axis or main axis called tigellum, to which one or two cotyledons (seed leaves) are attached, depending upon whether the seed is monocot or dicot. The portion of embryonal axis or tigellum below the point of attachement of cotyledons, is called hypocotyl, which bears radicle or future root at its tip. Similarly, portion of embryonal axis or tigellum above the point of attachment of cotyledons, is called epicotyl, which bears plumule (future shoot) at its tip.

Difference between Embryo and Endosperm

S.No.	Embryo	Endosperm
(i)	It is formed by fertilized egg (syngamy)	It is formed by fusion of secondary nucleus (triple fusion)
(ii)	It is always diploid structure	It is generally triploid structure
(iii)	It gives rise to new plant	It provides nutrition to the developing embryo.
(iv)	Cotyledons, plumule and radicle are formed in embryo	Such type of structures are never formed.
(v)	Embryo is present is seed.	It is only found endospermic seeds otherwise. it degenerates with the formation of seed.
(vi)	Embryo dies in the absence of endosperm	Endosperm does not die in absence of embryo.
(vii)	Germination of seed takes place.	There is no germination is found in endosperm.

(iii) Cotyledons (seed leaves) :

In some seeds (e.g. legumes), reserve food is stored in cotyledon, whereas in other (e.g. cereals), there is special nutritive tssue called endosperm. The seeds having endosperm are called endospermic or albuminous seed, e.g. *Cereals, Castor* etc., whereas seeds in which endosperm is fully consumed by embryo and no endosperm is left, are called non-endospermic or ex-albuminous seeds, e.g., *Gram, Pea, Sem, Cucumber, Tamarind*, etc. The reserve food material in seeds may be carbohydrate (e.g. *Wheat, Rice*)

or proteins (legumes) or fats (Castor, peanut, Sunflower), etc. Some time, some part of nucellus remains unused which is present in the form of thin layer around the endosperm is called perisperm e.g. *Betel nut, Black pepper, Castor.*

In Monocot embryo, there is a single cotyledon called scutellum. In some grasses like Wheat, on opposite side of scutellum is a tongue shaped outgrowth which represents the remains of second cotyledon is present called epiblast. In Dicot albuminous seed-castor *(Ricinus communis)*, there is a specific outgrowth called caruncle or strophiole, present over micryopyle. It is formed by proliferation of cells of outer integument at tip. Caruncle is somewhat spongy and helps in absorption of water during germination of seed. On the basis of cotyledon in the seed the angiosperm are called Monocotyledon (monocot) [one cotyledon] and dicotytedons / Dicot [Two cotyledon]. The angiospermic seed are classified into two categories on the presence or absence of endosperm in seeds –

Non Endospermic or Ex-albuminous seed :

Such type of seeds do not have an endosperm at maturity, therefore are called non endospermic or Exalbuminous seeds. The endospermic tissues are absorbed during the development of embryo. The absorbed food materials from the endosperm is stored in cotyledons, thats why they become so large and fleshy e.g. *Capsella* and in most of *dicotyledons*. But Castor seed is endospermic.

Endospermic or Albuminous seed :

This type of seeds, food is stored in endosperm. Such seeds are called endospermic seed or albuminous seed. The endospermic tissue in these seeds utilize during the germination of seed and their cotyledons are thin and membranous e.g. most of *Monocot seeds* e.g. *Wheat, Rice,* and *Maize* etc. Castor [dicot] is also endospermic seed.

Endospermic dicot seeds : e.g., *Castor, Papaya, Cotton.*

Non-endospermic dicot seeds : e.g., *Gram, Bean, Pea, cucumber, Tamarind.*

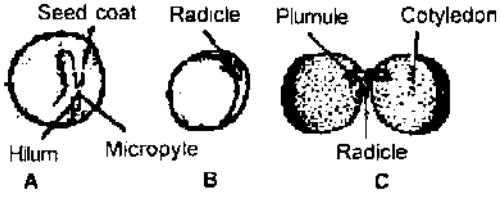
Endospermic monocot seeds : e.g. *Maize, Rice, Wheat and Coconut.*

Non-endospermic monocot seeds : *Pothos (money plant), Vallisneria, Alisma, Amorphophallus.*

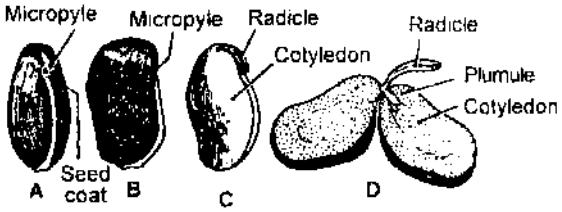
STRUCTURE OF BEAN SEED

Bean seed is kidney shaped having a concave side and a convex side. The concave side is slightly darker and posses a white elongated scar is called hilum, which marks the point of attachment of the seed with the funiculus. A small pore lies adjacent to the hilum, called micropyle, which performs the function of absorbing water during germination. There is a short ridge on the other side of hilum. It is called raphe.

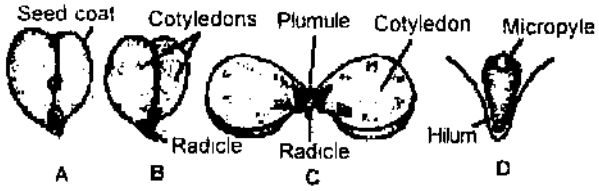
The Bean seed has two seed coats. The outer seed coat is called testa. It is hard, thick, smooth and variously coloured. It develops from outer integument of ovule. The inner coat is white, membranous and thin. It is called tegmen. It is difficult to separate tegmen from testa. The seed coats can easily be removed if the seeds are soaked in water for a few hours.



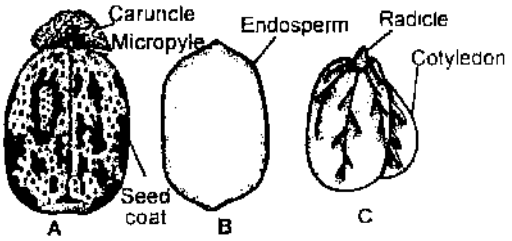
STRUCTURE OF PEA SEED



STRUCTURE OF BEAN SEED



STRUCTURE OF GRAM SEED



STRUCTURE OF CASTOR SEED

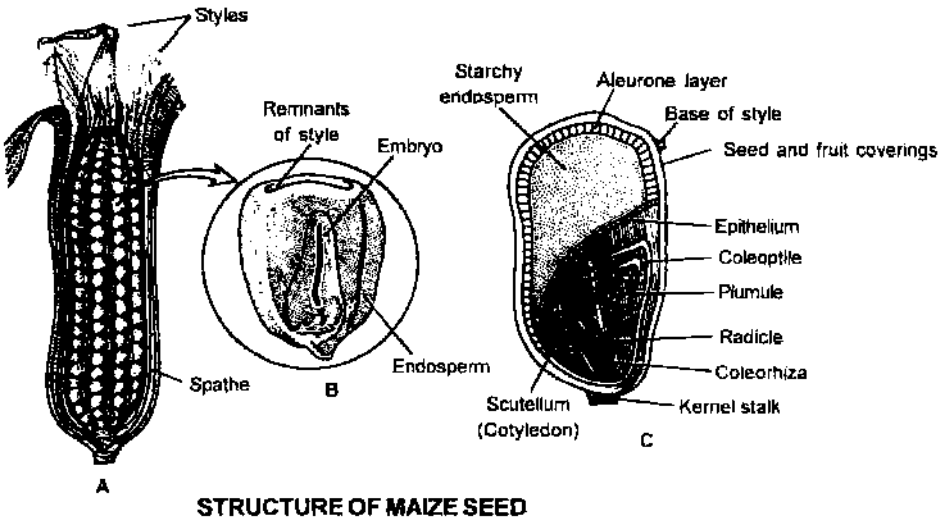
Each seed encloses an embryo which can be examined after removing the seed coats. The bulk of embryo consists of two large, white and kidney-shaped cotyledons (or seed leaves). They store reserve food material in the form of carbohydrates and proteins to provide nourishment to embryo at the time of seed germination and growth of young seedling. The cotyledons are attached laterally to the curved embryonal axis at the cotyledonary node. The micropylar end of embryonal axis is rod-shaped and slightly bulged. It is called radicle (or the embryonic root).

The other side of embryonal axis lies in between the two cotyledons. It is called **plumule** (or the shoot tip). The shoot tip remains protected by two small, folded leaves. The protion of embryo axis between the plumule and cotyledonary node is called **epicotyl.** The portion of axis between the radicle and cotyledonary node is called **hypocotyl.**

STRUCTURE OF MAIZE GRAIN [SEED]

A grain of Maize (*Zea mays*) is infect a dry one-seeded indehiscent fruit of caryopsis type in which pericarp (or fruit wall) is fused with the seed coat. The covering of grain encloses two major parts-endosperm and an embryo. As seen in longitudinal section, the major portion of grain is occupied by a large starchy endosperm. It is surrounded by a special one-celled thick layer, called aleurone layer. The cells of aleurone layer are filled with starch and proteineous grains which play an important role at the time of germination.

The embryo consists of an upper shield-shaped scutellum which is actually a cotyledon. The scutellum is closely pressed against the endosperm and helps in the translocation of nutrients from endosperm to the growing embryo at the time of germination and seed growth. The epidermal tissue of scutellum lying in direct contact with the endosperm which is both secretory and absorptive in function. It secretes certain hormones (Gibberellin) into the endosperm which synthesize enzymes (α-amylase). These enzymes are responsible for the break down of stored nutrients and convert them into soluble state. The soluble nutrients are then absorbed by epithelial layer of scutellum and transferred to the growing embryo.



STRUCTURE OF MAIZE SEED

The scutellum is attached laterally to the embryonal axis. One end of the embryonal axis points towards the pointed end of the grain. It is called **radicle.** The radicle is covered by a protective sheath called **coleorhiza.** The other end of embryonal axis, which faces towards the broader end of the grain, is called **plumule.** The plumule is surrounded by a conical protective sheath, called **coleoptile**. The coleoptile is capable in growth and covers the growing shoot tip till it passes out through the soil during germination.

GERMINATION OF SEED

The embryo of seed grows into a sporophyte plant. The radicle produces primary root. The plumule develops shoot and later on cotyledons degenerates. In some of the plants cotyledon comes above the surface of the soil during the germination of seed. Such type of germination is called epigeal germination e.g. *Capsella*. This is due to higher growth takes place in hypocotyl region of embryo in seed so cotyledon pushed above the soil surface [Capsella, Castor, French bean etc.].

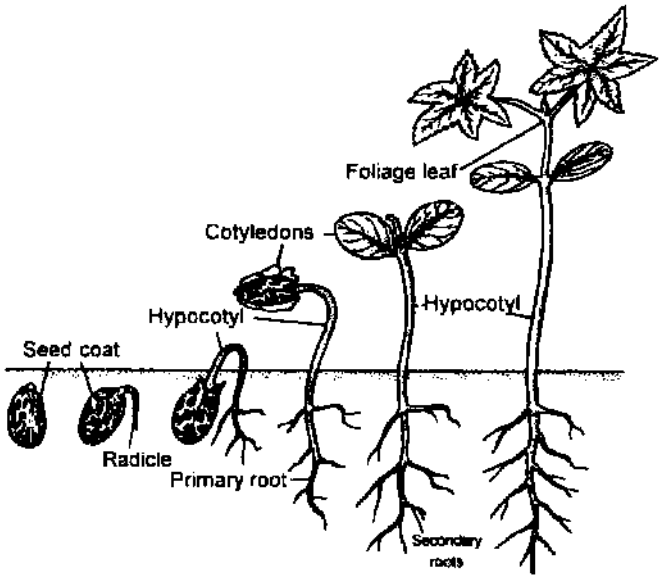
In some of plants the epicotyl region grow faster during the germination results cotyledon remains under the soil. It is known as hypogeal germination, e.g. In most of *Angiosperms* [*Pea, Gram, Rice, Maize* etc]

Types of seed Germination :

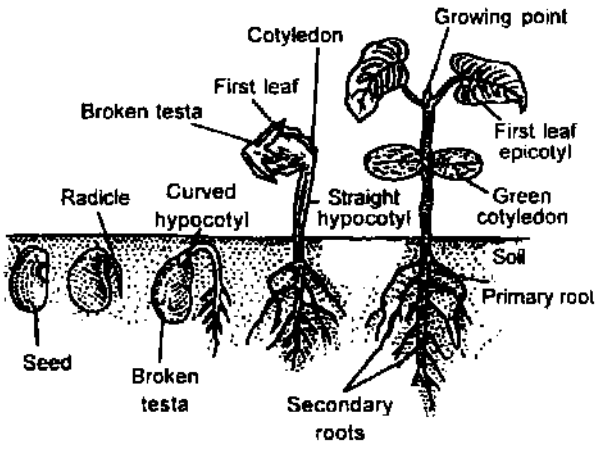
Germination is basically of two types, depending upon behaviour of cotyledons but viviparous germination also found :

Epigel germination :

Here due to faster hypocotyl growth or elongation than epicotyl the cotyledons are pushed out of soil. This is called epigeal germination. This type of germination occurs in *Cotton, Papaya, Castor, Onion, Cucurbits, Tamarind, French bean, mustard,* etc. In some cases, these above ground cotyledons become green leaf like (cotyledonary leaves) and perform photosynthetic function till the seedling assumes independency (e.g., *castor, cotton, onion, papaya*, etc.). In other plants, cotyledons do not assume leaf like shape and fall off (e.g., *French bean* and *Tamarind*).



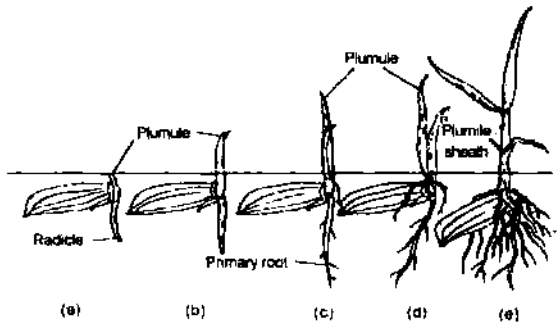
EPIGEAL GERMINATION OF CASTOR SEED



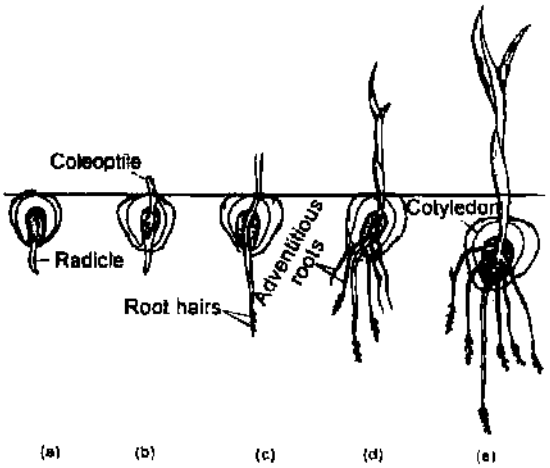
EPIGEAL GERMINATION OF BEAN SEED

Hypogeal germination :

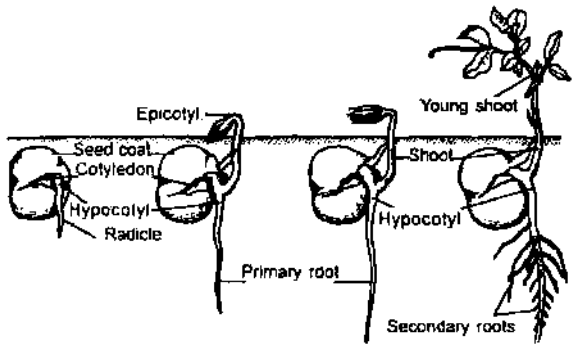
Here due to faster epicotyl elongation, than hypocotyl the plumule comes out of the ground and cotyledons remain underground. This is called **hypogeal germination.** This type of germination occurs in most of the monocotyledons and few dicotyledons, e.g., *Maize, Rice, Wheat, Cocount, Gram, Pea, Peant* and *Mango,* etc.



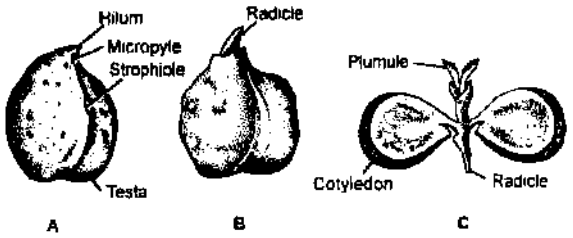
HYPOGEAL GERMINATION OF RICE SEED



HYPOGEAL GERMINATON OF MAIZE SEED



HYPOGEAL GERMINATION OF PEA SEED



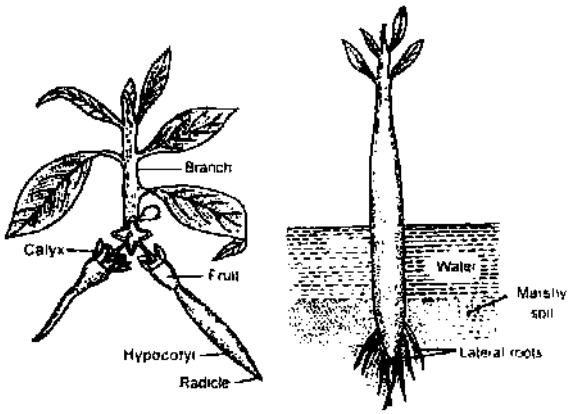
HYPOGEAL GERMINATION OF GRAM SEED

Difference between Epigeal and Hypogeal germination :

S.No.	Epigeal germination	Hypogeal germination
(i)	Cotyledons come above surface of soil during the germination and remains attached till the formation of new leaves.	Cotyledon remains under the soil surface.
(ii)	Due to the growth of hypocotyls, plumule and cotyledon pushed above the ground.	Due to very less growth of hypocotyls, cotyledons do not come above the ground
(iii)	Growth of epicotyl does not take place.	Due to high growth of epicotyl, plumule comes above ground and cotyledon remains inside the ground.
(iv)	Cotyledons become green and perform leaf like function	Cotyledon remains under the soil and do not perform leaf like function
(v)	Cotyledon is responsible to form first leaves, than after dries and fall on the ground	Cotyledon decomposed inside the soil

Vivipary :

A special type of seed germination is characteristic of Mangrove vegetation, found in muddy, saline conditions, seed does not imbibe water as water potential is highly negative and O_2 availability is low e.g., *Rhizophora, Avicennia, Ceriops, Breguira, Sonneratia,* etc. Here there is no resting period of embryo and germination occurs inside the fruit, while it is attached to the parent plant, i.e., "In-situ germination". The seedling is separated in the mud with the help of lateral roots developing from basal end of radicle. This is called viviparous germination or vivipary.



VIVIPARY GERMINATION IN RHIZOPHORA

Significances of seed :

In angiosperms the process of pollination and fertilization are independent of water. Seed formation is very important for plant dispersal. Seeds posses better adaptive strategies for dispersal to new habitat and help in colonisation of these species in new areas. Posses sufficient food so nourish the young seedling till the formation of photosynthetic tissues. Hard seed coat provide protection to young embryo.

Seed is product of sexual reproduction & generate new genetic combination leading to variations. Seeds are basis of agriculture as dehydration and dormancy of mature seed are crusial for storage of seed which can be used throughout the year and also to raise crop in next year or season.

Vaibility of Seeds :

Period of viability of seeds in angiosperms is variable. In some angiosperms seeds are viable only for few months. In many species seeds are viable for years. In some species seeds are viable for hundreds of years. In Lupine (Lupinus arcticus) excavated from Arctic Tundra, the seeds germinated and flowered after an estimated records of 10000 years of dormancy Date palm (phoenix dactylifera) seeds discovered during archeological excavation at king the Herod's palace near Dead Sea are 2000 year old viable seeds. Lotus seeds are viable for 1,000 years.

FACTORS AFFECTING SEED GERMINATION

The process by which the dormant embryo wakes up [becomes active] and begins to grow is known as germination of seed. The seed germination takes place in the presence of favourable condition such as temperature, moisture, and air. This is a very delicated stage in the life of the plant. An minute change in the environment have harmful effect on growing embryo. So favourable environment should be essential for germination. The following factors are essential for germination of seed.

Moisture :

First step of seed germination is imbibition of water by seed surface. The moisture or water is the most important factor for germination of seed. Generally, the cells of embryo contain about 10-15% water in the dormancy period. The vital activities like growth and development is unable to continue in this less amount of water. For active life processes, water must be present about 75-90%. The seed imbibe enter through water and swell up to increase in size before the germination. Water imbibe by seed coat and enter through microypyle. The following effects have been observed in seed due to imbibition of water -

The seed coat becomes soft and imbibed or adsorbed water reaches to the cells of embryo. When the ratio of water increases in the cells, the protoplasmic contents become more active. The size of embryo

increased due to water adsorption results, seed coat breaks up and radicle and plumule easily comes out. Seed coat imbibe water, it becomes soft and increase its permeability. Resulting it increases rate of exchange of oxygen and CO_2. The rate of respiration increases in active cells of embryo. Thus it requires more oxygen. The enzymes are present in the cells of endosperm or cotyledons which are only active in the presence of water. The stored food changed in to dissolved form by the activity of enzyme Gibberellin and it reaches to the active embryo.

Oxygen [O_2] :

The process like cell division, cell elongation etc. of the embryo require energy. This energy is released by the oxidation of organic substances by the process of respiration. Oxygen is essential for oxidation process. The upper surface of soil contains sufficient amount of O_2. The healthy germination does not take place in the absence or scarcity of oxygen in deep soil so crop seed sown in the soil by the farmers upto 5-7 c.m deep.

Temperature :

The suitable temperature is essential for germination of seed. The protoplasm of the cell remains active at certain range of temperature. Most of seed do not germinate in between the range of 0ºC to 5ºC and above the 45ºC. The favourable range of temperature is 20-25ºC for germination of seed in the majority of seeds.

Food or Nutrition :

The growing embryo requires nutrition during germination. The embryo depends upon stored food materials in cotyledons or endosperm in the germination period upto the formation of primary root from the radicle and first leaf from the plumule.

Light :

Light produces different effect in different variety of seeds. The most of the plants do not require light up to the formation of first leaf. Adversely, the rate of germination very fast is the absence of light. But for some plants light is very essential for germination.

They will not germinate in the dark. For example seed of Orchids, Tobacoo, Lettuce etc called photoblastic seeds. After the development of new leaves on shoot light becomes very essential factor. The chlorophyll is not formed in the absence of light and this newly formed plant [Juvenile] will die in the absence of photosynthesis and deficiency of food.

DORMANCY OF SEED

DEFINITION OF DORMANCY OF SEED

The presence of dormancy in a seed is the most important characteristic feature. Because of this character, seeds remain viable for many years. The seeds are dispersed very far places through water, air or insects. Most of the seeds are unable to germinate just after dispersal. They germinate after some time. The time between the maturation and germination of seed is known as "Dormancy period". The sate of inhibited germination as a result of internal factors is usually called 'dormancy' while by external factors in called quiscence. This seed dormancy is of considerable advantage to the plant which helps in adverse environmental conditions. The embryo remains inactive in this period and all the growth processes suspended temporarily. These are three main basic reasons of dormancy of seed.

REASONS OF SEED DORMANCY

Impermeability of seed coat :

The seed coats of many species of Leguminosae and Convolulaceae families are completely impermeable to moisture [water] and oxygen at the time of their maturity. Seed coats, in these are thick and hard. Their cell wall is covered by a layer of lignin which is water proof coating. Such seeds take more time for germination. The dormancy of seeds break by different artificial methods -

By making minute hole/pores with help of pointed sharp apparatus on the seed coat. The seeds are rubbed on hard object so that seed coat become thin. The partial degeneration of seed coat is carried by the action of sulphuric acid. Under natural conditions seed dormancy is gradually over come by the action of microbes [bacteria] in soil, in the alimentary canal of fruit eater birds and due to the presence of high cold or high temperature.

Dormant Embryo :

In many species, although, the embryo completely not matured when the seed is ripe, even than it fails to germinates when ever the environmental conditions are favourable or even seed coat is removed. This is known as "Embryo dormancy". Normally embryo dormancy occurs in many fruit yielding plants of forest. This condition is achieved due to physiological action of seed. Such type of seed must complete their enzymatic and chemical reaction before the germination of seed. In the lack of these reactions, seeds are unable to germinate. Such seed are kept in low temperature and in desirable moisture. Due to this seed dormancy can be broken. The low temperature is the main reason for germination of seeds of Apple, Peaches, pears, Mapple and Pine etc.

Germination Inhibitors :

Germination of some seeds is sometimes checked or prevented by the presence of some chemical compounds are called Germination Inhibitors such as Ferulic acid present in Tomato juice, Caumarin, Abscisic Acid, Dormin and Para ascorbic acid etc. These germination inhibitors washed away with water is known as Leaching.

METHODS OF BREAKING OF SEED DORMANCY

Scarification : The hard seed coat is broken in this method so that water and oxygen enter into the seed coat.

Stratification : The seed kept at low temperature and in the presence of oxygen and water for some time, so that embryo can completes its germination period.

Light Requirement : The plants which seed germination requires light are known as Photoblastic seeds. Such as Lettuce, Capsella, Lepidium and Tobacco etc. Seeds in which germination not affected by light are called nonphotoblastic seeds. The dormancy of photoblastic seeds can be broken by the treatment of red light. The phytochrome red, absorbs red light and convert into phytochrome far red which increase the germination of seed.

Seed + R [red light]	$\rightarrow$	Germination
Seed + R + FR	$\rightarrow$	No germination
Seed + R + FR + R	$\rightarrow$	Germination
Seed + R + FR + R + FR	$\rightarrow$	No germination

Alternative Temperature : Seeds are trated with high and low temperature alternatively at high pressure to increase the germination of seed. e.g. The seed of Malilotus (Sweet clover) and Alfa-alfa are treated at 2000 atmospheric pressure and 18^{o}C temperature.

Viability : This is called existence of life in a seed. The viability of seed can be found out by 2, 3, 5, triphenyl tetrazolium chloride. The embryonal axis of living seed becomes pink in colour in the solution of T.T.C. Seed dormancy also broken by the treatment of Gibberellin.

BUD DORMANCY

REASONS OF BUD DORMANCY

The buds are of two types -

- Vegetative bud
- Floral bud

Before showing their respective growth, the bud of many plants undergoes a dormant phase.

Causes of Bud Dormancy :

According to Hemberg in woody plant, the bud dormancy is caused by Abscisic acid. The level of endogenous ABA increases with the onset of dormant period and decreases when it is broken. In non woody plant like Potato, the bud dormancy is again due to the presence of an inhibitor. Bannet Clark and Kefford (1953) identified this substance as Inhibitor-β. It present in the peel of dormant Potato tuber, which is actually ABA. The inhibitor-β is responsible for checking the sprouting of buds located in the 'eyes' of Potato tuber.

Perception of Dormancy by Buds -

According to Wareing. The bud dormancy, at least in woody plant, is caused by short day length, while it is broken by long day.

BREAKING OF BUD DORMANCY

Chilling : The bud dormancy of some plant can be broken, if they are given cold temperature treatment for specific duration. Alternating temperature treatment : The dormancy of buds of some plants can be broken, if they are subjected to low temperature (0º-10ºC) for a brief duration and then high treatment.

High temperature treatment : If dry Potato tubers are stored at 35ºC or moist at 20ºC, the dormancy of tubers buds is broken.

Chemicals : Some chemicals like 2-chloro ethanol, Gibberellin and Thiourea are capable of breaking of dormancy of buds. Of these 2-chloro ethanol is very effective in breaking the dormancy of Potato tuber's buds. Endogenous Gibberellin plays a very significant role in conrolling the dormancy of Potato tubers.

Gene De-represssion : The genome of the dormant potato bud lacks the ability of DNA dependent RNA synthesis. By treating the bud with Ethyl chlorohydrin or Gibberellin, the ability of RNA synthesis is achieved. Thus causing derepression of a repressed gene.

SPECIAL POINT

FLOWER IS A MODIFIED SHOOT

According by Goethe, Flower is modified shoot which shows favourable adaptation for reproduction through a special method. Flower has a small or long stalk like – structure called pedicel. Free end of the pedicel is flattaned or dome shaped is called thalamus. The thalamus is a type of modified stem, on which nodes and internodes are present. Nodes are present very close to each other and internodes are small highly reduced in the thalamus.

The whorls present in the flower are the modifications of leaves and arranged in four circles on the thalamus. The four nodes are present on the thalamus, in which first modified leaves are attached on the first lower node are called **calyx**. The **corolla** born on the second node. Androecium are present on the

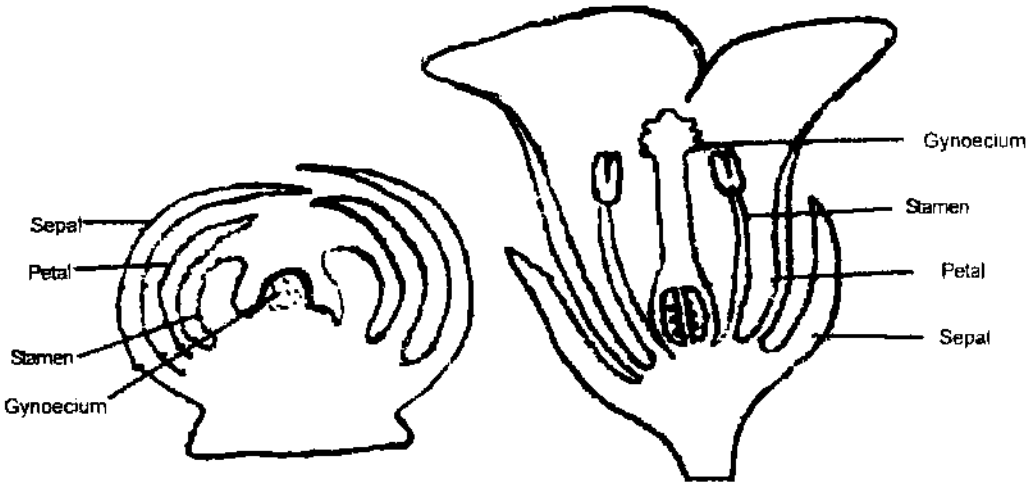
third node and gynoecium on the fourth node in uppermost position. In some of the plants the length of internode increases which is present in between Calyx and Corolla is called **Anthophore** e.g. *silene plant, Dianthus.* The length of internode between the corolla and androecium increases. It is called **androphore** e.g. *Passiflora.*

If the internode between androecium and gynoecium increases then it is called **gynophore** e.g. *androgynophore* e.g. *Gynandropsis pentaphylla* and *Cleome gynandra.* Clayx is also modified vegetative leaves. Such as in Mussaenda flower, one sepals of calyx modified into leaf like bright and attractive yellow colour structure called "**Advertising flag**". It helps in pollination. In some flowers, thalamus grows inside the ovary is called **carpophore** e.g. *Coriandrum* and *Foeniculum.* Nymphaea Petals like stamens are present. On the basis of above examples, we can prove "Flower is modified shoot".

Development of floral organs in *arabidopsis* :

Arabidopsis thaliana is a small weed belonging to family Brassicaceae. It contains approximately 26000 genes and the complete gene sequence has been studied by plant biologists. Like other plants in Arabidiopsis the initiation of flowering is influenced by various environmental factors, of these photoperiodism and temperature are more important. Under the influence of the two factors the apical meristem starts producing flowers instead of vegetative structure. The development of calyx, corolla, androecium and gynoecium is controlled by specific genes. These are called homeotic selector genes, example – *Apetala-2, Apetala-3, Agamous* etc. As a result of effect of these genes, the development of leaves is replaced by the development of flowers.

Similar to leaves, the floral organs developed by periclinal divisions in protodermal or subprotodermal cells. Initially these cells show periclinal divisions followed by periclinal as well as anticlinal divisions resulting in formation of an outgrowth. Cells of the outgrowth divide, develop and differentiate to form different floral organs. In Arabidopsis calyx are the first to develop followed by corolla, androecium and gynoecium. The order of development of floral whorls may vary from plant to plant. For example in members of family Umbelliferae the sequence of development of floral organs is – androecium, corolla, calyx and gynoecium.



Development of floral organs in *Arabidopsis*
(A) intial stage of development (B) fully developed flower

Difference between Male and Female gametophyte of *Arabidopsis thaliane*

S.No.	Male gametophyte	Female gametophyte
(i)	It is developed from microspore or pollen grain.	It is developed from megaspore.
(ii)	It does not remain embedded permanently in microsporangium	It remains embedded permanently in megasporangium
(iii)	Male gametes come out of pollen grain due to the formation of pollen tube	Female gamete always remains inside, covered by membrane of megasporangium
(iv)	There are two phases of growth-prepollination and post pollination	Only single phase of growth
(v)	It is there called structure in mature stage.	It has seven cells in mature stage.
(vi)	It will distintegrate after fertilization	Two new structure are formed after fertilization, that is endosperm and oospore.

Number of Chromosomes in different parts of *Arabidopsis thaliane* plant

S.No.	Sporophyte	
(i)	Zygote	2n
(ii)	Embryo	2n
(iii)	Endosperm	3n
(iv)	Radicle	2n
(v)	Plumule	2n
(vi)	Cotyledon	2n
(vii)	Nucellus	2n
(viii)	Integument	2n
(ix)	Microspore mother cell	2n
(x)	Megaspore mother cell	2n
(xi)	Ovary wall	2n
(xii)	Carpel	2n
(xiii)	Sepal, Petal	2n
(xiv)	Stamen	2n
(xv)	Leaf, Root, Stem	2n

Gametophyte of *Arabidopsis thaliane* :

S.No.	Parts of Plants	Number of Chromosome
(i)	Microspore	n
(ii)	Tube cell	n
(iii)	Male gamete	n
(iv)	Megaspore	n
(v)	Embryo sac	n
(vi)	Synergid	n
(vii)	Antipodals	n
(viii)	Egg cell	n
(ix)	Polar nuclei	n + n

Difference between Pollination and Fertilization in *Arabidopsis thaliane*

S.No.	Pollination	Fertilization
(i)	Transfer of pollen grains from anther to stigma of the flower is called pollination.	Fusion of male gametes and egg cell in embryo sac situated inside the ovule is called fertilization.
(ii)	This process take place before fertilization	This process take after pollination
(iii)	For the completion of this process, insects, water, air like agencies are essential	There is no any external medium is utilized in this process
(iv)	Pollen tube is not formed	Pollen tube is formed which transfer male gametes up to egg cell.
(v)	This process take place on outer parts of flower, so that it is external mechanism	This process take place inside the flower, so that it is internal mechanism

EXERCISE - 1

Q.1 **P**ollen tube exhibits -
(1) Basal growth (2) Apical growth
(3) Both the above (4) Intercalary growth

Q.2 Movement of pollen tube is -
(1) Tactic (2) Tropic
(3) Nastic (4) Autonomous

Q.3 Pollen tube is composed of -
(1) Pactin (2) Cutin
(3) Sporopollenin (4) Pecto-cellulose

Q.4 Polyembryony was first discovered by -
(1) Rosenberg (2) Hofmeister
(3) Leeuwenhoek (4) Guha

Q.5 Longest pollen tube is found in -
(1) Wheat (2) Maize
(3) Barley (4) Rice

Q.6 Tegmen of the seed develops from -
(1) Perisperm (2) Funiculcum
(3) Inner integument (4) Outer inergument

Q.7 Stigma of Anemophilous flower is -
(1) Rough (2) Smooth
(3) Sticky (4) None of above

Q.8 The most simple and most common type of embryosac discovered by -
(1) Nawaschin (2) Straburger
(3) Schleiden (4) Amici

Q.9 Endosperm is not formed in the members of -
(1) Compositae (2) Orchidaceae
(3) Cucurbitaceae (4) Malvaceae

Q.10 In **Casuarina**, pollen tube enters through -
(1) Intergument (2) Chalaza
(3) Micropyle (4) Funiculum

Q.11 'Callase' enzyme which dissolve callose of tetrad of microspores to separate 4 microspores is provided by -
(1) Pollen grains (2) Middle layer
(3) Tapetum (4) Endothecium

Q.12 The common type of embryo sac development is -
(1) Oenothera type (2) Polygonum type
(3) Allium type (4) Adoxa type

Q.13 Example of Epihydrophily is -
(1) **Zostera** (2) **Vallisneria**
(3) **Ceratophyllum** (4) **Nymphea**

Q.14 Pollination in **Yucca** plant takes place by -
(1) Honey bee (2) Butter fly
(3) Pronuba (4) Bird

Q.15 The primary Endosperm nucleus in **Polygonum** type of Embryosac is -
(1) Haploid (2) Diploid
(3) Triploid (4) Tetraploid

Q.16 Protandry is the situation when -
(1) Anther matures later than the stigma of flower
(2) Anther matures earlier than the stigma of flower
(3) Anther and stigma mature at the same time
(4) All of the above

Q.17 The anterior end of pollen tube burst by the process of _____ in embryosac -
(1) Imbibition (2) Exo-osmosis
(3) Enzymatic action (4) Endo-osomosis

Q.18 Which of the following nuclei participate in double fertilization -
(1) The egg
(2) The secondary nucleus
(3) The two male nuclei
(4) All of the above

Q.19 Perisperm is -
(1) Degenerate secondary nucleus
(2) Remnant of nucellus
(3) Peripheral part of endosperm
(4) Degenerate synergids

Q.20 The Parenchyma tussue which forms the bulk of ovule where the sporogenous tissue is produced is -
(1) Megaspore mother cell
(2) Nucellus
(3) Ovule
(4) Embryo sac

Q.21 The main embryo developed from the structure formed as a result of -

(1) Double fertilization

(2) Triple fusion

(3) Syngamy

(4) fusion of two polar nuclei of an embryosac

Q.22 After fertilization the outer integument of ovule change into -

(1) Testa (2) Tegmen

(3) Fruit (4) Seed

Q.23 In **Capsella** the pollen tube enters through the micropyle, therefore fertilization is -

(1) Porogamous (2) Chalazogamous

(3) Mesogamous (4) Basigamous

Q.24 The process of double fertilization was discovered by -

(1) Hofmeister (2) Strasburger

(3) Newaschin (4) Amici

Q.25 The chalazogamy was reported by **"Treub"** in-

(1) **Casuarina** (2) **Capsella**

(3) **Capsicum** (4) Datura

Q.26 After fertilization the seed is developed from -

(1) Ovule (2) Ovary

(3) Embryo (4) Endosperm

Q.27 The pollen tube was discovered by -

(1) Schleiden (2) Amici

(3) Hofmeister (4) Trueb

Q.28 Double fertilization means -

(1) Fusion of male gametes and ovum

(2) Fusion of two polar bodies

(3) A male gamete fused with egg and second male gamete fused secondary nucleus

(4) All the above

Q.29 After fertilization seed coat is formed by -

(1) Chalaza (2) Ovule

(3) Integument (4) Embryo sac

Q.30 Pollen tube enters into embryo sac of Angiosperm through the

(1) Egg cell

(2) Any one of the synergids

(3) Any one of the antipodal cells

(4) None of these

Q.31 Development of embryo from -

(1) Two polar nuclei of embryosac

(2) Secondary nucleus and male gamets

(3) Egg cell and male gamete

(4) Synergids

Q.32 Who discovered fertilization in plant

(1) Newaschin (2) Strasburger

(3) Amici (4) P. Maheshwari

Q.33 Fertilization & double fertilization occurs in -

(1) Ovary (2) Ovule

(3) Embryo sac (4) Nucellus

Q.34 The fusion product of polar nuclei and male gamet is -

(1) Nucellus

(2) Primary endosperm nucleus

(3) Zygote

(4) Secondary nucleus

Q.35 When a diploid $\underset{+}{\bigcirc}$ plant is crossed with a tetraploid $\circlearrowright$ plant, the endosperm will be -

(1) Diploid (2) Triploid

(3) Tetraploid (4) Pentaploid

Q.36 Stigma of the entomophilous flower is -

(1) Sticky (2) Rough

(3) Hairy (4) Smooth

Q.37 Bisporic type of embryo sac is found in -

(1) **Polygonum** (2) **Oenothera**

(3) **Adoxa** (4) **Allium**

Q.38 In which plant self sterility is found -

(1) **Gossypium** (2) **Pitunia**

(3) Marigold (4) Mangifera

Q.39 In pollination "Trap door mechanism" is found in -

(1) **Salvia** (2) **Aristolochia**

(3) **Ficus** (4) Yucca

Q.40 Male gametes of the **Capsella** fused with -
(1) Egg (2) Secondary nucleus
(3) Both of the above (4) None of above

Q.41 Synergids help in -
(1) Pollen entry into embryosac
(2) Endosperm formation
(3) Embryo sac nutrition
(4) Both 1 & 3

Q.42 Embryogeny in **Capsella** was first of all studied by-
(1) Hanstein (2) Famintzin
(3) Souges (4) All of the above

Q.43 The term xenia denotes the effect of pollen on the -
(1) Somatic tissue (2) Root
(3) Flowers (4) Endosperm

Q.44 In **Capsella** the endosperm is formed -
(1) At the time of fertilization
(2) Before fertilization
(3) After fertilization
(4) Before pollination

Q.45 The function of suspensor is -
(1) To provide water
(2) To provide oxygen
(3) To push the embryo towards endoperm to provide more food
(4) To suck food

Q.46 What are x-bodies in ovules -
(1) Two polar nuclei
(2) Disintegrating tube nucleus & synergids nucleus
(3) Filiform apparatus
(4) Two male nuclei

Q.47 Scutellum is a
(1) Endosperm of gymnosperm
(2) Sheild shaped cotyledon of monocot
(3) Protective covering of radicle
(4) Protective covering of plumule

Q.48 Coleoptile is -
(1) Coat of plumule (2) Coat of Radicle
(3) Plumule (4) None of these

Q.49 Water of coconut is -
(1) Endosperm (2) Nucellus
(3) Endocarp (4) Mesocarp

Q. 50 Suspensor is one celled in -
(1) **Capsella** (2) **Triticum**
(3) **Raphanus** (4) **Brassica**

Q.51 Embryonal development in **Capsella** is -
(1) Asteroid type (2) Caryophylloid type
(3) Crucifer type (4) Solanum type

Q.52 The suspensor in **Capsella** develops from
(1) Apical - cell (2) Basal-cell
(3) Micropylar- cell
(4) Apical & basal cell both

Q.53 In monocot plant endosperm is -
(1) Monoploid (2) Diploid
(3) Mixture of monoploid & diploids cells
(4) Triploid

Q.54 Mosaic endosperm is characteristic of -
(1) Wheat (2) **Plumbago**
(3) Maize (4) Coconut

Q.55 Tigellum is known as -
(1) Testa (2) Tegmen
(3) Both of the above
(4) Main axis of the embryo

Q.56 Chasmogamous and cleistogamous type of flower are found in -
(1) Primrose (2) Ficus religiosa
(3) Commelina (4) Calotropis

Q.57 Apex of radicle is formed with help of -
(1) Epibasal cells (2) Hypobasal cells
(3) Cotyledon (4) Hypophysis

Q.58 Embryo is formed in dicotyledon plants -
(1) Lateral (2) At the apex
(3) In middle (4) 2 & 3 both

Q.59 The last cell of suspensor is called -
(1) Hypophysis (2) Suspended cell
(3) Terminal cell (4) Haustorial cell

Q.60 Haploid, diploid and triploid conditions respectively can be traced in -
(1) Egg. Nucellus, Endosperm
(2) Antipodal, Egg, Endosperm
(3) Endosperm, Nucellus, Synergids
(4) Antipodal, Synergids & Integuments

Q.61 Formation of fruit without fertilization known as -

(1) Parthenogenesis (2) Polyembryony

(3) Polygamy (4) Parthenocarpy

Q.62 If the leaf of **Capsella** has 46 number of chromosomes then how many chromosomes number will be there in endosperm -

(1) 46 (2) 23

(3) 69 (4) 138

Q.63 If the nucellus cell of an Angiosperm contains 24 chromosomes the number of chromosomes present in pollen grain, endosperm & embryo will be -

(1) 24, 36, 24 (2) 12, 36, 24

(3) 12, 24, 360 (4) 24, 12, 12

Q.64 How many meiotic division are required to produce 40 seeds in the **Capsella** plant -

(1) 50 (2) 40

(3) 80 (4) 20

Q.65 The number of nuclei taking part in double fertilization are -

(1) two (2) three

(3) four (4) five

Q.66 In Angiosperm, if haploid number of chromosome is 12 then what will be the no of chromosomes in integuments and synergids -

(1) 12, 12 (2) 24, 12

(3) 24, 24 (4) 12, 24

Q.67 How many meiotic divisions are required for the formation of 200 seeds of **Capsella** -

(1) 200 (2) 400

(3) 250 (4) 300

Q.68 In Angiosperm, if number of chromosomes in endosperm is 30, what will be the no. of chromosomes in nucellus -

(1) 15 (2) 30

(3) 20 (4) 40

Q.69 How many meiotic divisions are essential formation of 100 seeds in Cyperaceae family -

(1) 100 (2) 125

(3) 150 (4) 200

Q.70 How many meiotic divisions are necessary for formation of 100 functional megaspores -

(1) 25 (2) 50

(3) 100 (4) 200

Q.71 What type of germination is found in **Capsella**-

(1) Hypogeal (2) Epigeal

(3) Both (4) None

Q.72 In albuminous seed, the food is stored in -

(1) Testa (2) Plumule

(3) Cotyledon (4) Endosperm

Q.73 Seed is not a morphological equivalent of spore because -

(1) Spore is not produced through fertilization

(2) Spore does not posses embryo & endosperm

(3) Spore is a haploid structure

(4) All the above

Q.74 In non endospermic seed or ex-albuminous seed -

(1) The endosperm may be completely used up by developing embryo

(2) No endosperm form

(3) Endosperm is starchy

(4) Endosperm is oily

Q.75 Helobial endosperm is restricted usually to -

(1) Gymnosperm (2) Dicotyledons

(3) Monocotyledons (4) Both 2 & 3

Q.76 "Ruminate endosperm" is commonly found in seed of -

(1) Euphorbiaceae

(2) Cruciferae

(3) Palmae or Arecaceae

(4) Compositae

Q.77 The seeds of which type of plant have no dormancy

(1) Xerophytes

(2) Mesophytes

(3) Halophytes and hydrophyte

(4) Mangrooves

Q.78 What is the cause of long-dormancy in seeds-
(1) Impermiable seed coat
(2) Undeveloped embryo
(3) Presence of ABA/Ferulic acid
(4) All of the above

Q.79 Seeds of Water melon are embeddend in water pulp of the fruit but do not germinate because -
(1) Light is absent
(2) O_2 is absent
(3) ABA is present
(4) Nutrients are absent

Q.80 Low temperature induction of germination is called
(1) Vernalization (2) Stratification
(3) Scarification (4) Chilling

Q.81 What is the cause of dormancy in Tomato seeds -
(1) Hard seed coat
(2) Presence of ferulic acid
(3) Undeveloped embryo
(4) All the above

Q.82 The first requirement for germination of seed is-
(1) Light (2) H_2O
(3) Low temperature (4) Mineral salts

Q.83 Which light is more effective in inducing germination of seeds -
(1) Red (2) Blue
(3) Green (4) Infra red

Q.84 Mechanical cracking of hard seed coat can induce germination of certain seeds this phenomenon is termed as -
(1) Cracking (2) Stratification
(3) Scarification (4) Chilling

Q.85 During seed germination -
(1) Heat is liberated
(2) Starch is synthesized
(3) Light is absorbed
(4) Fat is synthesized

Q.86 What type of pattern of endosperm, development in **Capsella** -
(1) Cellular type (2) Nuclear type
(3) Helobial type (4) None of the above

Q.87 Cotyledons absent in seed of -
(1) **Capsella** (2) **Cuscuta**
(3) **Santalum** (4) 2 and 3 both

Q.88 The dormancy in seeds is naturally induced by-
(1) IAA (2) A.B.A.
(3) ATP (4) N.A.D.P

Q.89 Which hormone can break dormancy of seed -
(1) ABA (2) Auxin
(3) GA (4) Coumarin

Q.90 The seed of black pepper is -
(1) Albuminous (2) Exalbuminous
(3) Perispermic (4) With fleshy testa

Q.91 The seed of **Capsella** is -
(1) Albuminous monocot
(2) Ex albuminous dicot
(3) Albuminous dicot
(4) Ex albuminous monocot

Q.92 The most common natural inhibitor of seed germination is -
(1) Ferulic acid (2) Abscisic acid
(3) Citric acid (4) Phytochrome

Q.93 Which of the following is not essential for the germination of most of seeds -
(1) Light (2) Temperature
(3) O_2 (4) H_2O

Q.94 In which of the following plants cotyledons remains under ground during germination -
(1) **Rhizophora** (2) Gram
(3) Bean (4) Castor

Q.95 In which part of the Embryo maximum growth take place in eqigeal germination -
(1) Redicle (2) Plumule
(3) Epicotyl (4) Hypocotyl

Q.96 The chemical which can break bud dormancy by its spray -
(1) IAA (2) 2,4-D
(3) Zeatin (4) Thiourea

Q.97 Seeds of Gram are -
(1) Exalbuminous and epigeal
(2) Exalbuminous and hypogeal
(3) Albuminous and eqigeal
(4) Albuminous and hypogeal

Q.98 In which part of embryo maximum growth take place in hypogeal germination -

(1) Plumule (2) Radicle

(3) Epicotyl (4) Hypocotyl

Q.99 Which of the following is negative photoblastic seed -

(1) **Lepidium** (2) **Nigella**

(3) Tobacco (4) **Capsella**

Q.100 A which temperature, germination of seed can not possible in most of the plants -

(1) 10° – 15°C (2) 5° – 10°C

(3) 0°– 5°C (4) 20° – 25°C

Q.101 The bud dormancy in Potato is due to -

(1) ABA (2) Ethylene

(3) IAA (4) Phenolics

Q.102 Important "Aeroallergens in India is -

(1) **Serjania** (2) **Amaranthus**

(3) **Borassus** (4) **Holoptelia**

Q.103 Fore most Indian Embryologist is -

(1) S.C. Meheshwari (2) P. Maheshwari

(3) H.Y. Mohan Ram (4) None of above

Q.104 In seeds, characterised by hypogeal germination, cotyledons generally do not becomes green because-

(1) They lack chloroplast

(2) They developed very early

(3) Contains inhibitor

(4) They remains below the soil

Q.105 Which statement is false -

(1) Pollens are received by stigma

(2) Pollen tube discovered by Amici

(3)Pollen kitt is absent on pollen grains of **Capsella**

(4) Tigellum is the main axis of embryo

ANSWER KEY

Exercise – 1

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	2	2	4	3	2	3	3	2	2	2	3	2	2	3	3	2	4	4	2	2
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	3	1	1	3	1	1	2	3	3	2	3	2	3	2	3	2	4	2	3	3
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	4	1	4	3	3	2	2	1	1	2	3	2	4	3	4	3	4	4	4	1
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	4	3	2	1	4	2	3	3	4	3	2	4	4	1	3	3	4	4	3	2
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	2	2	1	3	1	2	4	2	3	3	2	2	1	2	4	4	2	3	2	3
Ques.	**101**	**102**	**103**	**104**	**105**															
Ans.	1	2	2	4	3															

EXERCISE - 2

Q.1 Anthophore structure is formed by :
(1) Internode (2) Node
(3) Sepals (4) Petals

Q.2 When embryo develops from a haploid cell of embryosac, other than egg cell the process is known as -
(1) Apogamy (2) Apospory
(3) Adventive embryony
(4) Diplo spory

Q.3 Which of the following statement is correct -
(1) Flower is a modified root
(2) Flower is a modified shoot
(3) Flower is a modified leaf
(4) Flower is a modified infloresence

Q.4 Androgenic haploid plants are produced from
(1) Pollen grains (2) Connective tissues
(3) Tapetum (4) Wall of the Anther

Q.5 Apomixis was discovered by -
(1) Leeuwenhoek (2) Winkler
(3) Juel & murbeck
(4) Navaschin & guignard

Q.6 In which Era angiosperms originated -
(1) Coenozoic (2) Jurassic
(3) Mesozoic (4) Holozoic

Q.7 Which of the following is monocarpic plant -
(1) Shisham (2) Mango
(3) Pinus (4) Bamboo

Q.8 Anthophore is
(1) Receptacle between two carpels
(2) Internode between Androecium and Gynoecium
(3) Internode between calyx and corolla
(4) None of these

Q.9 Which is the most logical sequence with reference to the life cycle of angiosperm
(1) Germination, endosperm formation, seed dispersal, double fertilization.
(2) Cleavage, fertilization, grafting, fruit formation
(3) Pollination fertilization, seed formation & germination
(4) Maturation, mitosis, differentiation

Q.10 After culturing the anther of a plants few diploid plant were got along with haploid plant. Which of the following part might have given rise to diploid plant
(1) Vegetative cell of pollen
(2) Exine of pollen wall
(3) Cells of anther wall
(4) Generative cell of pollen

Q.11 **Capsella** is angiosperm because it possess-
(1) Seed (2) Pollen grain
(3) Vascular tissue (4) Fruit

Q.12 Anther of **Arceuthobium** plant is -
(1) Tetra sporangiate (2) Bisporangiate
(3) Monosprangiate (4) (1) and (2) both

Q.13 Which part of the reproductive structure produces both enzymes & hormones -
(1) Archesporium (2) middle layer
(3) Tapetum (4) Endo thecium

Q.14 Ubisch bodies are produced in -
(1) embryosac (2) Endothecium
(3) Pollen grain (4) Tapetum

Q.15 The mature male gametophyte in angiosperm is represented by -
(1) Pollen grain
(2) Germinating pollen grain
(3) Embryo sac
(4) Anther

Q.16 Which structure of pollen grain protect it from ultra violet rays
(1) Sporopollenin (2) Pollen kitt
(3) Ubisch body (4) 1 & 2 both

Q.17 Tapetum is -
(1) Parietal in origin usually the inner most layer of anther wall
(2) Modified endothecium of anther wall
(3) Outer most layer of sporogenous tissue modification
(4) Parietal in origin and is the inner most layer of ovule wall

Q.18 Division taking place in tapetum cell is -
(1) Meiosis (2) Amitosis
(3) Endomitosis (4) Only mitosis

Q.19 in Capsella pollen grains are shed at
(1) One celled stage (2) Three cell stage
(3) Three nuclei stage (4) Two celled stage

Q.20 Example of polyploid tissue present in an angiosperm plant is -
(1) Perisperm (2) Embryo
(3) Tapetum (4) Placenta

Q.21 A microspore is a first cell of -
(1) Female gametophyte
(2) Male gametophyte
(3) Sporophyte (4) Anther

Q.22 Pollen grains of some plants cause -
(1) Pneumonia (2) Typhoid
(3) Allergy (4) None of these

Q.23 Anther is generally composed of
(1) One sporangium (2) Two sporangium
(3) Three sporangium (4) Four sporangium

Q.24 Anther of **Capsella** is equivalent to which structure of fern plant -
(1) Sporangia (2) Sorus
(3) Antheridia (4) Male gametangia

Q.25 Occurrence of more than four spores from Spore mother cells is called -
(1) Polysiphony (2) Polyspermae
(3) Polyspory (4) Polyembryony

Q.26 How many cells or nuclei are present in male gametophyte of **Capsella**
(1) One (2) Two
(3) Three (4) Many

Q.27 How many and what type of male gametes are produced by the male gametophyte of **Capsella**-
(1) One,. multi cilliated
(2) two, biciliated
(3) two, multi ciliated (4) Two, non motile

Q.28 The particular type of fossils of pollen grains present in area may be helpful in the exploration of -
(1) Coal (2) Petroleum
(3) Fossil plants (4) All the above

Q.29 Ubisch bodies are associated with the development of -
(1) Embryo (2) Pollen grains
(3) Endosperm (4) Embryo sac

Q.30 In a pollen grain the small nucleus is -
(1) Generative nucleus (2) Tube nucleus
(3) Vegetative nucleus (4) Pollen nucleus

Q.31 Most reduced size gametophyte is of -
(1) Bryophytes (2) Pteridophyte
(3) Gymnosperm (4) Angiosperm

Q.32 Pollen grain of **Capsella** -
(1) Monocolpate (2) Bicolpate
(3) Tricolpate (4) Polycolpate

Q.33 Essential whorls of a flowers-
(1) Calyx and Corolla
(2) Corolla and Gynoecium
(3) Androecium and Gynoecium
(4) All the above

Q.34 Filiform pollen grains are found in -
(1) **Calotropis** (2) **Myosotis**
(3) **Cyperus** (4) **Zostera**

Q.35 Which statement is false -
(1) Unisexuality of flower induces cross pollination
(2) Androgenic plants are developed by Guha & Meheshwari
(3) Morphological barriers are absent in Gloriosa flower
(4) All

Q.36 Isobilateral tetrad is common in-
(1) Monocots (2) Dicots
(3) Halophia (4) None of these

Q.37 Which type of tetrad is found in **Magnolia** plant -
(1) Isobilateral (2) T-shaped
(3) Linear (4) Decussate

Q.38 Sporopollenin is found in -
(1) Exine (2) Intine
(3) Cytoplasm (4) Nucleus

Q.39 Microsporophyll of Angiosperms is known as -
(1) Androecium (2) Anther
(3) Filament (4) Stamen

Q.40 Main function of endothecium (in anther) is -
(1) Mechanical (2) Nutritive
(3) Dehiscence (4) None of above

Q.41 Which of the following is wrong statement -
(1) Monothecous anthers are found in Malvaceae family
(2) Middle layer is ephemeral
(3) Amoeboid tapetum releases ubisch bodies
(4) Banana is a monocarpic plant

Q.42 Development of male gametophyte is -
(1) Invivo (2) Insitu
(3) Both (4) None of the above

Q.43 Pollen grains preserved for long time because of -
(1) Cellulose (2) Carotenoids
(3) Ubisch bodies (4) Sporopollenin

Q.44 Endothecium, middle layer and tapetum in anther are derived from -
(1) Primary sporogenous layer
(2) Primary parital layer
(3) Both
(4) None of the above

Q.45 Which one is female gametophte -
(1) Embryo (2) Embryosac
(3) Endosperm (4) Pistil

Q.46 What type placentation is found in **Capsella**-
(1) Axile (2) Parietal
(3) Marginal (4) None

Q.47 The ovule of **Capsella** derives it's nutrition from-
(1) Sporogenous (2) Tapetum
(3) Epithecium (4) Placenta

Q.48 A polygonum type of embryosac is -
(1) 7-celled and 8 nucleate
(2) 8-celled and 7-nucleate
(3) 7-celled and 7-nucleate
(4) 8-celled and 8-nucleate

Q.49 What type of ovule found in Capsella
(1) Anatropous (2) Orthotropous
(3) Circinotropus (4) Campylotropous

Q.50 The functional megaspore in **Capsella** is always -
(1) Micropylar (2) Chalazal
(3) All (4) Any

Q.51 Crassinucellate ovule shows -
(1) Absence of nucellus
(2) Well developed nucellus
(3) Partially developed nucellus
(4) Modified nucellus

Q.52 Ovule in angiosperm is technically equivalent to-
(1) A megasporangium
(2) A megasgametangium
(3) A micro spore
(4) A mega spore

Q.53 Proliferation of integumentary cells at the micropylar region of the ovule in castor develops -
(1) Aril (2) Funicle
(3) Caruncle (4) Apophysis

Q.54 Caruncle is formed by -
(1) Peduncle (2) Cotyledons
(3) Integument (4) Perisperm

Q.55 Obturators which help in fertilization are out growth of -
(1) Pollen tube
(2) Stigma
(3) Placenta or funiculus
(4) Pollen grains

Q.56 Just before fertilization the diploid structure in the ovule of **Capsella** is -
(1) Pollen tube
(2) Nucellus/Sec.nucleus
(3) Synergids (4) Antipodals

Q.57 Fillform apparatus are found in -
(1) Antipodal cell (2) Egg cell
(3) Secondary nucleus (4) Synergids

Q.58 Which type of gametes are present in **Capsella**-
(1) Flagellated (2) Motile
(3) Non-motile (4) None of these

Q.59 Perisperm is -
(1) Persistant nucellus in seed
(2) Ovule wall
(3) Ovule coat
(4) Fossil of haustoria

Q.60 Free nuclear division in an angiosperm takes place during -
(1) Gamete formation
(2) Endosperm formation
(3) Embryo formation
(4) Flower formation

Q.61 Archesporial cells in **Capsella** do not form -
(1) Epidermis
(2) Endothecium
(3) Tapetum
(4) Micro spore mother cell

Q.62 Rephe and hilum in seed represent -
(1) Nucellus (2) Funiculus
(3) Integument (4) Micropyle

Q.63 Micropyle in seed helps in the entry of -
(1) Male gamete (2) Pollen tube
(3) Water & air (4) All

Q.64 Anther of the **Moringa** plant is -
(1) Tetrasporangiate
(2) Monosporangiate
(3) Bisporangiate
(4) Above (1) & (2) both

Q.65 The plant in which G.B. Amici discovered pollen tube is -
(1) **Capsella** (2) **Parthenium**
(3) **Portulaca** (4) None of above

Q.66 Megasporophyll is called -
(1) Gynoecium (2) Carpel
(3) Ovary (4) Stigma

Q.67 How many pollen sacs are present in a mature anther
(1) 4 (2) 1
(3) 3 (4) 2

Q.68 The ovule in which single layer nucellar tissue is present is known as -
(1) Crassinucellate (2) Tenuincellate
(3) Amphinucellate (4) Circinotropous

Q.69 The structure which is formed on micropyle by elongation of inner integument known as -
(1) Sarcotesta (2) Operculum
(3) Caruncle (4) Aril

Q.70 In which family, endothelium is formed by integuments -
(1) Malvaceae (2) Compositae
(3) Podostemaceae (4) Crucifereae

Q.71 When outer integument becomes fleshy then known as -
(1) Aril (2) Sarcotesta
(3) Operculum (4) Caruncel

Q.72 By which structure, funiculum is attached with ovule -
(1) Funiculum (2) Raphe
(3) Hilum (4) Placenta

Q.73 Resupinate type of ovule are-
(1) Straight (2) Inverted
(3) Transverse (4) Coiled

Q.74 The barrier which is present towards the micropyle is known as -
(1) Epistase (2) Hypostase
(3) Both of the above (4) None of above

Q.75 Horizontally oriented ovule in Angiosperm is called -
(1) Amphitropous (2) Hemitropous
(3) Campylotropous (4) Circinotropous

Q.76 The structure is formed by integument which helps in germination is called -
(1) Aril (2) Sarcotesta
(3) Caruncle (4) Operculum

Q.77 In anatropous ovule, the micropyle is present -
(1) In straight line with funiculum
(2) At right angles with funiculum
(3) At 45° with funiculum
(4) Side by side with funiculum

Q.78 In ovule a barrier is present towards the chalaza out side the embryo sac is called -
(1) Nuclellar beak (2) Epistase
(3) Hypostase (4) Perisperm

Q.79 Which structure of the ovule remains unchanged in the end -
(1) Embryosac (2) Integuments
(3) Funiculum (4) Micropyle

Q.80 The special features of the endothecium of anther of **Capsella** -
(1) Radially elongated
(2) Thickening of cellulose
(3) Hygroscopic (4) All of the above

Q.81 The type of cells under going meiosis in the flowers are -
(1) Microspore mother cell & megaspore mother cell
(2) Ovule & stamen
(3) Tapetal cells
(4) Placental cell

Q.82 Which of the following types of embryo sac is mostly found in Angiosperm-
(1) Bisporic polygonum type
(2) Tetra sporic type
(3) Monospric –onagrad type
(4) Monosporic-polygonum type

Q.83 In many plants, the sexual reproduction replaced by asexual reproduction it is called -
(1) Semigamy (2) Apospory
(3) Apomixis (4) Amphimixis

Q.84 "Endostome" and "Exostome" are part of -
(1) Nucellus (2) Chalaza
(3) Pollen wall (4) Micropyle

Q.85 Pseudo embryo sac is derived from -
(1) Nucellus (2) Integument
(3) Placenta (4) Funiculus

Q.86 Endothelium is derived from -
(1) Integument (2) Placenta
(3) Nucellus (4) Funiculus

Q.87 Which type embryo sac is found in **Plumbago** plant -
(1) Monosporic (2) Bisporic
(3) Tetrasporic (4) None of above

Q.88 Age of the angiosperms known as -
(1) Mesozoic Era (2) Holozoic Era
(3) Coenozoic Era (4) Archaeozoic Era

Q.89 Female gametophyte like pollens are found in -
(1) **Sorgham** (2) **Hyacinthus**
(3) **Vinca** (4) None of these

Q.90 Which type of growth is found in pollen tube -
(1) Leteral growth (2) Apical growth
(3) Middle growth (4) No growth

Q.91 Monosporic eight nucleated embryo sac reffered as -
(1) Peperomia type (2) Allium type
(3) Polygonum type (4) Oenothera type

Q.92 When funiculum, chalaza, and micropyle lie in one straight line then ovule is called -
(1) Amphitropous (2) Orthotropous
(3) Campylotropous (4) Anatropous

Q.93 Chasmogamy refers to the condition where -
(1) Flower remains closed
(2) Flowers absent
(3) Flowers open
(4) Flowers gamopetalous

Q.94 When pollen grains of flower are transferred to stigma of another flower on a different plant, the process is called -
(1) Geitonogamy (2) Xenogamy
(3) Autogamy (4) Homogamy

Q.95 When anther and stigma mature at the same time is called as -
(1) Dichogamy (2) Allogamy
(3) Xenogamy (4) Homogamy

Q.96 Self-pollination means -
(1) Transfer of pollen from anthers to stigma in the same flowers
(2) Transfer of pollen from one flowers to another flower on the different plant
(3) Occurence of male and female sex organ in the same flowers
(4) Germination of pollen

Q.97 "Lever mechanism" or "turn pipe mechanism" for pollination is characterstic feature of -
(1) Antirrhinum (2) Ocimum
(3) Salvia (4) Ficus

Q.98 Maize is best example of -
(1) Anemophilous (2) Ornithophilous
(3) Entomophilous (4) Hydrophilous

Q.99 Translator apparatus is found in -
(1) Mustard (2) Pea
(3) Calotropis (4) Mango

Q.100 Which type of pollination occurs in **Capsella** -
(1) Stigmatic (2) Micropylar
(3) Nucellar (4) None

Q.101 Insect pollinated flowers usually posssess-
(1) Brightly coloured pollens in large quantity
(2) Dry pollens with smooth suface
(3) Sticky pollen and rough surface stigma
(4) Light coloured scented pollen covered with nectar

Q.102 A close relation between a flower and a pollinating agent is best exemplified by -
(1) Cocos (2) Salvia
(3) Yucca (4) Avena

Q.103 Polysiphonous pollen grains occurs in -
(1) Malvaceae (2) Cucurbitaceae
(3) Both (4) None of these

Q.104 Pollen tube was discovered by -
(1) Strasburger (2) Hofmeister
(3) Amici (4) Winkler

Q.105 Which of the following promote pollen germination and tube growth -
(1) Sucrose (2) Boron
(3) Calcium (4) Potassium

ANSWER KEY

Exercise – 2

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	1	1	2	1	2	3	4	3	3	3	4	3	3	4	2	4	1	3	4	3
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	2	3	4	2	3	3	4	4	2	1	4	3	3	4	3	1	4	1	4	3
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	3	3	4	2	2	2	4	1	4	2	2	1	3	3	3	2	4	3	1	2
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	1	2	3	3	3	2	4	2	2	2	2	3	2	1	2	3	4	3	4	4
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	1	4	3	4	1	1	3	3	2	2	3	2	3	2	4	1	3	1	3	1
Ques.	**101**	**102**	**103**	**104**	**105**															
Ans.	3	3	3	3	2															

EXERCISE-3 PREVIOUS YEAR'S QUESTIONS

Q.1 Orthotropus ovule belongs to – **[Uttarachal PMT 2004]**

(1) Capsella (2) Polygonum

(3) Ranuculus (4) All of these

Q.2 In a flowering plant, megaspore develops into an embryo sac, which contains - **[Uttarachal PMT 2004]**

(1) 4 cell, one of which is an egg cell

(2) 6 cells, one of which is an egg cell

(3) 8 cells, one of which is an egg cell

(4) 7 cells, one of which is an egg cell

Q.3 The adaptation of pollination found in **Calotropis** is- **[Uttarachal PMT 2004]**

(1) Dicliny (2) Pollinia

(3) Heterostyly (4) Dichogamy

Q.4 Apogamy is - **[Uttarachal PMT 2004]**

(1) Reproduction of virus

(2) Failure of fusion of gametes

(3) Development of bacteria

(4) All of the above

Q.5 When vegetative cells of sporophyte form an embryo it is called - **[Uttarachal PMT 2004]**

(1) Apospory

(2) Apogamy

(3) Apomixis

(4) Adventive embryony

Q.6 When seed germinates, while the fruit is attached to parent plant, it is called – **[Uttarachal PMT 2005, C.G. 2006]**

(1) Apomixis (2) Vivipary

(3) Parthenocarpy (4) Parthenogenesis

Q.7 Pollinia are present in family - **[Uttarachal PMT 2005]**

(1) Brassicaceae (2) Cucurbitaceae

(3) Asclepiadaceae (4) Malvaceae

Q.8 Nuclear endosperm is present in - **[Uttarachal PMT 2005]**

(1) Banana (2) Coconut

(3) Phoenix (4) Mango

Q.9 Development of embryo from a cell of embryo sac other than egg is an example of – **[Uttarachal PMT 2006]**

(1) Apospory

(2) Apogamy

(3) Adventive embryony

(4) Parthenogenesis

Q.10 Seed coat is derived from - **[Jharkhand 2003]**

(1) Pericarp

(2) Epicarp

(3) Integuments of ovule

(4) Nucellus

Q.11 What is pollen grain - **[Jharkhand 2003]**

(1) Microspore mother cell

(2) Male gamete

(3) Male gametophyte

(4) Partially developed embryo

Q.12 Entry of pollen tube through micropyle is – **[Jharkhand 2004]**

(1) Porogamy (2) Mesogamy

(3) Psemigamy (4) Chalazogamy

Q.13 Micropyle halps in - **[Jharkhand 2003]**

(1) Germination of pollen grain

(2) Growth of pollen tube

(3) Coming out of pollen tube from pollen grain

(4) Allowing entry of pollen tube

Q.14 Ovule with helium lying close to micropyle is known as - **[Jharkhand 2005]**

(1) Anatropous (2) Circinotropous

(3) Atropous (4) All of the above

Q.15 Syngamy is the process in which – **[Jharkhand 2005]**

(1) Male gamete fuses with female gemete

(2) Pollen tube enters into the ovule through chalaza

(3) Pollen tube enter into the ovule through micropyle

(4) Generative cell and tube cell fuse

Q.16 In embryo sac, n 2n, 3n conditions are found respectively in - **[Jharkhand 2006]**

(1) Egg, antipodal, endosperm

(2) Nucellus, endosperm, egg

(3) Antipodal, zygote endosperm

(4) Endosperm, nucellus, egg

Q.17 In angiosperms, endosperm is formed by – **[UP CPMT 2001]**

(1) Division of fused polar nuceli

(2) Free nuclear division of megaspore

(3) Division of fused synergids and male gamete

(4) Division of fused polar nuclei and male gamete

Q.18 Endosperm of angiospermic plant is – **[UP CPMT 2002]**

(1) Triploid (2) Diploid

(3) Haploid (4) Tetraploid

Q.19 Rarely among angiosperms the pollen grains influences the endosperm. This is called as – **[UP CPMT 2004]**

(1) Metaxenia

(2) Nemec phenomenon

(3) Xenia

(4) Mesogamy

Q.20 Pollination in which pollen grains of one flower are transferred to the stigma of another flower of the same plant is called – **[UP CPMT 2005]**

(1) Xenogamy (2) Autogamy

(3) Geitonogamy (4) Allogamy

Q.21 Aleurone layer is part of - **[UP CPMT 2005]**

(1) Endosperm (2) Embryo

(3) Tegmen (4) Tests

Q.22 Function of embryonal suspensor in angiosperms is to - **[UP CPMT 2005]**

(1) Serve as channel for H_2O

(2) Push embryo deeper into endosperm

(3) Release growth hormones

(4) Transfer nutrients from parent sporophyte to young embryo

Q.23 Microsporophyll contains - **[UP CPMT 2006]**

(1) Pollen tube (2) Pollen grain

(3) Nucellus (4) All of these

Q.24 Mesogamy is - **[UP CPMT 2007]**

(1) Fusion of male and female gametes

(2) Fusion of physiologivally similar and different gametes

(3) Entry of pollen tube through integuments

(4) None of the above

Q.25 Nucellus forms which of the following part of fruit - **[UP CPMT 2007]**

(1) Seed coat (2) Perisperm

(3) Seed (4) Raphe

Q.26 If root of a flowering plant has 24 chromosomes. then its gamete has how many chromosomes – **[UP CPMT 2007]**

(1) 24 (2) 12

(3) 4 (4) 8

Q.27 Raphe is - **[UP CPMT 2007]**

(1) Part of flower

(2) Funicle attached to ovule

(3) Ridge fromed by funiculus

(4) Part of nucellus

Q.28 Caruncle is formed by - **[CG CPMT 2004]**

(1) Peduncle (2) Cotyledons

(3) Integument (4) None of the above

Q.29 Perisperm is - **[CG CPMT 2004]**

(1) Outer part of endosperm

(2) Destroyed synergids

(3) Destroyed secondary nucleus

(4) Remains of nucellus

Q.30 In Pea, the ovule is - **[CG CPMT 2004]**

(1) Hemianatropous (2) Amphitropous

(3) Anatropous (4) Campylotropous

Q.31 A bisexual flower which never opens in life is known as - **[CG CPMT 2005]**

(1) Homogamous (2) Heterogamous

(3) Anatropous (4) Cleistogamous

Q.32 If testa is removed from water soaked gram seed the reaming structure is – **[CG CPMT 2005]**

(1) Full mature embryo with cotyledons

(2) Cotyledons with endosperm and pericarp

(3) Cotyledons filled with starch

(4) None of the above

Q.33 Double fertilization means fusion of - **[CG CPMT 2005]**

(1) One of the polar nuclei fused with the synergids and one male gamete with egg cell

(2) Fusion of one of the male gemetes with polar nuclei and other with antipodal cells

(3) Fusion of one of the male gametes with secondary nucleus and the other male gamete with egg cell

(4) Fusion of one antipodal cell with egg cell and synergid cell with other antipodal cell

Q.34 Doubel fertilization was first discovered by Nawaschin in - **[CG CPMT 2005]**

(1) Lilium and Feritillaria

(2) Mango and Sugarcane

(3) Papaya and Pea

(4) Brassica and candytuft

Q.35 Embryo sac of an Angiospermic plant is – **[Bihar 2001]**

(1) Male gametophyte

(2) Female gametophyte

(3) Male sporophyte

(4) Either female sporophyte

Q.36 Pollination by wind is called - **[Bihar 2004]**

(1) Anemophily (2) Hydrophily

(3) Zoophily (4) Entomophily

Q.37 Development of embryo from egg without fertilization is called - **[Bihar 2004]**

(1) Parthenogenesis (2) Pathenocarpy

(3) Apospory (4) Apomixis

Q.38 Pollen tube enters into ovule through micropyle is called - **[Bihar 2004]**

(1) Porogamy (2) Chalazogamy

(3) Mesogamy (4) None of these

Q.39 Which of the following is not true for double fertilization - **[Bihar 2005]**

(1) Discovered by Newaschin

(2) Male gamete and secondary nucleus fused to form endosperm nucelus

(3) Endosperm nucleus is diploid

(4) Endosperm provides nutrition to embryo

Q.40 In the anther wall- **[Bihar 2006]**

(1) Tapeum lies between endothecium and middle layers

(2) Tapetum lied just inner to endothecium

(3) Middle layer lies between endothecium and tapetum

(4) Endothecium lies just inner to middle layer

Q.41 Aleurone grains are rich in - **[Bihar 2006]**

(1) Fat (2) Protein

(3) Carbohydrates (4) Auxins

Q.42 Meiosis can be observed in - **[Bihar 2006]**

(1) Tapetal cells (2) Megaspores

(3) Micropores (4) Spore mother cells

Q.43 Mark the correct sequence - **[Bihar 2006]**

(1) Anthesis→Meiosis→Pollination→ Syngamy

(2) Pollination→Meiosis→anthesis→Syngamy

(3) Anthesis→Pollination→Meiosis→Syngamy

(4) Meiosis→Anthesis→Pollination→Syngamy

Q.44 Through which route the pollen tube enters the ovule - **[MP PMT 2001]**

(1) Chalaza (2) Micropyle

(3) Funiculus (4) Any of these

Q.45 The point of attachment of ovule to the funicle is known as - **[MP PMT 2001]**

(1) Raphe (2) Chalaza

(3) Micropyle (4) Hilum

Q.46 In Angiosperms the endosperm is – **[MP PMT 2001]**

(1) Diploid (2) Triploid

(3) Haploid (4) Polyploid

Q.47 The endosperm in angiosperms developd from-

(1) Micropylar polar nucleus **[MP PMT 2002]**

(2) Chalazal polar nucleus

(3) Secondary nucleus

(4) Zygote

Q.48 The formation of embryo without fusion of gametes is termed as - **[MP PMT 2003]**

(1) Apospory (2) Isogamy

(3) Apogamy (4) Syngamy

Q.49 In angiosperms embryo sac is developed from -

(1) Megaspore **[MP PMT 2003]**

(2) Secondary nucleus

(3) Endothecium

(4) Microspore mother cell

Q.50 Doubel fertilization was discovered by – **[MP PMT 2003]**

(1) S.G. Nawaschin (2) Strasburger

(3) Robert Brown (4) Purkinje

Q.51 The part of Gynoecium which recives the pollen is called - **[MP PMT 2004]**

(1) Stigma (2) Style

(3) Ovule (4) Ovary

Q.52 Bisexual flowers which never open, demonstrated by - **[MP PMT 2004]**

(1) Autogamy (2) Allogamy

(3) Cleistogamy (4) None of these

Q.53 Double fertilization is characteristic only in – **[MP PMT 2004]**

(1) Bryophytes (2) Angiosperms

(3) Cleistogamy (4) Pteridophytes

Q.54 When pollen tube enters by integument then the process is known as - **[MP PMT 2004]**

(1) Mesogamy (2) Porogamy

(3) Chalazogamy (4) Pseudogamy

Q.55 In which of the following plant group, seeded plants are placed - **[MP PMT 2005]**

(1) Algae (2) Bryophyta

(3) Angiosperms (4) Fungi

Q.56 The main function of tepetum is- **[MP PMT 2005]**

(1) Division (2) Support

(3) Nutrition (4) None

Q.57 The endosperm in angiosperms is - **[MP PMT 2006]**

(1) Triploid (2) Haploid

(3) Diploid (4) Polyploid

Q.58 Polygonum type of embryo sac is - **[MP PMT 2006]**

(1) 7-celled, 8-nucleate

(2) 8-celled, 7-nucleate

(3) 9-nucleate

(4) 16-nucleate

Q.59 The plant which raised from pollen grain is called– **[MP PMT 2006]**

(1) Haploid plant (2) Diploid plant

(3) Polyploid plant (4) Heterosis

Q.60 Male gamete in Angiosperm is produced by- **[MP PMT 2007]**

(1) Generative cell (2) Microspore cell

(3) Vegetative cell (4) Tube cell

Q.61 Plants which flower only once in their life are termed as - **[CGPMT 2009]**

(1) Monochalmydous (2) Monocious

(3) Monocarpic (4) Monosomic

Q.62 The male gametophyte in Angiosperm is reduced to - **[CGPMT 2009]**

(1) One cell (2) Two cell

(3) Three cell (4) Four cell

Q.63 Pollen embryo sacs are - **[CGPMT 2009]**

(1) Pollen like embryo sacs

(2) Pollen developed in embryo sacs

(3) Embryo sacs developed from pollen

(4) Fused pollen and embryo sac

Q.64 The part of Castor seed that yields oil is – **[CGPMT 2009]**

(1) Cotyledon (2) Caruncle

(3) Endosperm (4) Nucellus

Q.65 A hyaline bisexual and self fertilized flower that does - **[CGPMT 2009]**

(1) Chasmogamas (2) Apogamous

(3) Cleistogamous (4) Polygamous

Q.66 Which one of the following is a pseuedocarp – **[CGPMT 2009]**

(1) Apple (2) Guava

(3) Tomato (4) Banana

Q.67 In Gymnosperms the seeds are naked because they lack - **[CGPMT 2009]**

(1) Integument (2) Nucellus

(3) Pericarp (4) Perianth

Q.68 Sprouting of Potato under storage condition is due to - **[CGPMT 2009]**

(1) Auxin (2) Glibberellin

(3) Ethylene (4) Cytokinin

Q.69 For good growth of pollen tube necessary element is - **[CGPMT 2009]**

(1) Ca (2) B

(3) mg (4) Mo

Q.70 Embryo of Sunflower has - **[AIPMT 1998]**
(1) Two cotyledons (2) One cotyledons
(3) Eight cotyledons (4) Cotyledon absent

Q.71 Ornithophily takes place in - **[AIPMT 1999]**
(1) Yellow flower having nectaries
(2) Scented flower
(3) Flower with charming colour
(4) Modified corolla

Q.72 The plant having largest flower is- **[AIPMT 1999]**
(1) Total stem parasite (2) Epiphyte
(3) Total root parasite
(4) Partial stem parasite

Q.73 Eight nucleated embryo sac is -**[AIPMT 2000]**
(1) Only monosporic (2) Only bisporic
(3) Only tetrasporic (4) Any of the above

Q.74 Endosperm is formed during the double fertilization by - **[AIPMT 2000]**
(1) Two polar nuclei & one male gamete
(2) One polar nuclei & One male gamete
(3) Ovum and male gamete
(4) Two polar nuclei & two male gametes

Q.75 By which action a seed coat becomes permeable to water - **[AIPMT 2000]**
(1) Scarification (2) Stratification
(3) Vernalization (4) All of the above

Q.76 Anemophily type of pollination is found in – **[AIPMT 2001]**
(1) **Salvia** (2) Bottle brush
(3) **Vallisneria** (4) Coconut

Q.77 What is the eyes of potato - **[AIPMT 2001]**
(1) Auxillary bud (2) Accessary bud
(3) Adventitious root (4) Apical bud

Q.78 Which one breaks the dormancy of Potato tuber – **[AIPMT 2001]**
(1) Gibberellin (2) IAA
(3) ABA (4) Zeatin

Q.79 In grass what happens in microspore mother cell for the formation of mature pollen grains – **[AIPMT 2001]**
(1) One meiotic and two mitotic divisions
(2) One meiotic and one mitotic division
(3) One meiotic division
(4) One mitotic division

Q.80 Adventive embryony in **Citrus** is due to – **[AIPMT 2001]**
(1) Nucellus (2) Integuments
(3) Zygotic embryo (4) Fertilized egg

Q.81 In Angiosperms pollen tube liberate their male gametes into the - **[AIPMT 2002]**
(1) Central cell (2) Antipodal cells
(3) Egg cell (4) Synergids

Q.82 What is the direction of micropyle in anatropous ovule - **[AIPMT 2002]**
(1) Upward (2) Downward
(3) Right (4) Left

Q.83 Which type of association is found in between entomophilous flower and pollinating agent – **[AIPMT 2002]**
(1) Mutualism (2) Commonsalism
(3) Co-operation (4) Co-evolution

Q.84 In Angioperms all the four microspores of tetrad are covered by layer which is formed by– **[AIPMT 2002]**
(1) Pectocellulose (2) Callose
(3) Cellulose (4) Sporopollenin

Q.85 Seed dormancy is due to the presence of – **[AIPMT 2002]**
(1) Ethylene (2) Abscisic acid
(3) I.A.A (4) Starch

Q.86 In a flowering plant, archesporium gives rise to– **[AIPMT 2003]**
(1) Only the wall of the sporangium
(2) Both wall and the sporogenous cells
(3) Wall and the tapetum
(4) Only tapetum and sporogenous cells

Q.87 The aleurone layer in Maize grain is specially rich in - **[AIPMT 2003]**
(1) Proteins (2) Starch
(3) Lipids (4) Auxins

Q.88 Anthesis is a phenomenon which refer to **[AIPMT 2004]**
(1) Formation of pollen
(2) Development of anther
(3) Opening of flower bud
(4) Reception of pollen by stigma

Q.89 An ovule which becomes curved so the nucellus and embryo sac lie at right angles to the funicle is - **[AIPMT 2004]**
(1) Campylotropous (2) Anatropous
(3) Orthotropous (4) Hemitropous

Q.90 When a diploid female plant is crossed with a tetraploid male, the ploidy of endosperm cells in the resulting seed is - **[AIPMT 2004]**
(1) Pentaploidy (2) Diploidy
(3) Triploidy (4) Tetraploidy

Q.91 Monothecous anther is found in which family – **[RPMT 2000]**
(1) Malvaceae (2) Liliaceae
(3) Brassicaceae (4) Asteraceae

Q.92 Onagrad type of embryo development is found in - **[RPMT 2000]**
(1) **Solanum** (2) **Capsella**
(3) **Lilium** (4) **Hibiscus**

Q.93 In **Capsella** which type of embryosac is found– **[RPMT 2000]**
(1) Bisporic (2) Monosporic
(3) Tetrasporic (4) Trisporic

Q.94 All the cells in Polygonum type of embryo sac are - **[RPMT 2000]**
(1) Haploid
(2) Diploid
(3) Haploid and diploid
(4) Haploid and polyploid

Q.95 In which family pollinia are found - **[RPMT 2000]**
(1) Papilionaceae (2) Asteraceae
(3) Asclepiadaceae (4) Apocyanaceae

Q.96 When the pollens of one flower falls on the stigma of another flower of the same plant then it is known as - **[RPMT 2001]**
(1) Cieistogamy (2) Allogamy
(3) Autogamy (4) Dichogamy

Q.97 What is the liquid part of green Coconut – **[RPMT 2001]**
(1) Endosperm
(2) Female gametophyte
(3) Nucellus (4) Embryo

Q.98 Parthenogensis occurs when - **[RPMT 2001]**
(1) When embryo is formed without the fusion of egg and the sperm
(2) When embryo is formed by the fusion of egg and sperm
(3) When embryo is formed from another cell
(4) When sperm produces the embryo directly

Q.99 Nucellus is found in - **[RPMT 2001]**
(1) Cell (2) Pollen
(3) Ovule (4) Leaf

Q.100 The nutritive layer of microsporangia of **Capsella** - **[RPMT 2002]**
(1) Endothecium (2) Exothecium
(3) Sporogenous tissue (4) Tapetum

Q.101 That haploid cell divides by mitosis to form embryo sac - **[RPMT 2002]**
(1) Megaspore mother cell
(2) Microspore mother cell
(3) Functional megaspore
(4) Non functional megaspore

Q.102 Seed coat is derived from - **[RPMT 2002]**
(1) Pericarp
(2) Epicarp
(3) Integuments of ovule
(4) Nucellus

Q.103 What is pollen grain - **[RPMT 2002]**
(1) Microspore mother cell
(2) Male gamete
(3) Male gametophyte
(4) Partially developed embryo

Q.104 Anther culure yields some haploid and diploid plants. Diploid plants are produced from – **[RPMT 2003]**
(1) Zygote
(2) Seed coat
(3) Anther wall
(4) Wall of pollen grains

Q.105 Endosperm nucleus is formed by the fusion of– **[RPMT 2003]**
(1) 2 nuclei (2) 3 nuclei
(3) 4 nuclei (4) 5 nuclei

Q.106 Embryo sac is represented by - **[RPMT 2003]**
(1) Megagametophyte (2) Megasporophyll
(3) Megagametes (4) Megaspore

Q.107 Double fertilization is essential for formation of– **[RPMT 2004]**
(1) Cotyledons (2) Seed coat
(3) Endosperm (4) Nucellus

Q.108 Entry of pollen tube through micropyle is called- **[RPMT 2004]**
(1) Porogamy (2) Syngamy
(3) Chalazogamy (4) Mesogamy

Q.109 Pollen grains are able to withstand extremes of temperature and dessication because their exine is composed of - **[AIIMS 2003]**
(1) Cutin (2) Suberin
(3) Sporopollenin (4) Callose

Q.110 The pollen tube usually enters the embryo sac– **[AIIMS 2004]**
(1) Through one of the synergids
(2) By directly penetrating the egg
(3) Between one synergid and central cell
(4) By knocking off the antipodal cells

Q.111 In which one pair both the plants can be vegetatively propagated by leaf pieces – **[AIIMS 2005]**
(1) **Bryophyllum** and **Kalanchoe**
(2) **Chrysanthemum** and **Agave**
(3) **Agave** and **Kalanchoe**
(4) **Asparagus** and **Bryophyllum**

Q.112 In a type of apomixis known as adventive embryony, embryos develop directly from the **[AIPMT 2005]**
(1) nucellus or integuments
(2) Synergids or antipodals in an embryo sac
(3) accessory embryo sac in the ovule
(4) zygote

Q.113 Through which cell of the embryo sac, does the pollen tube enter the embryo sac – **[AIPMT 2005]**
(1) Egg cell (2) Central cell
(3) Persistant synergid
(4) Degenerated synergid

Q.114 Which one of the following represents an ovule, where the embryo sac becomes horse-shoe shaped and the funiculus and micropyle are close to each other - **[AIPMT 2005]**
(1) Circinotropous (2) Anatropous
(3) Amphitropous (4) Atropous

Q.115 What would be the number of chromosomes in the cells of the aleurone layer in a plant species with 8 chromosomes in its synergids ? **[AIPMT 2006]**
(1) 16 (2) 24
(3) 32 (4) 8

Q.116 Treatment of seed at low temperature under moist conditions to break its dormancy is called– **[AIPMT 2006]**
(1) Scarification (2) Vernalization
(3) Chelation (4) Stratification

Q.117 The arrangement of the nuclei in a normal embryo sac in the dicot plants is - **[AIPMT 2006]**
(1) 2 + 4 + 2 (2) 3 + 2 + 3
(3) 2 + 3 + 3 (4) 3 + 3 + 2

Q.118 In a Cereal grain the single cotylendon of embryo is represented by - **[AIPMT 2006]**
(1) Coleorrhize (2) Scutellum
(3) Prophyll (4) Coleoptile

Q.119 Long filamentous threads protruding at the end of a young cob of maize are - **[AIPMT 2006]**
(1) Hairs (2) Anthers
(3) Styles (4) Ovaries

Q.120 In which of the following fruit is the edible part the aril ? **[AIPMT 2006]**
(1) Litchi
(2) Custard apple
(3) Pomegranate
(4) Orange

Q.121 Embryo sac represents - **[RPMT 2006]**
(1) Macrogamete
(2) Macrospore
(3) Macrosprophyll
(4) Macrogametophyte

Q.122 Double fertilization involves - **[AIIMS 2005]**

(1) Fertilization of the egg by two male gametes

(2) Fertilization of two eggs in the same embryosac by two sperms brought by one pollen tube

(3) Fertilization of the egg and the central cell by two sperms brought by different pollen tubes

(4) Fertilization of the egg and the central cell by two sperms brought by the same pollen tube

Q.123 A scion is grafted to a stock. The quality of fruits produced will be determined by the genotype of - **[AIIMS 2006]**

(1) Stock

(2) Scion

(3) Both stock and scion

(4) Neither stock not scion

Q.124 Male gametes in angiosperms are formed by the division of - **[AIPMT 2007]**

(1) Microspore mother cell

(2) Microspore

(3) Generative cell

(4) Vegetative cell

Q.125 Which one of the following is surrounded by a callose wall ? **[AIPMT 2007]**

(1) Pollen grain

(2) Microspore mother cell

(3) Male gamete

(4) Egg

Q.126 Unisexuality of flowers prevents – **[AIPMT 2008]**

(1) Geitonogamy, but not xenogamy

(2) Autogamy and geitonogamy

(3) Autogamy, but not getionogamy

(4) Both geitonogamy and xenogamy

Q.127 Endosperm is consumed by developing embryo in the seed of - **[AIPMT 2008]**

(1) Pea (2) Maize

(3) Coconut (4) Castor

Q.128 Which one of the following is resistant to enzyme action ? **[AIPMT 2008]**

(1) Pollen exine (2) Leaf cuticle

(3) Cork (4) Wood fibre

Q.129 What does the filiform apparatus do at the entrance into ovule ? **[AIPMT 2008]**

(1) It brings about opening of the pollen tube

(2) It guides pollen tube from a synergid to egg

(3) It helps in the entry of pollen tube into a synergid

(4) It prevents entry of more than one pollen tube into the embryo sac

Q.130 Which one of the following pairs of plant structures has haploid number of chromosomes? **[AIPMT 2008]**

(1) Nucellus and antipodal cells

(2) Egg nucleus and secondary nucleus

(3) Megaspore mother cell and antipodal cells

(4) Egg cell and antipodal cells

Q.131 An example of a seed with endosperm, perisperm and caruncle is - **[AIPMT 2009]**

(1) Castor (2) Cotton

(3) Coffee (4) Lily

Q.132 What does Angiosperm mean - **[RPMT 2007]**

(1) Naked seed (2) Covered seed

(3) Leaf fall (4) Seed bub

Q.133 How many times flowering takes place in biennial plants - **[RPMT 2007]**

(1) Once (2) Twice

(3) Many (4) None

Q.134 Endosperm of Angiosperm is - **[RPMT 2007]**

(1) 2n (2) 3n

(3) n (4) 2n + 1

Q.135 Apomictic embryos in citrus arise from : **[Pre AIPMT 2010]**

(1) Synergids

(2) Maternal sporophytic tissue in ovule

(3) Antipodal cells

(4) Diploid egg

Q.136 Keel is characteristic of the flowers of:

[Pre AIPMT 2010]

(1) Gulmohur (2) Cassia

(3) Calotropis (4) Bean

Q.137 Transfer of pollen grains from the anther to the stigma of another flower of the same plant is called : **[Pre AIPMT 2010]**

(1) Xenogamy (2) Geitonogamy

(3) Karyogamy (4) Autogamy

Q.138 Even in absence of pollinating agents seed-setting is assured in : **[AIPMT Pre 2012]**

(1) Zostera (2) Salvia

(3) Fig (4) Commellina

Q.139 An organic substance that can withstand environmental extremes and cannot be degraded by any enzyme is :

[AIPMT Pre 2012]

(1) Sporopollenin (2) Lignin

(3) Cellulose (4) Cuticle

Q.140 Which part would be most suitable for raising virus-free plants for micropropagation?

[AIPMT Pre 2012]

(1) Vascular tissue (2) Meristem

(3) Node (4) Bark

Q.141 Both, autogamy and geitonogamy are prevented in : **[AIPMT Pre 2012]**

(1) Cucumber (2) Castor

(3) Maize (4) Papaya

Answer Key

Exercise – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	2	2	4	2	3	2	2	3	3	1	4	1	1	3	4	1	3	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	2	2	3	2	2	3	3	4	3	4	1	3	1	2	1	1	1	3	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	4	1	4	4	2	3	3	1	1	1	3	2	1	3	3	1	1	1	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	3	3	3	3	1	3	2	2	1	1	3	4	1	1	4	1	1	2	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	2	1	2	2	2	1	3	4	4	1	2	2	1	3	3	1	1	3	4
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	3	3	3	2	1	3	1	3	1	1	1	4	3	2	4	2	2	3	1
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	4	4	2	3	2	3	1	1	3	4	1	2	1	2	2	4	2	4	1	2
Ques.	141																			
Ans.	4																			

These questions consist of two statements each, printed as Assertion and Reason. While answering these Questions are required to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **Assertion :-** Some of the Angiospermic plants are propagated only by vegetative propagation.
Reason:- They have lost the capacity of seed formation.

Q.2 **Assertion :-** Clone is formed by amphimixis.
Reason:- In amphimixis, new plants are formed without fertilization and meiosis.

Q.3 **Assertion :-** In apomixis, plants are formed in new genetic sequence.
Reason:- In apomixis two of genetical similar type of organisms fuse together.

Q.4 **Assertion :-** Diplospory is also known as diploid parthenogenesis.
Reason:- In this, embryo is formed from the diploid egg cell without fertilization.

Q.5 **Assertion :-** The plants in which amoeboid type of tapetum is found, middle layer of anther immediately degenerates.
Reason:- Entire food of middle layer is absorbed by tapetum.

Q.6 **Assertion :-** Grafting is possible only in dicot plants.
Reason:- In these plants vascular cambium is absent.

Q.7 **Assertion :-** When formation of embryo takes place inside the ovule nucellus or integuments then it is called ‘‘adventive embryony’’
Reason:- In adventive embryo, formation of embryo occurs at place other than the mother place.

Q.8 **Assertion :-** seedless fruits are formed in parthenocarpy.
Reason:- In this process fruits are formed without fertilization.

Q.9 **Assertion :-** In **Pinus,** symbiosis furnished by mycorrhiza.
Reason:- In mycorrhiza, symbiosis is established between fungus and root of pinus

Q.10 **Assertion :-** The plants in which glandular tapetum is found, formation of exine of pollen grains takes place in these plants.
Reason:- Ubisch bodies formed only in glandular tapetum which participate in the formation of exine.

Q.11 **Assertion :-** Occurence of two male gametes is the constant feature of male gametophyte of angiosperms.
Reason:- Only in-vitro development takes place of male gametophyte of angiosperms.

Q.12 **Assertion :-** Shape of **Pinus** plant is conical.
Reason:- The conical shape of **Pinus** is due to excurrent growth.

Q.13 **Assertion :-** In circinotropous ovule, the entire body of ovule is covered by funiculum
Reason:- Due to growth of funiculum the body of ovule turns on the funiculum at angle of 360°.

Q.14 **Assertion :-** In **Legume** plants, naturally self pollination takes place.
Reason:- Both the types of reproductive organs are present inside the keel and it always remains closed.

Q.15 **Assertion :-** Xenia is the effect of pollen grains on the structure of endosperm.
Reason:- Xenia effect is produced in the seed of Maize due to heterofertilization.

Q.16 **Assertion :-** Night flowering plants are entomophillous.
Reason:- Flowers of these plants are odour less.

Q.17 **Assertion :-** Pollination in **Ophrys** plant take place by pseudo copulation
Reason:- Mimicry is found in flowers of this plant

Q.18 **Assertion :-** Straight position of embryo of **Capsella** is called torpedo stage.
Reason:- Amphitropous type of ovule is found in **Capsella.**

Q.19 **Assertion :-** Symbiosis is found in between **Pronuba** moth and **Yucca** plant.
Reason:- Life cycle of both completely depended on each other.

Q.20 **Assertion :-** Pollen grains are preserved for a long time in fossil form.
Reason:- Sporopollenin is the chief component of exine of pollen grains

Q.21 **Assertion :-** Double fertilization is the universal feature of all plants.
Reason:- In this fusion of only male gamtes and secondary nucleus take place

Q.22 **Assertion :-** Cross-pollination is usually takes place in unisexual plants.
Reason:- Cleistogamy promotes cross-pollination

Q.23 **Assertion :-** Two cotyledons in the seed are the embryonic leaves.
Reason:- Radicle and plumule are present in embryo.

Q.24 **Assertion :-** Synergids of embryo sac also help in fertilization in Angiosperms.
Reason:- Obturators of synergids attract the pollen tube.

Q.25 **Assertion :-** Middle layer of anther known as ephemeral.
Reason:- It secretes all food into the pollen sacs.

Q.26 **Assertion :-** Pollen is known as the first cell of female gametophyte.
Reason:- Pollen grains are formed by microgametogenesis.

Q.27 **Assertion :-** Sexual reproduction takes place with the participation of two different type of gametes.
Reason:- Sexual reproduction is also known as apomixis.

Q.28 **Assertion :-** Periplasmodium is formed by glandular tapetum.
Reason:- Periplasmodium participate in the formation of exine of pollen grains.

Q.29 **Assertion :-** When embryo sac develops from megaspore mother cell without meiosis it is called diplospory.
Reason:- Fruits are formed without seeds in diplospory.

Q.30 **Assertion :-** Ovules of **Santalum** plant are unitegmic.
Reason:- Santalum is a complete root parasitic plant.

Q.31 **Assertion :-** Flower of **Rafflessia** is the largest in the plant kingdom.
Reason:- Rafflessia is total root parasite.

Q.32 **Assertion :-** Nuclear type of endosperm is found in Coconut.
Reason:- Endosperm of Coconut is formed by free nuclear divisions of primary endosperm nucleus.

Q.33 **Assertion :-** In Angiosperm, endosperm is generally triploid
Reason:- In **Oenothera** plant always diploid endosperm is formed.

Q.34 **Assertion :-** After development of embryo, an ovule modifies into seed.
Reason:- Seeds are also formed during the normal sexual reproduction without fertilization.

Q.35 **Assertion :-** Cotyledons come above soil surface during the epigeal germination of seeds.
Reason:- In this type of germination, fast growth occurs in epicotyl region.

Q.36 **Assertion :-** Seeds of monocotyledon plants are called endospermic seeds.
Reason :- Generally in seeds of monocotyledons plants food is stored in cotyledons.

Q.37 **Assertion :-** Seed and fruit formation are the advanced feature of Angiosperms.
Reason:- Triple fusion is considered as universal feature of Angiosperms.

Q.38 **Assertion :-** Viability of seed is checked by TTC.
Reason:- Highest viability of seed is found in Mangroove vegetation.

Q.39 **Assertion :-** Development of mature pollen grain is endoscopic.
Reason:- Pollination in most of the flowering plants take place in three called stage.

Q.40 **Assertion :-** During the germination of pollen grains, pollen tube is formed by Vegetative cell.
Reason:- Male gametes are carried by pollen tube only in Angiosperms.

Q.41 **Assertion :-** Grafting is not possible in Monocotyledon plants.
Reason:- Vascular cambium is not found in Monocots.

Q.42 **Assertion :-** The unit of Androecium is called stamen.
Reason:- The most important part of microsporophyll is anther.

Q.43 **Assertion :-** Development of anther in Angiosperms take place by more than one archesporials.
Reason:- This type of development of anther is called leptosporangiate.

Q.44 **Assertion :-** Gemetophytic phase starts with the formation of pollen grain.
Reason:- Study of structure of pollen grains is called palynology.

Q.45 **Assertion :-** In agamospermy, genetic variations are produced in progeny.
Reason:- In this process, new progeny is formed by gametic fusion.

Q.46 **Assertion :-** Anemophily includes wastage of pollen grains.
Reason:- Anemophillus flowers are neither attractive nor fragrant.

Q.47 **Assertion :-** Life cycle of Pronuba moth depends on Yucca plant.
Reason:- It is the example of commensalisms.

Q.48 **Assertion :-** Pollen tube shows apical growth.
Reason:- Growth of pollen tube is controlled by generative nucleus.

Q.49 **Assertion :-** Polygonum type of embryo sac is the most common in Angiosperms.
Reason:- Polygonum type of embryo sac is monosporic type.

Q.50 **Assertion :-** Generally megaspore mother cell undergoes meiosis to produce four megaspores in Angiosperms.
Reason:- Megaspore is the first cell of male gametophyte.

Answer Key

Exercise – 4

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	1	4	4	1	1	3	2	1	2	1	3	1	1	1	1	3	1	4	1	1
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	4	3	2	3	3	4	3	4	3	4	2	1	2	3	3	3	2	3	4	3
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**										
Ans.	1	2	3	2	4	2	2	3	2	3										

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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(Human Reproduction & Health)

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REPRODUCTIVE SYSTEM

INTRODUCTION :

To continue its own race, an organism by the process of reproduction, produces off springs like its own. In sexual reproduction the organisms produce male and female gametes which on combining, develop into a new individual. The formation of gametes takes place in the reproductive organs.

PRIMARY SEX ORGAN :

Essential organs which form the gametes. In males, the gamete forming organs are the testes. In females, the corresponding organs are ovaries.

The male gametes is the spermatozoan.

The female gamete is the ovum.

SECONDARY SEX ORGAN :

These form the passage for the gametes to help the union of male & female gametes.

In male this include epididymis, vas deferens, seminal vesicles, prostate, bulbourethral glands & penis.

While in female - Fallopian tube, uterus & vagina. (Breast is an accessory sex organ)

DEVELOPMENT OF SEX ORGAN :

During intra uterine life (IUL) testis & ovary develop from mesoderm. They develop in abdominal cavity in IUL, at the time of birth, testes descend down into scrotal sac but ovaries remain in abdominal cavity.

MALE REPRODUCTIVE SYSTEM

- In man, one pair of testes are the main or primary reproductive organ. Size 4-5 cm × 2-3 cm
- Both testes are located in a small bag like structure situated below & out side the abdominal cavity called as scrotum or scrotal sac. The temperature of scrotum is 2 to 3°C lesser than body temperature.
- Internally scrotum is lined by dartos muscle & spermatic fascia.

  Dartos muscle helps in regulation of the temperature with in the scrotum during cold season,

  It becomes contracted in cold & during warm season, it becomes relaxed.

  Cremaster muscles line inside the wall of scrotal & inguinal canal region and help in elevation of testes.
- Each testis is attached to the walls of the scrotal-sac through flexible, elastic fibres. This group of fibres is called Gubernaculum or Mesorchium.
- Each testis is attached to the dorsal body wall of the abdominal-cavity through a cord termed as the **Spermatic cord.** This cord is made up of elastin fibres & spermatic fascia. The contents of cord are vas deferens, gonadal veins, gonadal arteries, nerves and lymphatics.

  During embryonic stage, testes develop in abdominal cavity & they descend to reach the scrotum at the time of birth. When the testes does not descend to reach the scrotum but remain in abdominal cavity at the time of birth this conditions is called **undescended testes** or **cryptorchidism.** Such testis can not develop and function properly and may develop malignancy.

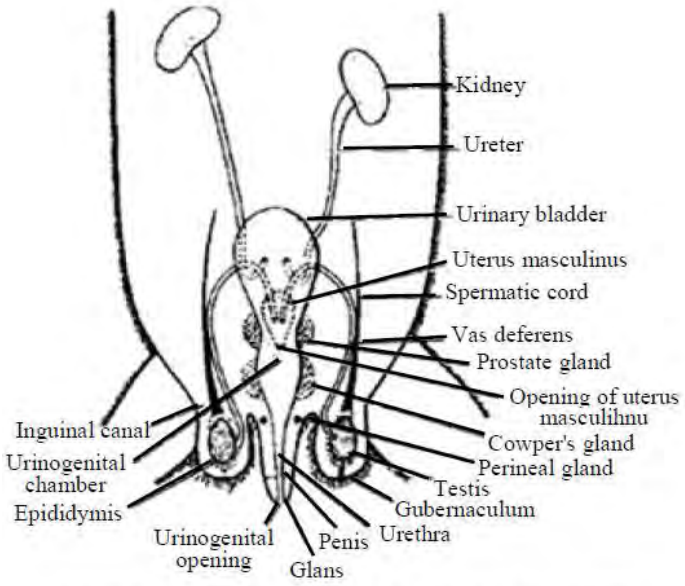
Orchiopexy : When the undescended testes are brought into scrotal sac by surgical process during childhood this process called as orchiopexy.

Castration : Crushing of testes in bulls to convert them to bullocks. (This makes them more obidient due to fall in the level of testosterone)

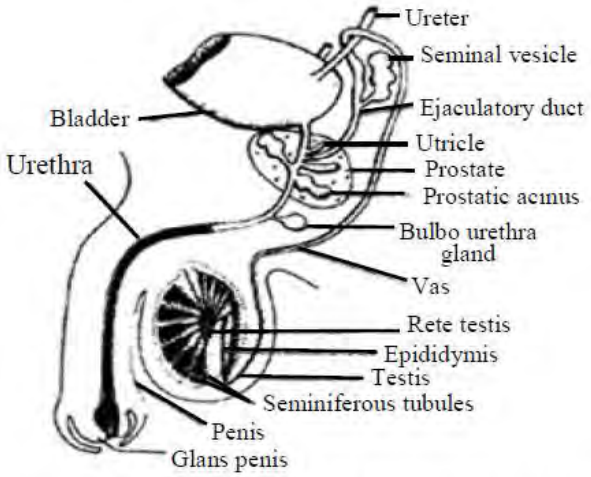
- In some animals the testes descend into the scrotum only in the breeding-season. e.g. Order Chiroptera Order Rodentia
- Testes of some animals are permanently placed in the abdominal-cavity. Their scrotum is vestigial-organ.e.g. Prototherians, animals of the order Edentata (Pangolin, Sloth)
  Order Proboscida (Elephant)
  Order Sirenia and Order Cetacea
- Each scrotum is connected to the abdominal cavity through a passage termed as inguinal-canal. Through this canal the testes descend down into the scrotal-sacs at the time of birth.

  Spermatic cord in males passes through the inguinal canal.

  Sometimes the inguinal canal may tear leading to abnormal protrusion of abdominal contents like loops of intestine into the inguinal canal. This condition is called as **inguinal hernia.**



MALE - REPRODUCTIVE ORGANS (RABBIT)



MALE REPRODUCTIVE SYSTEM (HUMAN)

Internal Structure of Testis :

Testis is covered by three coats. Outer most is tunica vaginalis. Middle coat is tunica albuginea & inner most is tunica vasculosa.

Tunica vaginalis has a parietal & visceral layer. It covers the whole testis except it's posterior border from where the testicular vessels & nerves enter the testis.

The **Tunica albuginea** is a dense, white fibrous coat covering the testis all around . The posterior border tunica albuginea is thickened to form vertical septum called the **Mediastinum testis.**
Tunica vasculosa is the inner most vascular coat of the testis lining testicular lobules.

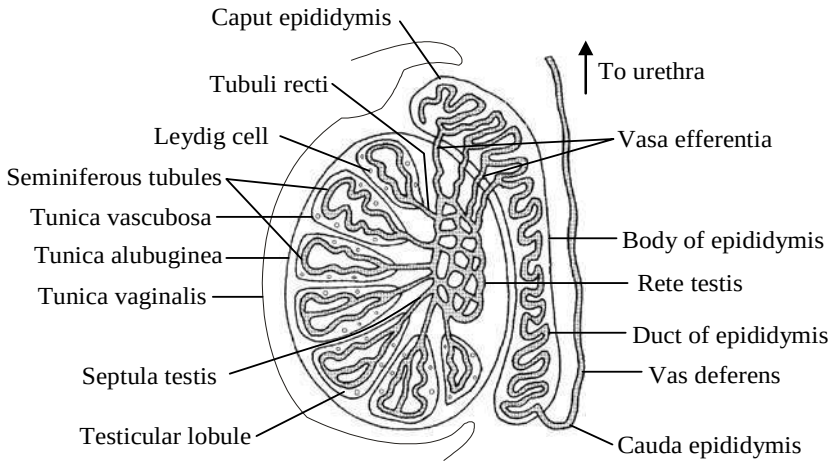


Fig. Median longitudinal section of mammalian testis

- Each lobules has 2 to 3 seminiferous tubules, which join together at the apices of the lobules to form straight tubules or tubulirecti which enter the mediastinum. Here they form a network of tubules called as **rete testis.** Rete testis fuse to form 10 to 20 efferent ductule called as **vasa efferentia or ductuli efferentes.** These ductules come out from upper dorsal surface of testis & open into common tubules, which get highly coiled to form epididymis or ductus epididymis. This epididymis is responsible for functional maturation of sperm.
- Total number of seminiferous tubules in each testis is about 750 to 1000.
- In rabbit, epididymis is 3 m long and in man it is 6 m in length.

  Epididymis has 3 parts :

  (i) Upper, highly coiled part - Caput epididymis or Globus-major

  (ii) Middle part - Corpus epididymis

  (iii) Basal, least coiled part - Cauda epididymis or Globus minor

  Cauda-epididymis, enters inside the abdominal-cavity from the scrotal-sac in the form of Vas deferens or ductus deferens. Terminal dilated part of vas deferens are called **ampulla.** Vas deferens and Epididymis both develop from the **wolfian-duct** of **mesonephros. Epididymis can temporarily stores the sperms for as long as one month and here the functional maturation of sperms takes place.** 18 to 24 hr. after functional maturation of sperm, sperms proceed further to store in vas deferens, specially in its ampulla part. The wall of epididymis is made up of 2 layers-outer circular muscle layer and inner epithelium. Wall of vasdeferens is also made up of 2 layers-outer circular muscle layer and inner epithelium. The sperms reach the abdominal cavity due to the pulsation of the vas-deferens.
- Cutting of the vasa-deferens & tieing it by a thread is termed as **vasectomy.**

  Vas deferens runs upward & enter into abdominal cavity. Both vas deferens coil around the ureter of their respective sides and then dilate to form ampulla. Ampulla of each side receives the seminal vesicle of that side.
- The vas deferens now forms ejaculatory duct and opens into prostatic urethra.

In rabbit 1 seminal vesicle is found on dorsal side of urinary bladder & it opens at the junction of both vas deferens, while in human 1 pair of seminal vesicles are situated on dorsolateral side of urinary bladder which open separately before the terminal ends of vas deferens. So terminal ends of vas deferens meet to form a single ejaculatory duct.

Accessary Reproductive Glands

- The substances secreted by the accessory reproductive glands help in reproduction, these are-

1. Seminal vesicle

It is also called **Uterus-masculinus.** If forms from the Mullerian-duct of the embryo. In females, these ducts form the oviducts. Internally, it is lined by glandular epithelium which secretes seminal fluid, which is lubricating, transparent & jelly like substance, which makes 60-70% part of semen. It is slightly alkaline (pH 7.3.). **Fructose** is found in seminal fluid, it act as fuel to sperm. Fibrinogen, prostaglandin, citrate, inositol and several proteins are also present in semen.

2. Prostate gland

This gland is located below the urinary bladder. It is unpaired & made up of 5 lobes in man. In Rabbit 3 or 4 lobe are found. Each lobe opens into prostatic urethra through many fine apertures. It secretes slightly alkaline prostatic fluid which is milky, thick, sticky or jelly like. It makes about 30% part of semen and helps in sperm activation. In the secretion of prostate-gland citric acid, Calcium and phosphate, clotting enzyme and profibrinolysin are present. The secretion of the prostate gland combines with the secretion of seminal vesicle and so the semen gets coagulated. In the coagulated semen, the mobility of sperms is reduced and so their energy is conserved. After some time of ejaculation due to fibrinolysins, semen again liquefies and in this semen now the sperms can move.

3. Cowper's glands

It is a pair of glands found on lateral side of urethra. It is also called as **bulbourethral gland.** It is situated in membranous part of urethra & opens into penile urethra. It secretes transparent, slimy, jelly like fluid. It is slightly alkaline (pH is 7.2). This destroys the acidity of the urethra and cleans it for the movement of sperms.

4. Perineal or Rectal glands

These are found both in male and female rabbits. Perineal gland is found around external genital organ & perineal region, while rectal glands are found around external genital organs & anus. During the breeding season, these glands secrete odoriferous liquid which has pheromones or **Ectohormones** in it. The pheromone develops sexual attraction between opposite sexes & also develops desire for copulation.

Note : - In man, Perineal or Rectal glands are absent.

Semen - Semen = Sperm + Accessary reproductive gland fluid

Volume = 3 to 4ml.

Normal sperm count 20 to 120 million/ml.

Oligospermia < 20 million/ml.

Azospermia – either absence or near absence of sperms.

Penis

Urethra continues in a muscular & tubular organ called as **penis.** Terminal part of shaft of penis is bulging, it is called as **Glans penis.** This glans penis is covered by a movable skin called as **prepuce or foreskin.**

A special type of sebaceous gland is found on the prepuce called **preputial gland** which secretes **smegma.**

Removal of prepuce by surgery is called as **circumcision.**

Prepuce is attached to the base of glans with the help of an elastic cord like membrane called **Frenulum prepuce.**

In penis of some animals a bone is present called **Baculum** and such a penis is called **Os-penis** e.g. Whale, Bat, Rat etc. The penis of opposum, Bandicoot etc. is double branched (Bifurcated).

Penis is an erectile copulatory intromittent organ. Root of the penis containing muscles is called crura. Penis consists of a long shaft that enlarges to form an expanded tip called the glans penis.

Body of Penis :

It is composed of three longitudinal cylindrical masses of erectile tissue. These masses are, the right & left corpora cavernosa & a median corpus spongiosum.

The two corpora cavernosa do not reach the end of the penis. Each of them terminates under cover of the glans penis.

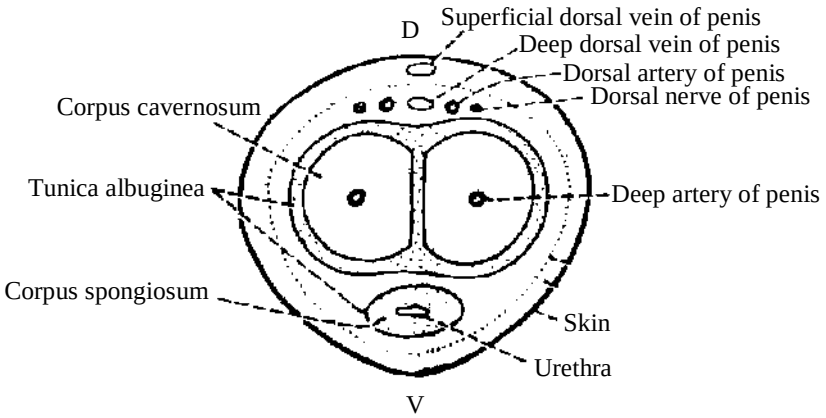
The corpus spongiosum continues further, its terminal part is expanded to form a conical enlargement called the **glans penis**. Through out its whole length it is transversed by the **urethra.**

The base of the glans penis has projecting margin the **corona glandis.**

External opening of penis is called penile meatus.

Erection of Penis :

Erection of penis is purely vascular phenomenon and is controlled by A.N.S It occurs due to increase of blood supply, due to dilation of penile arteries causing enlargement and hardening of penis. During this time the muscles of crura are relaxed.



Transverse section through the body of the penis

Histology of seminiferous Tubules :

Outer surface of seminiferous tubules is composed of white fibrous connective tissues called as **tunica propria.** While inner surface is of cuboidal germinal epithelium. This epithelium is made of spermatogenic cells which forms sperm by spermatogenesis. Some columnar cells are found in the layer of germinal epithelium called as **Sertoli cells.** These provide nutrition to sperm, so they are also called as **subtentacular or sustentacular** or **nurse cells** (these occur in mammals).

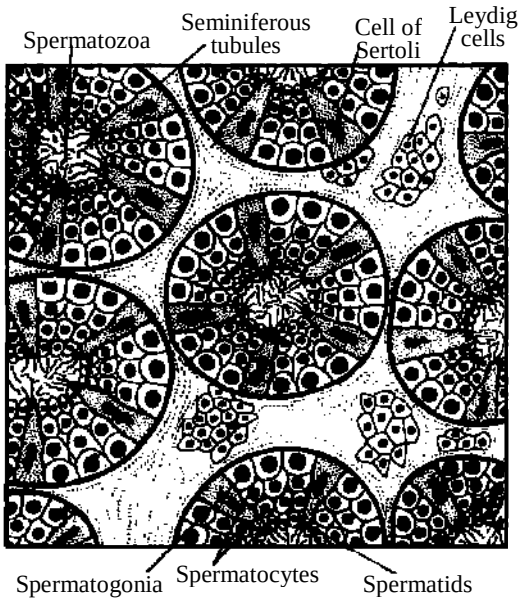
Other function of Sertoli cells -

(1) They phagocyte the injured or dead sperm cells

(2) They are the basis of blood testis barrier

(3) Sertoli cells produce inhibin.

Some endocrine cells are found between seminiferous tubules in intertubular space, these are called as **interstitial or Leydig cells.** These cells secrete **testosterone.** The testosterone from Leydig's cells enter the seminiferous tubules by diffusion under the effect of ABP & promotes spermatogenesis.



HISTOLOGY OF TESTIS

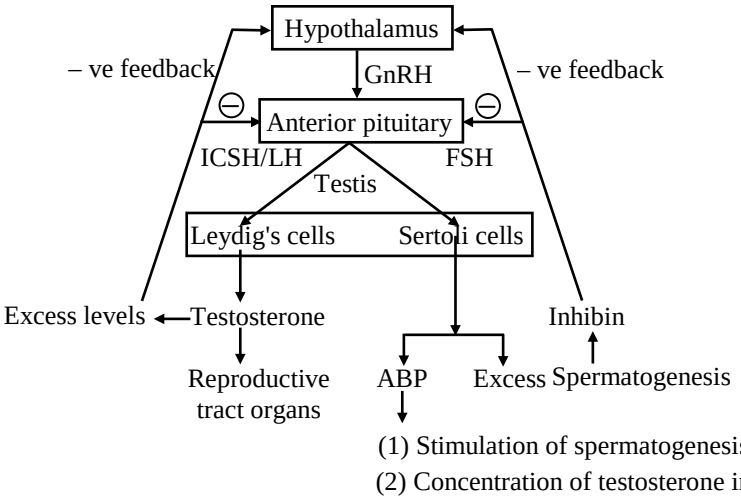
Male Reproductive Hormones

FSH : Binds with FSH receptors attached to the Sertoli cells in seminiferous tubules. This causes these cells to grow and secrete various spermatogenic substances and androgen binding proteins (ABP)

ABP : Concentrates the testosterone inside seminiferous tubules.

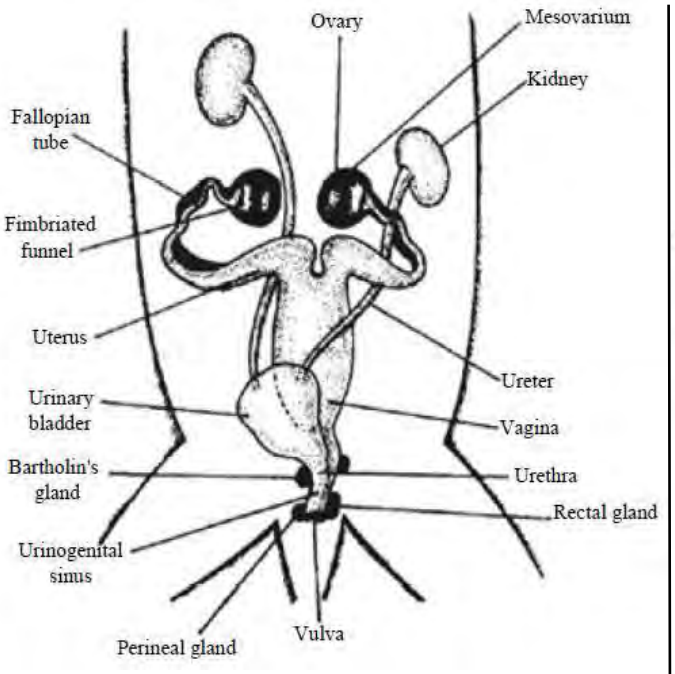
LH/ICSH : - It stimulates the leydig cells to secrete testosterone. Leydig's cells mature at 10 years of age .

Inhibin : : It is secreted by Sertoli cells in response to excess spermatogenesis. The inhibin gives a negative feedback to the hypothalamus and anterior pituitary, this results in suppression of synthesis and release of FSH ($\therefore$ Spermatogenesis decreases).

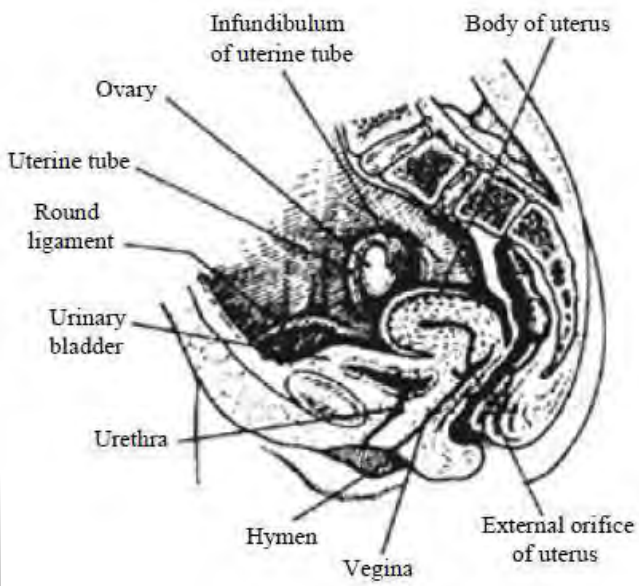


Testosterone : Secreted by Leydig cells. It is essential for (1) Sperm production (2) development of secondary sexual characters (3) ABP secretion (4) it also gives – Ve feedback to hypothalamus and anterior pituitary in its excess concentration to suppress GnRH, FSH & LH release. (5) It is secreted in foetal stage in as low as 30 ng/nl plasma concentration to cause descent of testis in last trimester of intrauterine life.

FEMALE REPRODUCTIVE SYSTEM



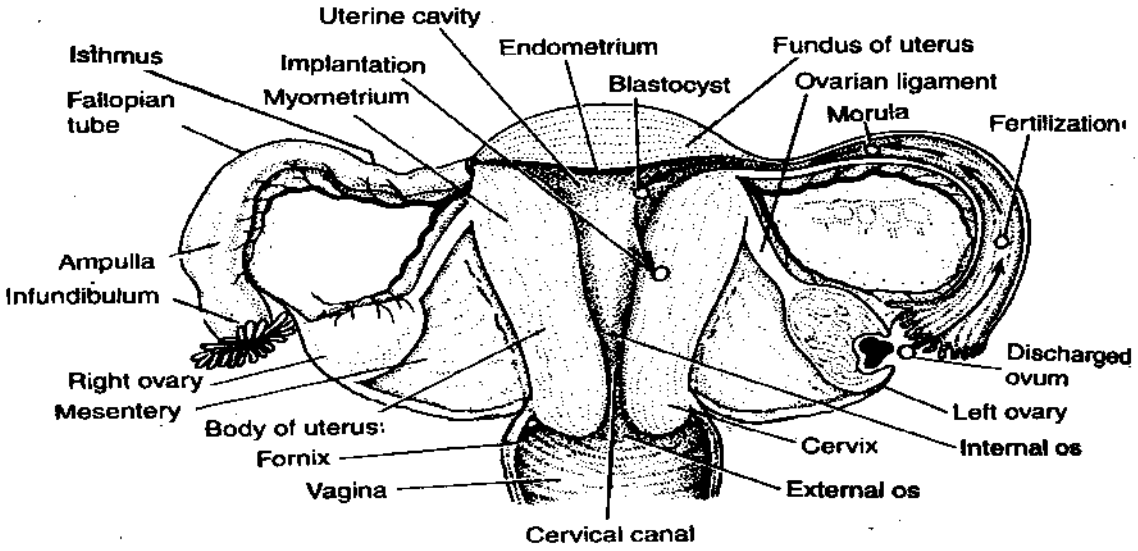
(RABBIT)



(WOMAN)

FEMALE – SEX – ORGANS

A pair of ovaries is the main or primary sex organ of female reproductive system. Both ovaries are located in abdominal cavity in the ovarian fossa. Each ovary is attached to the posterior layer of broad ligament (Peritoneal ligament) with the help of mesovarium. It is short fold of peritoneum & it is the route of vessels & nerves to ovary .



A tubule is situated near the ovary. It is also attached with broad ligament, this tubule is called as **oviduct.** Oviducts develop from the Mullerian-duct of the embryo. In mammals this oviduct is differentiated into two part. It's proximal (towards ovary) narrow & thin part is called as **infundibulum**. Its fimbriated & terminal end bears aperture called as **abdominal ostium** which opens into peritoneal cavity. The part medial to the infundibulum is called **ampulla**, it is a thin walled dilated part of tube. Fertilization takes place in the ampulla. The part medial to ampulla is called **isthmus**. The most medial part of this tube situated in the uterus is called **intramural or interstitial part of tube**. During ovulation, the egg are released in the peritoneal cavity, due to this it is called **coelomic egg.** The distal & dilated part of oviduct forms the **uterus**.

The upper expanded part is called as body or fundus while lower cylindrical part is called as **cervix**;

Upper part of uterus forms the body while lower part forms cervix.

On internal surface of cervix 2 types of constrictions are found which form the **Os-cervix.**

The body of uterus communicates with the cervix through opening called **internal Os.**

The cervix communicates with the vagina through an opening called **external Os.**

The uterus open into a fibromuscular & non glandular tube like organ called **vagina** (Copulatory organ).

Types of Uterus :

I. **Duplex : -** These are the simplest type of uteri. Here both the uteri are completely separated and open independently into the vagina through two separate openings e.g. Rat.

II. **Bipartiate :** In these uteri, the lower part of the two uteri are fused and there is a septa in between them, e.g. Carnivorous mammals.

III. **Bicornuate :-** The lower parts of the 2 uteri are fused with each other but their partition wall is absent e.g. Rabbit.

IV. **Simplex :-** When both the uteri are completely fused with each other to form only one structure. These are the most developed uteri, e.g. Human.
It is the most developed form of the uterus which is made from the complete fusion of both uterus .

It is piriform (inverted pear) in shape,

Vulva

Vulva means external genitalia of female. They include mons veneris, labia majora, labia minora, clitoris, vestibule & related perineum.

Mons veneris (mons pubis) : - It is a pad of sub cutaneous connective tissue, lying in front of pubis & is covered by pubic hairs in adult female.

Labia Majora : - Vulva is bounded on each side by the elevation and folds of skin & subcutaneous tissue. Its inner surface is hairless.

Outer surface is covered by sebaceous gland, Sweat gland & hair follicles. It is homologous with the scrotum in the male.

Labia Minora :- They are two thin folds of skin present just within the labia majora. Lower portion of minora fuses across the midline & form a fold of skin called **fourchette**.

Clitoris :- Small cylindrical & erectile body made by fusion of two labia minora, situated in the most anterior part of vulva. Clitoris is a **homologus** to the penis in the male. It is also made up of two erectile bodies (corpora cavernosa). The skin which covers the glans of clitoris is called **prepuce.**

At the terminal part of vagina the urethra opens separately, so they form a common chamber called **vaginal vestibule or urino genital sinus.** Vagina opens outside through a slit like aperture or triangular space called vestibule. The vulva has following openings :-

(a) Urethral opening – Lies on anterior end

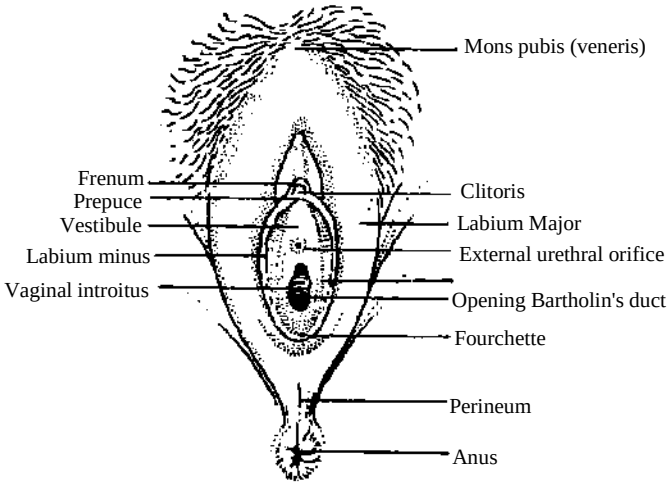
(b) Vaginal orifice – Lies on posterior end.

It is incompletely closed by a septum of mucous membrane called **hymen**, but it may not be a true sign of virginity.

(c) Openings of Bartholin; duct on either side

Bartholin Glands :

- It is homologous to **Cowper gland** of male
- In rabbit 1 pair is found on lateral side of vagina. It also opens into vagina.
- It secretes slimy alkaline, watery fluid which make alkaline media in vaginal passage.
- In human female it is **one pair** on each side. These are also known as **greater and lesser vestibular gland.** These glands are situated on lateral side of vagina and on both sides the Bartholin duct opens into vestibule. It secretes alkaline fluid during sexual excitement.



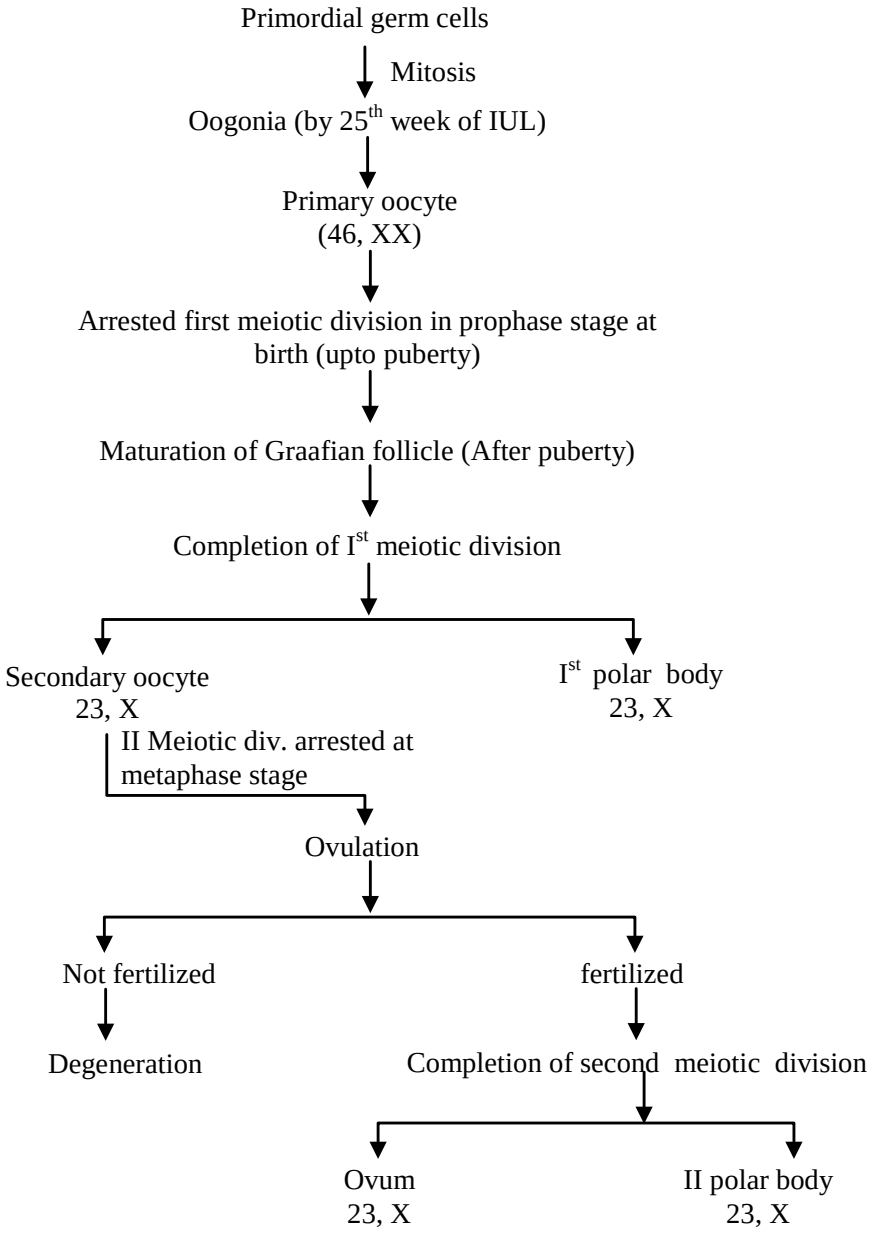
Histology of Oviduct :

I. **Serosa or the adventitia :-** It is the outermost layer of visceral-peritoneum **(Perimetrium)**

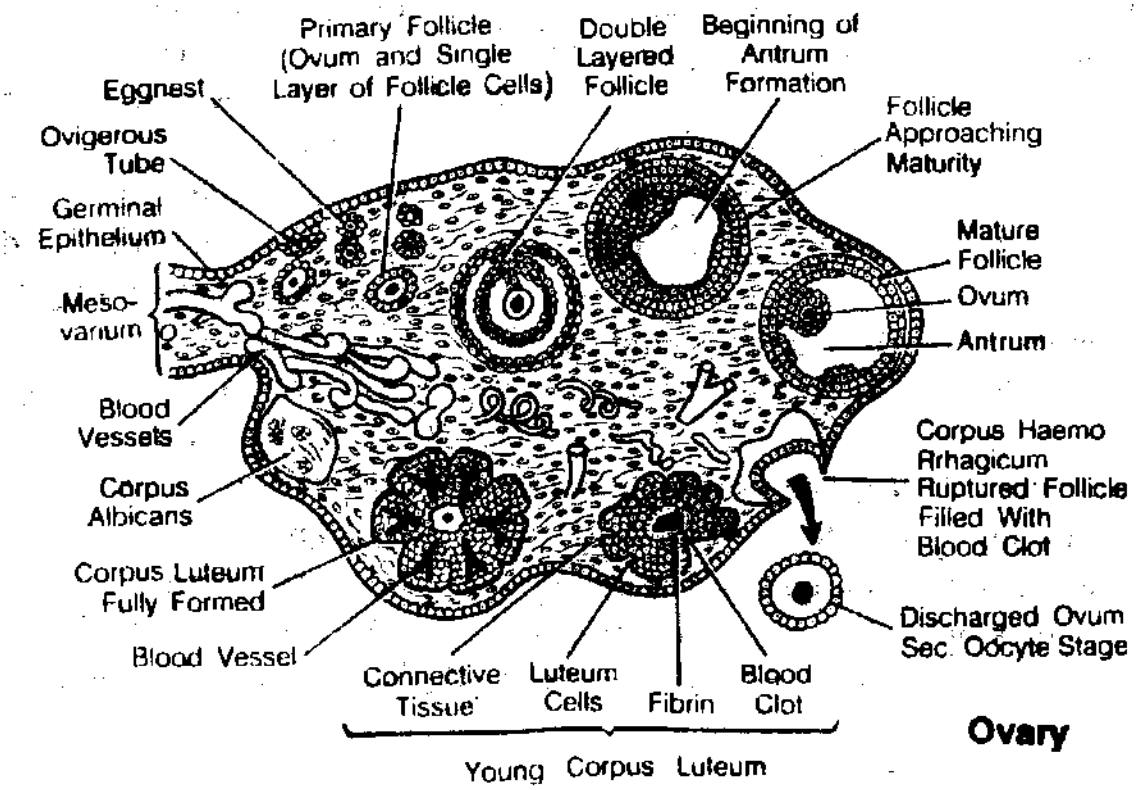
II. **Muscle-layer :-** The middle layer of the oviduct is made up of unstripped-muscle. In uterus, thick smooth muscle bundles are found, these are called as **myometrium.**

III. **Mucous membrane :-** It is the innermost layer. Mucosa consists of simple columnar epithelium. Epithelium contains both ciliated cells & secretory cells. The secretory cells produce viscous liquid film that provides nutrition & protects the ovum. Mucosa of Uterus is called **endometrium**, It contains tubular glands, many fibroblasts & blood vessels. In the uterus, the embryo is attached to endometrium. Longest unstripped muscles of the body are found in the walls of uterus. (During pregnancy)

SCHEME SHOWING GAMETOGENESIS



STRUCTURE OF OVARY :



Outer most layer of ovary is called germinal epithelium while the inner layer called T. albuginea is made up of White fibrous connective tissue.

The inner part of ovary is called as stroma. it is differentiated into 2 parts, outer peripheral part is cortex & inner part is called medulla. Stroma consists of follicular cells, connective tissue, blood vessels & lymphatics.

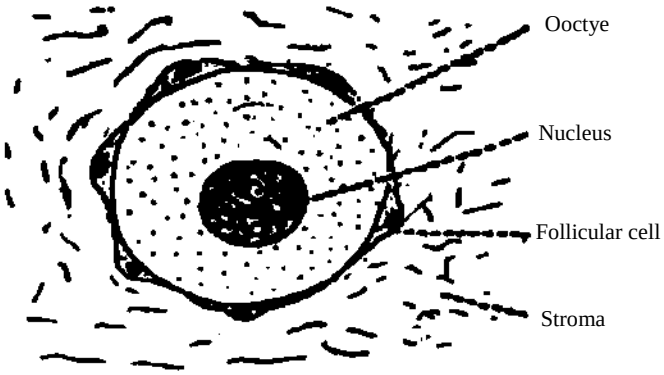
Numerous oogonial are found in cortical region in intrauterine life. In early stage of intrauterine life, they proliferate by mitosis, after which meiosis starts in them and proceeds upto prophase stage & halts there itself up to puberty (when the ovulation starts). Now the halted meiosis process restarts at puberty causing primary oocyte to convert into secondary oocyte Just before ovulation. With this the 1st meiotic division completes & first polar body is formed . The secondary Oocyte immediately begins the second meiotic division but this division stops again at metaphase stage. It proceeds further only when a sperm penetrates the oocyte.

Formation of ovarian or Graafian follicle

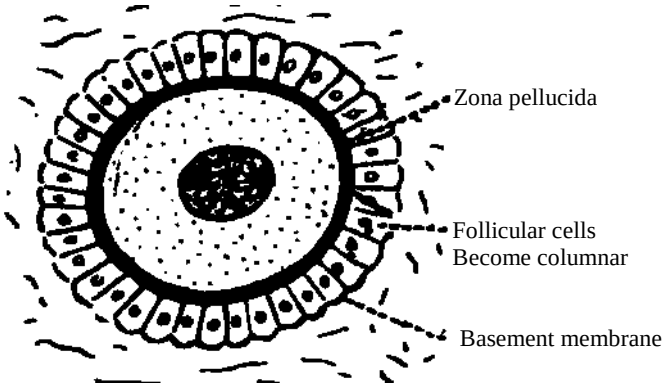
Ova develop from oogonia present in the cortex of the ovary. The oogonia are surrounded by other cells that form a stroma for them. These stromal cells form the ovarian or Graafian follicle that surrounds the ovum and protects it.

The stages of formation of **Graafian** follicle are as follows :

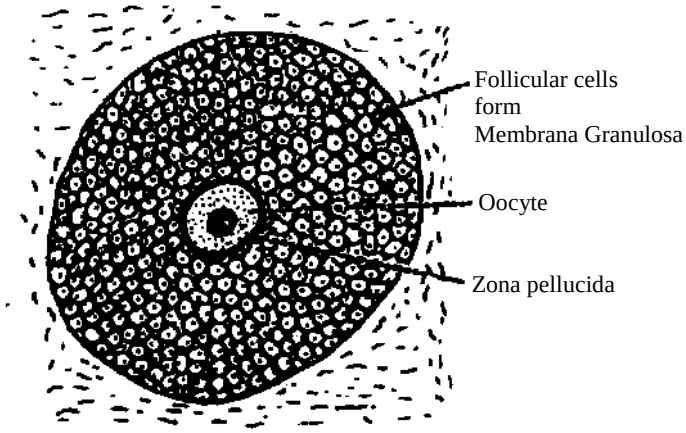
(1) Firstly some cells of the stroma become flattened and surround a primary oocyte (which develops from oogonia). These flattened cells ultimately form the ovarian follicle and are therefore called follicular cells.



(2) The flattened follicular cells now become columnar. Follicles upto this stage of development are called primordial follicle.

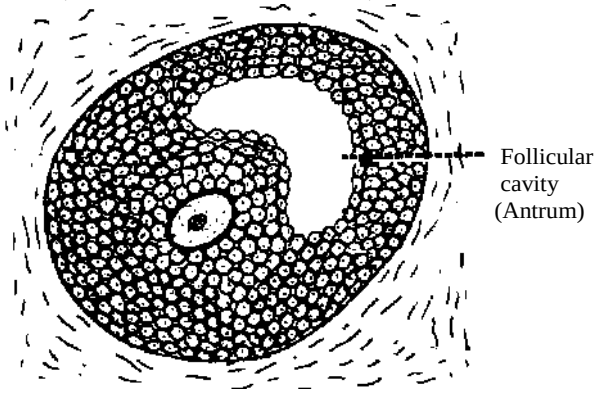


(3) A membrane called the zona pellucida, now appears between the follicular cells and the oocyte.

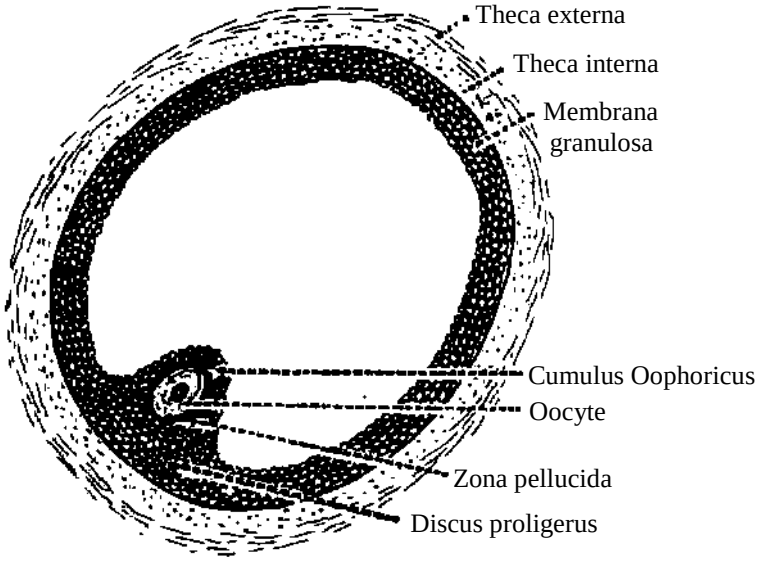


(4) After puberty the follicular cells proliferate now to form several layers of cells to form the membrana granulosa. These cells are now called granulosa cells.

(5) A cavity appears within the membrana granulosa. It is called the **antrum.** With the appearance of this cavity, the follicle is formed (follicle means a small sac).



(6) The cavity of the follicle rapidly increases in size and gets filled with a fluid called liquor folliculi. Due to increases in the size of the cavity the wall of the follicle (formed by granulosa cells) becomes relatively thin. The oocyte now lies eccentrically in the follicle, surrounded by some granulosa cells that are called as cumulus oophoricus. The cells that attached it to the wall of the follicle are called as discus proligerus or Germ hill.



(7) As the follicle expands, the stromal cells surrounding the membrana granulosa become condensed to form a covering called the theca Interna. The cells of theca interna (Thecal cells) afterwards secrete a hormone called oestrogen.

(8) Outside the theca interna some fibrous tissue become condensed to form another covering called the theca externa. The ovarian follicle is now fully formed and is now called the Graafian follicle.

The granulosa cells lying in the close vicinity of the ovum (Secondary oocyte) and zona pellucida, become elongated to form the corona radiata.

After 13 days of menstrual cycle (on 14^{th} day when cycle is ideally for 28 days) Graafian follicle is ruptured & egg is released.

After ovulation the ruptured Graafian follicle is called corpus luteum. Soon after ovulation, the granulosa cells of Graafian follicle proliferate & these cells look yellow due to accumulation of pigment called Lutein. These cells are called lutein cells.

Before ovulation the follicle was avascular but soon after ovulation blood vessels grow & corpus luteum becomes filled with blood. Central part filled with blood is called corpus haemorrhagicum. Lutein cells synthesise the progesterone hormone.

If fertilization occurs in fallopian tube, the corpus luteum then becomes stable for next nine months. If fertilization does not occur then the corpus luteum starts degenerating after about 9 days of it's formation. The degeneration is completed in 14 days to form corpus albicans, which gradually disappears. Progesterone hormone maintains pregnancy and repairs the wall of uterus to make its surface adhesive to help in implantation.

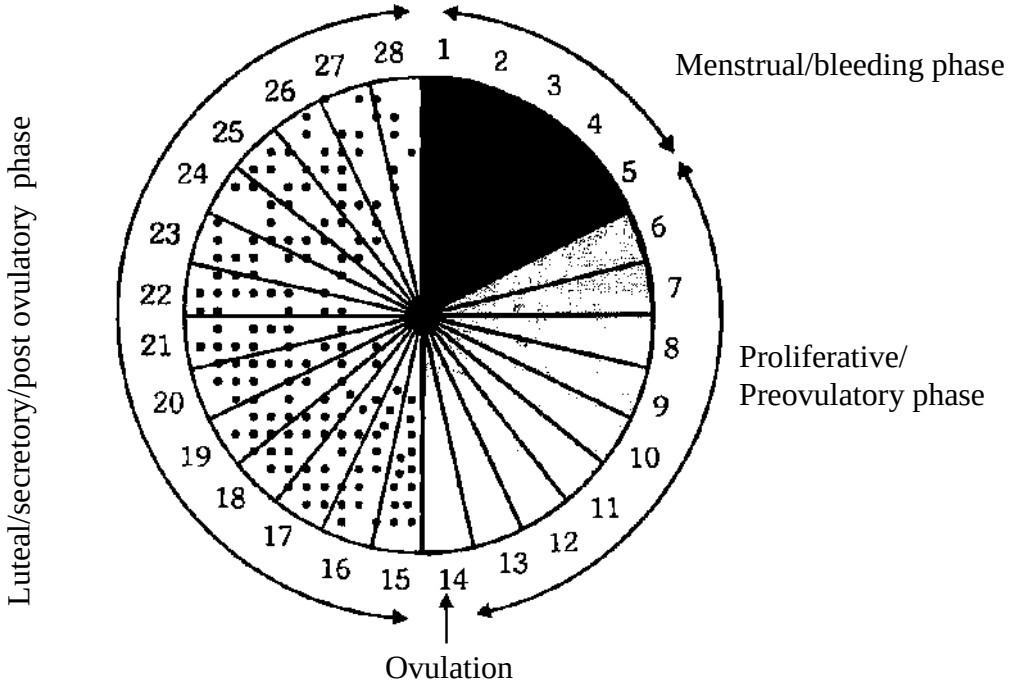
The total number of follicles in the two ovaries of a normal young adult woman is about four lakhs. However most of them undergo regression and disappear due to death and are disposed off by the phagocytes during the reproductive year of the females. This is termed as follicular atresia. This is

responsible for limited number of gamete production in females. Generally, only one ovum is liberated in each menstrual cycle, by alternate ovaries. Only about 450 ova are produced by a human female over the entire span of her reproductive life which lasts till about 40-50 years of age.

Although most of the follicular cells and the oocytes undergo degeneration during follicular atresia, some thecal cells, formed from the stroma and located around the follicle, persists and become active. These are called **interstitial cells.** These cells secrete small amount of androgen.

MENSTRUAL CYCLE

Duration – 28 days Ideally (Range 24 to 32 days)



This is exhibited by primate group of animals. In this cycle the female body prepares itself for a possible pregnancy. If the pregnancy does not occur then the body aborts all preparation done and restarts the prepration for pregnancy again in a monthly cyclic manner.

Menstrual cycle has three main phase.

(i) Bleeding phase or menstruation phase.

(ii) Proliferative/Preovulatory/follicular phase or oestrogenic phase.

(iii) Secretory/Post ovulatory/luteal phase or progesteronic phase.

(i) Bleeding Phase :

The cycle starts with bleeding phase in its first four to five days. During this bleeding the part of the layer of endometrium called decidua gets shed off.

(ii) Preovulatory/Proliferative phase :

After first four or five days this phase begins. During this phase, Due to release of some GnRH, Pituitary secretes some FSH to stimulate the ovarian follicle. The ovarian follicle now begins to develop. Its theca interna now starts secreting an increasing amount of oestrogen.

The rising level of oestrogen causes the endometrium to proliferate and thicken. It also causes increase in the vascularity and glandularity of the endometrium.

Rising level of oestrogen also provides a positive feed back to the hypothalamus. Due to this, the hypothalamus releases more of GnRH . This GnRH induces the pituitary to release more of FSH. The rising FSH levels now cause:

(i) further growth and development ovarian follicle to form Graafian follicle

(ii) even further release of oestrogen from the theca interna of this developing follicle.

As the oestrogen level goes on rising, by the end of 10^{th} day the extreme levels of oestrogen (which have by then caused maturation of Graafian follicle and growth of endometrium) now give a negative feed back to the pituitary causing a fall in FSH secretion but also causing a rise in LH secretion. Now the LH secretion from the pituitary goes on rising. This abrupt rise (on 11^{th} to 13^{th} day) in LH concentration in blood is called as LH surge. This LH now causes the Graafian follicle to rupture after partial completion of II meiotic division in oocyte and thus the secondary oocyte is released. The release of egg (secondary oocyte) which occurs 14 day is called as **ovulation.**

(iii) Post ovulatory/secretory phase :

After ovulation the ruptured Graafian follicle transforms into corpus luteum. The granulosa and theca cells of the ruptured Graafian follicle (which is now called as corpus luteum) is found only in mammals and contain a yellow lutein or carotene pigment.

In case of absence of pregnancy this corpus luteum will get degenerated after 14 days of its formation. The degenerated corpus luteum is called **corpus albicans** (white body).

Function of corpus luteum :- Stimulated by the rising levels of LH, the corpus luteum secretes progesterone hormone. The progesterone facilitates the preparation of endometrium for receiving the embryo and its implantation. Progesterone inhibits the contractions of uterus so that the pregnancy could be maintained. Progesterone also inhibits development of next new ovarian follicle.

If pregnancy occurs then the corpus luteum persists and secretes progesterone. Progesterone is important to maintain the pregnancy and it is thus called as the **pregnancy homone.** By the fourth month of pregnancy, the placenta has developed completely. This placenta now takes over the job of further progesterone secretion. Ovary also secretes some amount of relaxin at the time of parturition.

If pregnancy does not occur after ovulation, then as the progesterone level rise, its rising levels inhibits the release of GnRH from hypothalamus. Due to this FSH, LH secretion by pituitary falls and thereby progesterone secretion by the corpus luteum (which was due to influence of LH) also now falls.

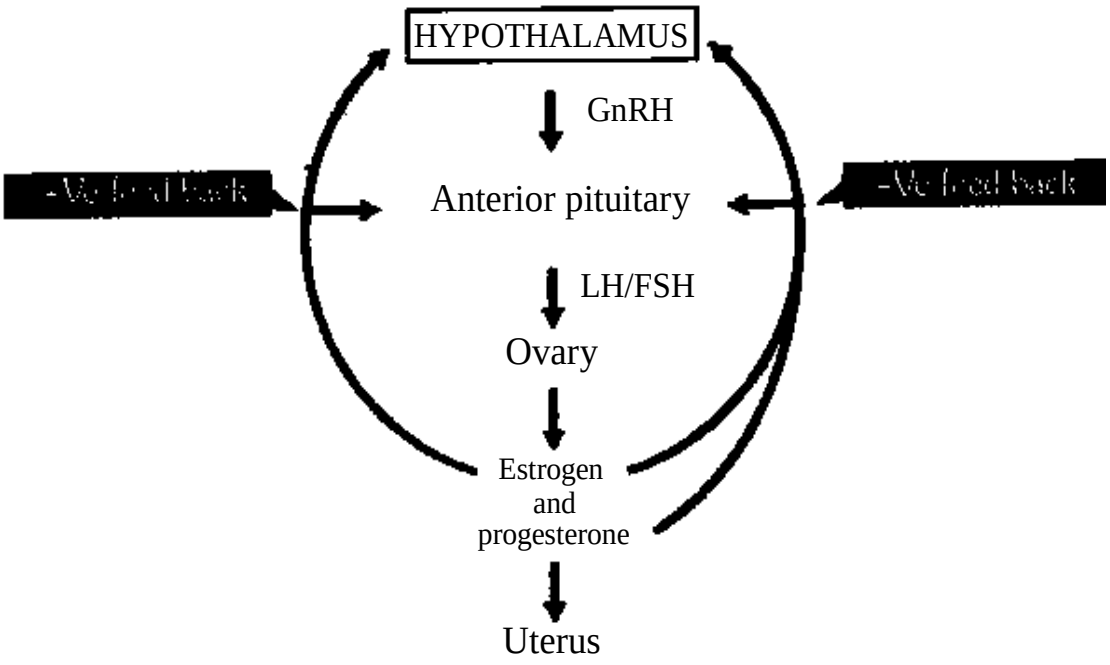
As the progesterone level drops, the corpus luteum begins to degenerate and transform in corpus albicans (which can not secrete progesterone). Due to the lack of progesterone : -

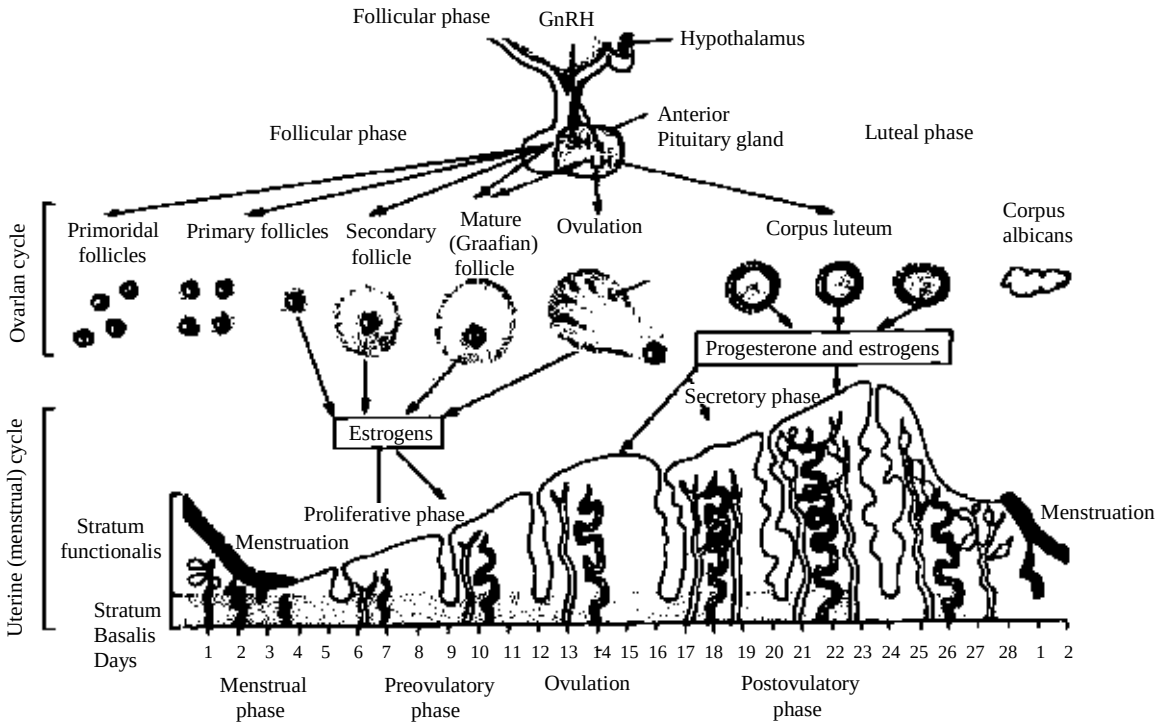
(i) The overgrown endometrium now begin to break and separate from the inner uterine wall causing bleeding.

(ii) The uterine contraction (which was till now inhibited due to presence of progesterone) now start. Thus the separated endometrium along with blood is now being passed out via vaginal route. This is again the beginning of next menstrual or bleeding phase.

Total loss of blood per day is about 20 ml, so an average 40 to 80 ml blood/cycle is lost. This blood can not clot. The period between ovulation and next menstrual bleeding (post ovulatory period) is always constant (i.e. is 14 days). However the ovulation date may vary (causing a change in pre ovulatory period). After ovulation the ovum is viable only for two days, while sperms introduced into the vagina can survive for a maximum of four days.

On basis of the above data, safe period method for family planning is calculated. Normally it is considered to be day 1 to day 8 and then from day 20 to day 28.



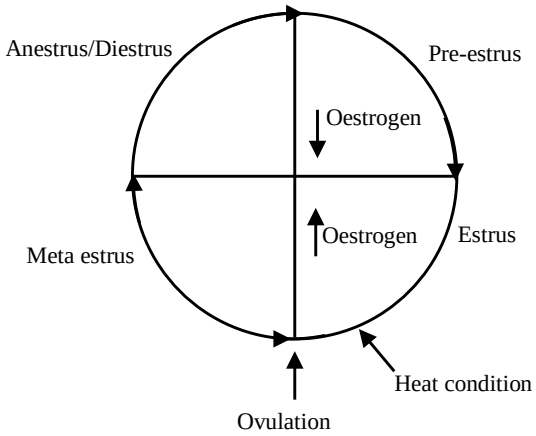


Schematic representation of menstrual cycle

ESTRUS CYCLE

t estrus or menstrual cycle. Except primate mammals, the estrus cycle is found in all mammals. Menstrual cycle is found in primates

On the basis of estrus cycle these mammals are of 2 types :



(1) Mono estrus animals :

Only 1 cycle is found in breeding season.

(2) Poly-estrus animals :

More than 1 estrus cycles are found in the breeding season. Estrus cycle completes in 4-stages :-

(1) Pre-estrus phase
(2) Estrus phase
(3) Meta-estrus phase
(4) Anestrus/Diestrus phase

Pre Estrus :

1st step of estrus cycle. In this stage, **oogenesis** starts in the ovary. In this stage estrogen level is minimum. In low concentration of estrogen some changes occur in uterus.

(i) Blood capillaries become more branched

(ii) Muscles of uterus become more active

(iii) The stratified glandular epithelial layer of uterus known as **stratum Basalis** now divides actively to form new stratified epithelial layer known as **stratum functionale.**

In this phase no copulation occurs between opposite sexes.

Estrus phase :

In this phase secondary follicle develops in the ovary. Concentration of estrogen is increased. Due to high concentration of estrogen following changes occur in the uterus.

(i) The diameter of blood vessels increases
(ii) The circulation also increases
(iii) The muscles of uterus divide to cause further thickening of myometrium.
(iv) Cells of stratum functionale enlarge. New connective tissue & mucous cells are developed.
(v) Mammary glands also get enlarged.

Due to high concentration of estrogen the sex urge develops in the female. This stage is known as **heat condition.** Copulation occurs only in this phase.

Meta-Estrus Phase :

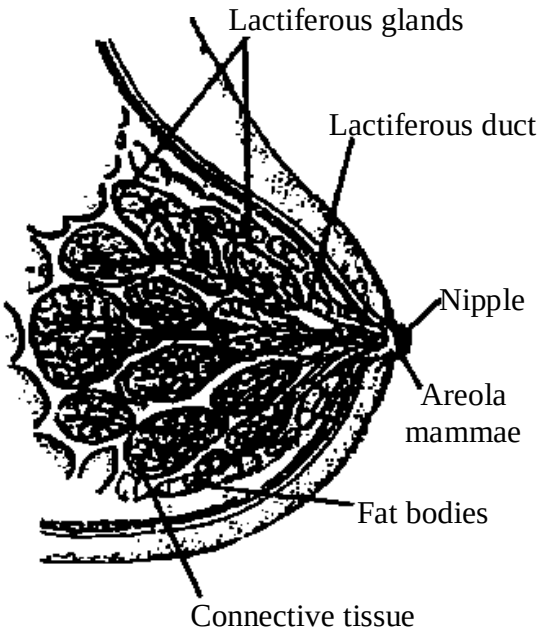
All physiological symptoms which develop in this phase are similar to normal pregnancy even in absence of fertilization, so this phase is known as **Pseudo-pregnancy.** If fertilization occurs in fallopian tube then this phase extends upto parturition. If fertilization does not occur then this phase becomes short. Keratinization occurs in stratum functionale. myometrium is gradually reduced. Blood vessels gradually constrict. Mammary glands are gradually reduced.

Anestrus/Diestrus phase :

Stratum functionale is destroyed by stratum basalis by phagocytosis. Mammary gland, myometrium & blood vessels of uterus become completely normal. So it is the **inter phase stage** of two estrus cycle & is also known as **diestrus phase.** In monoestrus animals the anestrus phase is the diestrus phase also.

BREAST

Breast also serves as an accessoary reproductive organs in women. Human female possesses a pair of breasts containing mammary glands. These are situated in the front of the thorax on pectoral muscles. Each mammary gland has 15-20 tubulo-alveolar lobules contained in its connective tissue. The space between the lobules is filled with fatty tissue. The lobules contain milk glands in the form of bunches of grapes, which secrete milk. Numerous small ductules arise from each lobule, combine to form a lactiferous duct. Such lactiferous ducts open independently in the nipple.



A nipple is pigmented structure which is a elevated knob like structure at the apical part of mammary glands. The area adjacent to the nipples is also deeply pigmented, which is known as areola mammae.

The area surrounding the nipples become much elevated because of the accumulation of fat and by the presence of muscles, Nipple is provided with about 15-20 small pores of 0.5 mm size. In men the nipples are vestigial.

Mammary glands produce a nutritive fluid, milk for the nourishment of young ones. milk protects the young ones from various infections upto some months after birth.

For development of breast four hormones are work :

(1) Oestrogen - For growth of tubules of breast glands.

(2) Progesteron - For growth of follicles of breast glands.

(3) Prolactin- Milk synthesyzing hormone in breast glands.

(4) Oxytocin - Help in milk ejection.

BRIEF REVIEW

Development of secondary sex organ –

Male	Female
Wolffian duct or Mesonephric duct → Epididymis or Vas deferens Regression of Mullarian duct or Paramesonephric duct → Seminal vesicle Urogenital sinus–Prostate Genital tubercle – Penis	Mullarian duct – Fallopian tube, uterus and vagina (Oviduct) Genital tubercle – Clitoris

Puberty –

The age of sexual maturity is called puberty.

Accessory sex character first appear in puberty

Puberty occurs in girls at the age of 11 to 14 year

Puberty occurs in boys at the age of 12-15 year

At puberty, women starts producing ova.

Age of puberty in rabbit – 5-7 months.

	BOYS	***GIRLS***
1. Gonadal	Enlargement of the testes, Spermatogenesis begins	*Ovarian cycle and ovulation begins*
2. Accessary Sexual Organ	Penis, prostate, seminal vesicles and epididymis grow in mass	*Uterus, vagina, fallopian tube, vulva increase in size. Endometrium shows menstrual changes and menstruation occurs*
3. Hairs and voice	Appearance of Beards, moustache, axillary, pubic & chest hair. Low pitch sound	*Typical femine distribution of hairs (axilla + pubis but no hair on chest or abdomen). Breasts grow. Fat deposition leading to feminine contours. High pitch sound.*

4. Somatic	Skeletal system – grows in length Muscular system – Grows in bulk & strength	*Pelvic girdle becomes roomy and bigger than pectoral (opposite to boys, where pectoral girdle is bigger and pelvic much less roomy)*
5. Psychic	Attraction for girls begins.	*Attraction for boys.*
6. Hormonal	*FSH, LH and testosterone secretion – all rise.*	*FSH, LH, estrogen, progesterone secretion – all rise.*

Vagina -

- The vagina is lined by a stratified squamous epithelium without any glands.
- During reproductive life the vagina contains **lactobacillus acidophilus or dorderlein's bacilli** which keeps the vaginal pH between **4 to 5** by producing lactic acid from glycogen.

Gametogenesis –

Formation of gametes for sexual reproduction.

- Germ cells in vertebrate gonads are produced by both mitosis and meiosis.

Clupein protein is present only in Man & fishes sperm

Menstrual Cycle –

Cyclic change in the reproductive tract of primate females.

- In healthy women, menstruation occurs at intervals of about 28 days.
- **Menarche –** Starting of menstruation in girls at about 13 years.

Menopause –

Menopause is the period of life when menstruation naturally stops.

- Menopause occurs in females at the age of 45-50 years.
- Ability of reproduce is lost in the female after menopause.

Estrous Cycle –

- Occurs in non-primate mammals.
- There is no menstruation at the end of estrous cycle.
- The estrous cycle runs only during the breeding season
- Monoestrous animal = Dog, Fox, Dear, Bat
- Polyestrous animal = Mouse, Pig, Squirrel, Cat

Gestation period -

- Duration between fertilization and Parturition.
  (1) Rabbit = 28 – 32 days.
  (2) Man = 270 – 290 days
  (3) Rat = 20 – 22 days

Gynaecomastia – Development of breast in the male

Amenorrhoea – Absence of menstruation cycle

Hysterectomy – Surgical removal of uterus.

Oopherectomy – Removal of ovaries.

World's oldest mother – Roshanna Della corte, an italian woman, gave birth to a baby boy on july 18, 1994 at the age of 62. She is believed to be the world's oldest mother.

Adolescence – Period between puberty and Maturity.

Path of sperms in mammals –

- Seminiferous tubules – Rete testis – vasa efferentia – Epididymis – Vasa deferens – Urinogenital Chamber – Urethra.
- Sterility results if sperms count is $< 20 \times 10^6$/ml or > 40% sperm are immotile.
- Use of antibiotics, smoking marijuana, alcohol, hot bath, high fever can also cause temporary drop in sperm count.

Spontaneous ovulator –

Ovulation occurs without any induction.

Ex. Most animals (Human)

Induced ovulator (Reflex ovulator) = ovulation occurs after copulation

Ex. Rabbit

Rut Cycle or Testicular cycle –

Reproductive cycle of male is known as rut cycle.

Vesectomy –

Cutting and tieing vas deferens

Tubectomy (salpingectomy) –

Cutting and ligating fallopian tube.

- Labia majora of female in homologous to scrotal sacs.
- Clitoris in female is homologus to penis.
- Prostatic utricle is homologous to vagina of female.
- Seminal vesicle is homologous to uterus (oviduct).
- Colostrum is the first milk produced after child birth
- In contraceptive pills oestrogen and progesterone are present in variable **combination.**

Human sperm –

60 μ long, of this 55μ is the length of the tail.

- In menstrual cycle proliferative phase is of 10-12 days and it is under the influence of oestrogen hormone.
- Luteal or secretory phase of menstrual cycle is of 14 days and it is under influence of progesterone hormone & It is always of fixed duration.

Testicle –

Testis + Epididymis

- Epididymis is 3m long in rabbit while 6 to 8 m long in man.
- Maximum no. of leydig's cells are in the testis of pig.
- Function of epididymis = functional maturity and storage of sperms.

Os-penis or Baculum –

In whale, Bat, Rat, Seal, Monkey etc. Ossification occur in septum present between two corpora cavernosa

Semen –

- Milky, viscous, alkaline fluid.
- pH = 7.3
- Quantity is 2.5 – 4 ml at one ejaculation.
  Maximum growth in human embryo occurs in fourth month of pregnancy and minimum in last months.

  Pseudopregnancy = Due to hormonal disturbance, false symptoms of pregnancy may appear.

  Menarche - Begining of menstrual cycle in females.
- Size of human ovary – Length × Width × Thickness
  3 to 3.5 cm 2 to 2.5 cm 1 to 1.8 cm
- Diameter of Graafian follicle – 1 to 1.5 cm
- Fallopian tube length – 10 cm to 12 cm.

Hermaphroditism : Those animals who have both type of sex organs are called Hermaphrodite animals, it is found in tapeworms and earthworms.

Capacitation : Reactivation of sperm called capacitation. It occurs in vagina. After ejaculation of sperm in vagina, cervical mucous secretory fluid dissolves inhibitory substances related to sperm & provide more energy to sperm.

Precautious puberty : Menstruation occurs before the age of 9 years.

Pregnancy is detected with the help of HCG in urine of pregnant lady.

Cryptomenorrhoea: Occurrence of menstrual symptoms without external bleeding.

Dysmenorrhoea : Painful menstruation is called Dysmenorrhoea.

Menorrhagia : A normal menstrual blood loss is 50-80 ml, and does not exceed 100 ml. In menorrhagia the menstrual cycle is unaltered but the duration and quantity of the menstrual blood loss are increased.

Polymenorrhoea : In polymenorrhoea or epimenorrhoea, the menstrual cycle is reduced from the normal of twenty-eight days to a cycle of two to three weeks and remains constant at that increased frequency.

Male hormonal contraceptive : Research is on for development of a male contraceptive by administration of progesterone hormone.

Oral contraceptive pill –

It is commonly used method for contraception. It is in the form of oral tablet. If menstrual cycle is to start on I^{st} day then OCP is taken from 5^{th} day & regulary uto 21st day. Remaining 7 day iron & folic acid tablet is given instead of hormonal preparations.

Mechanism of Action –

(i) It inhibits Ovulation (main action)

(ii) It prevents fertilization due to atrophy or hypertrophy of endometrium.

(iii) Formation of thick cervical mucus plug, so that entry of sperm is resisted.

PARTURITION

Parturition is a **hormonal process** Many hormonal changes take place during it.

1. The progesterone secretion stops, so the placenta dissolves and the foetus is separated from the walls of the uterus.
2. Pituitary gland secretes **Oxytocin** in more amount This hormone induces intense contractions in the uterus. Due to these contractions, the foetus starts moving towards the vagina, The labour pain during child-birth, is due to this hormone. **Oxytocin is the main parturition hormone.** After parturition, Oxytocin stimulates milk-let down by **milk ejection reflex.**
3. **Relaxin** hormone is secreted by the placenta and the ovary. This hormone relaxes the pubic-symphysis i.e. the joint between the pelvic-girdles. So more space is available to the foetus to move out.

GESTATION PERIOD

The time from fertilization to parturition is termed as gestation-period. Rabbit has gestation-period of 28-30 days. In one time 4-6 young- ones are born in rabbit (Maximum = 8). The group of young-ones born the at same time are called Litter. At the time of birth the young ones of rabbit are blind, deaf and uncovered with fur. They become normal in next 4-5 days. The young-ones of Hare are normal at the time of birth. In humans **actual gestation period is 9 months -7 days.**

In human expected date of delivery (EDD) = I^{st} day of last menstrual cycle plus 9 months + 7 days.

In Rabbit copulation occurs in breeding season which extend from Feb to June.

No specific breeding season is found in human being.

During copulation male ejaculates semen in vagina, this process is called as **insemination.**

In rabbit ovulation occurs after 12-24 hour of copulation. That means copulation is necessary for ovulation. Females in which coitus induction is compulsary for ovulation are called as **induced or reflex ovulator.**

In human female ovulation occurs in presence of FSH & LH. Coitus in not necessary for inducing ovulation. Such a female is called as **spontaneous ovulator.**

After copulation oxytocin hormone is secreted from pituitary gland. This hormone promotes the peristalsis in the fallopian tube.

Due to action of estrogens and progesterone, the endometrium of uterus is prepared for implantation. By the 6^{th} to 7^{th} day, embryo is implanted into endometrium (most commonly at the **fundus**).

BIRTH CONTROL MEASURES

Main aim of birth control measures is to check the population growth rate. These include the using of various types of contraceptives. An ideal contraceptive should be :

(i) User friendly.
(ii) Easily available and cheaper.
(iii) Effective but also reversible.
(iv) With no or least side effects.

These have a **significant role** in checking the uncontrolled growth of human population.

Annual Birth, Death and Growth Rates for Human Population in 1973.

Region	Population (Millions)	Average Birth Rate	Average Death Rate	Annual Growth Rate Percent
1. World	3,860	33	13	2.0
2. Developed Countries	1,120	17	9	0.8
3. Developed Countries	2,740	39	14	2.5

1. **Mechanical or Barrier methods**. These prevent coming closer of ovum and sperms and are of following types :

(a) Condoms : These are rubber or latex sheaths which are put on penis before starting coital activity (copulation). These are popularly called **"Niordh".** These check pregnancy by preventing deposition of sperms in the vagina. These are very widely used contraceptive in India because they are easily available, low cost, reliable, effective and with no side effects. These can be self inserted so give privacy to the user. These also prevent the spread of sexually transmitted diseases (STDs) including AIDS, syphilis, etc.

MALE CONDOM

Female condoms : Hindustan Latex of India and Female Health Company of England have agreed to introduce female condoms in India. It is made of **skinfriendly polyurethane** which acts as a clip on the vagina wall blocking the passage to the womb. These were first marketed in Britain in early 90's and are being used in the USA, Brazil, South Africa, Zimbabwe, France, Sri Lanka, Thailand and Nepal.

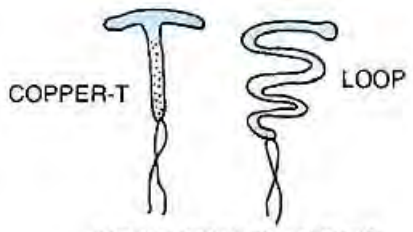
FEMALE CONDOM

(b) Diaphragms and Cervical caps : These are made of rubber and are fitted in vagina of female and check the entry of sperms in uterus. These are reusable.

CERVICAL CAP

(c) Intrauterine Devices (IUD). These include **copper-T** and **loops** which are fitted in the uterus and prevent the fertilization of the egg or implantation of the embryo. Several types of IUDs are available e.g.,

- Non-medicated IUDs e.g., Lippes loop.
- Copper-releasing IUDs e.g., CUT, Cu7 and multiload 375. These release Cu ions which decrease the sperm motility.



INTRA-UTERINE DEVICES

- Hormone-releasing IUDs whose hormones make the uterus unsuitable for implantation.

  But these have certain drawbacks like occasional haemorrhage, chances of infection and spontaneous expulsion.

2. Chemical methods. These are of following types:

(a) Spermicidal tablets, jellies, paste and creams are introduced in the vagina before coital activity. These kill sperms. Common spermicidal chemicals used are lactic acid, citric acid, potassium permanganate, zinc sulphate etc.

(b) Physiological (oral) devices. Birth control pills are taken through mouth. These contain a combination of synthetic progestins (acting like progesterone) and estrogens, so called **"combined pills"**. These progestogen-estrogen combinations inhibit secretion of FSH and LH from anterior lobe of pituitary gland so these inhibit ovulation from the ovary and implantation. These also retard the entry of sperms in the uterus. Commonly used hormonal pills in India are: **Mala-D** (daily) and Saheli (weekly). Saheli contains a non-steroidal preparation called **centchroman**. It has high contraceptive value and with very few side effects.

Drawbacks. These birth control pills generally have side effects like nausea, breast-tenderness, weight gain and breakthrough bleeding (bleeding between menstrual perilous) etc.

(c) Implants : These contain either only progesterone or progesterone-estrogens combinations. These are placed under the skin and act like the oral pills. These have much longer effective period and are found to be very effective even within 72 hours of coitus.

3. Natural or Traditional methods. These methods of birth control depend upon the natural rhythms of a woman. These include following methods

(a) **To abstain.** It involves refraining from coital activity.

(b) **Coitus interruptus.** It involves withdrawing penis by male before ejaculation so that semen is not deposited in the vagina. It is **oldest method** of voluntary fertility control. This method has certain limitations:

– some sperms me, be deposited in the vagina

– even before the sexual climax. may develop psychological and physiological problems to both the partners.

(c) **Rhythm period.** A weak before and a weak after the menstrual phase are supposed to be safe periods for sexual intercourse. It reduces the chances of pregnancy by about 80 per cent. It is so because :

(i) Ovulation generally occurs on 15th day of the menstrual cycle (range is 13-16th day of the cycle).

(ii) Viability period of ovum is of about two to three days.

(iii) Viability period c;f sperm is of only one day.

The period from 10th to 17th day (both days inclusive of the menstrual cycle is called **danger or risk or fertile period** and unprotected sexual intercourse should be avoided during this period. However, rhythm period is not 100 per cent safe period. Effectiveness of rhythm period can be increased by basal body temperature or BBT technology.

(d) Lactational amenorrhoea. It has been noticed that during the period of intense lactation after the parturition, the mother does not undergo menstruation and ovulation so the chances of conception are nearly nil. It also has no side effects but is effective only upto a maximum period of six months after parturition.

4. **Surgical methods.** These methods block the gamete transport and so prevent conception. These methods are highly effective but their reversibility is very low. These include following measures:

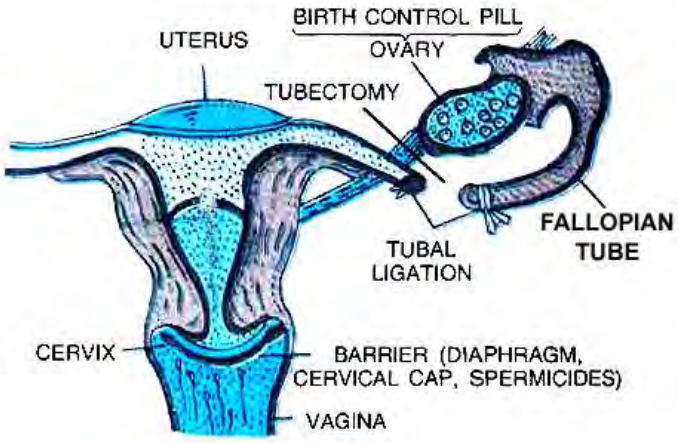
(a) Male sterilization : It is a permanent method of birth control in which either testes are surgically removed, called **castration**, or cutting of the vas deferens, called **vasectomy**.

(b) Female sterilization : Methods of female sterilization include:

(i) **Ovariectomy** involves surgically removal of ovaries.

(ii) **Tubectomy** involves cutting of Fallopian tubes.

(iii) **Tubal ligation** involves blocking of Fallopian tubes by an instrument called **laparoscope**.



SPECIAL POINT

- **Test tube baby -** First test tube baby born in England at 25th July 1978 it was a girl and discovered by Dr. **Steptoet. Edward** the name of baby "*Louis Joy born"*.
- In test tube baby" invitro fertilization" takes place. Invitro early development upto (32 cell stage). Transfer of 32 cells stage zygote into the uterus.
- **Surrogate mother -** When some time uterus of (mother) female used then this female is called. surrogate mother.
- Hysterectomy - Remove of uterus by the surgery.
- Research for a **contraceptive pill for men** that works by deforming the sperms in showing positive results. Its contraceptive effects are reversible.
- '**Injectable contraception** is a reversible and long-acting chemical birth control method. It is most common method of family planning in Indonesia. Injectables contain a synthetic version of progresterone which stops ovulation from the ovaries for about three months.
- Contraceptive pill, **Levonorgestrol**, can prevent pregnancy if taken within five days of unprotected sexual act.
- **Contraceptive corn :** Scientists have produced a genetically-modified com crop which produces antisperm antibodies and suggest that a plant-based jelly may be prepared that will not only prevents pregnancy but also the spraed of STDs. This m ay save the world from over-population.
- Since **September, 2003**, Beijing (China) has started issuing **condom cards** to married womenwho can get condoms free from vending machines.
- ***Family Planning Progmmme*** *was adopted as a* ***National Programme in 1995 A.D.*** *Now it has been renamed as* ***Family Welfare Programme.***

- *Only 12 per cent of males use either vasectomy or condoms indicating about their poor participation in family planning programmes so shifting most of burden on to the fameles .*
- ***Mirena:** A new contraceptive plastic coil coated in copper and is fitted ill the uterus. Copper acts as a spermicide while coil releases small amounts of an artificial hormone, **gastrogen** which further increases the spermicidal effect of copper. It combines both mechanical and hormonal contraceptive methods and has been found to have more than 99% efficary. It is introduced by a Germany company.*
- ***Central Drug Research Institute (Lucknow)** has developed a plant based spermicidal cream **"Consap"** from Reetha **(Sapindus mukrosii).***
- ***Nim-76:** It is a neem based, pre-coital vaginal contraceptive cream having spermicidal properties. It has been developed by Defence Institute of Physiology and Allied Sciences (DIPAS), **New Delhi.** It has been found to be safe, non-hormonal and non-toxic with no side effects. Nim-76 punctures the sperm skin cuasing leakage of cellular contents so preventing the capacitation of sperms. It also has both anti-bacterial and anti-fungal properties.*
- ***India's first test tube baby was "Kanupriya Agarwal".** India's second test tube baby was **"Kumari Harsha".** She was born on August 6, 1986.*
- ***NCP, (National Commission on Population)** in its **April, 2001 report,** has recommended to the Central Government that **"target-free approach",** which believed in the freedom of choice principle being followed after 1996, should be dispensed with. It has recommended that the country should actively preach **"two-children per couple dictum"** as a national goal. It is because that number of sterilisation has drastically declined in the four high-fertility states of U.P. (4.6 TFR), Rajasthan (4.1), Bihar (3.9) and Madhya Pradesh (3.8).*

EXERSICE – 1

Q.1 Which represents mullerian duct in male rabbit-
(1) Vasa differentia
(2) Seminal vesicle
(3) Seminiferous tubule
(4) Urethra

Q.2 Testes permanently retained in abdominal cavity in-
(1) Elephant (2) Whale
(3) Armadillo (4) All the above

Q.3 Temp. of scrotum as compared to abdominal cavity is less by
(1) 1ºC (2) 5ºC (3) 3–4ºC (4) 10ºC

Q.4 Outer coat of seminiferous tubules composed of fibrous connective tissue called
(1) Tunica propria (2) Lamina propria
(3) Plica semilunaris (4) Tunica albuginea

Q.5 Wall of vasa defrense-
(1) Ciliated glandular
(2) Ciliated non glandular
(3) Non-ciliated glandular
(4) Non-ciliated non glandular

Q.6 At the time of sexual excitation, muscles in penis-
(1) Relaxed (2) Contracted
(3) Collapsed (4) None

Q.7 Which acid occur in semen-
(1) Citric acid (2) Mallic acid
(3) Oxalo acetic acid (4) Succinic accid

Q.8 Secretion of which gland have high percentage of fructose
(1) Prostate gland (2) Cowper's gland
(3) Seminal vesicle (4) Tyson

Q.9 If testes of a male rabbit not transferred from abdominal cavity to testes sac then -
(1) Rabbit dies
(2) Absence of male characters
(3) Development of male reproductive system will not occur
(4) Sperms will not form

Q.10 Function of seminal fluid –
(1) Sexual attraction
(2) To provide motility to sperm
(3) To provide a medium for movement of sperms
(4) To provide acidic medium

Q.11 True placenta of mammals is formed by-
(1) Amnion (2) Chorion
(3) Allantois (4) Allanto-chorion

Q.12 Meaning of oligospermia is-
(1) Eggs are fertilized in less number
(2) Less number of sperms in semen
(3) Less munber of sperms formed
(4) Inactive sperm are formed

Q.13 If cowpers gland is removed which of the following will be affected
(1) Sexual attraction (2) Fertilization
(3) Hardness of penis (4) Copulation

Q.14 Atretic follicle is-
(1) Which are not developed completely and degenerate
(2) Other name of which corpus luteum
(3) Which excluded its oocytes
(4) None of the above

Q.15 Non-primate mammals have
(1) Menstrual cycle (2) Oestrous cycly
(3) Breeding seasons
(4) Non–breeding season

Q.16 For ovulation in reflex ovulators-
(1) Coitus is necessary
(2) Coitus is not necessary
(3) Plenty of food is necessary
(4) None

Q.17 Meaning of witches milk is :–
(1) Milk of cow
(2) Milk of women
(3) Sometimes, milk which occurs in infant
(4) None

Q.18 Vasa-efferentia connect the :–
(1) Testes with epididymis
(2) Kidneys with cloaca
(3) Testes with urinogenital duct (4) None

Q.19 Oral-contraceptives prevent the :–
(1) Fertilisation
(2) Ovulation
(3) Implantation
(4) Entrance of sperms in vagina

Q.20 Uterus-masculinus in mammals is derived from:–
(1) Inguinal canal (2) Wolfian's duct
(3) Mullerian duct (4) Ejeculatory duct

Q.21 HCGH is secreted by :–
(1) Trophoblastic cells (2) Interstitial cells
(3) Placenta (4) Mature ovum

Q.22 In mammals, failure of testes to descend into scrotum is known as :–
(1) Paedogenesis (2) Castration
(3) Cryptorchidism (4) Impotency

Q.23 Clupein protein occurs in :–
(1) Human sperms (2) Avian sperms
(3) Human ova (4) All the above

Q.24 A polyoestrous mammalian is :–
(1) Man (2) Cat
(3) Horse (4) All the above

Q.25 In aged person inguinal canal becomes loose, and some parts of intestine is pushed into scrotal sac, the disease is called :–
(1) Myctalopia (2) Hernia
(3) Achondroplasia (4) None

Q.26 Maximum growth in human foetus occurs at which month is :–
(1) Fourth month (2) Sixth month
(3) Second month (4) Eight month

Q.27 Which of the following is ageing pigment :–
(1) Lipofuschin (2) Viletemin
(3) 1 & 2 both (4) Bilirubin

Q.28 Vagina of the female reproductive system is–
(1) Primary sex organs
(2) Accessory sex organs
(3) Secondary sex organs
(4) None

Q.29 External/acessory sexual characters first appear in–
(1) Childhood (2) Puberty
(3) Foetus (4) None of these

Q.30 Puberty occurs in females at the age of :–
(1) 8 - 10 years (2) 11 - 14 years
(3) 15 - 17 years (4) 18 - 20 years

Q.31 Voice is high pitched in :–
(1) Aged persons (2) Adult males
(3) Boys (4) Females

Q.32 First menstrual cycle is :–
(1) Parturition (2) Menopause
(3) Menarche (4) Implantation

Q.33 Non-primate mammals have :–
(1) Menstrual cycle (2) Oestrous cycle
(3) Breeding seasons (4) None

Q.34 Partitions of testis develop from :–
(1) Tunica albuginea (2) Tunica vasculosa
(3) Tunica vaginalis (4) Rete testis

Q.35 Vasa-efferentia posses :–
(1) Peristalsis
(2) secretory cells
(3) Ciliated cells
(4) Opening for seminal vasicle

Q.36 Vas-defrens arises from :–
(1) Cauda-epididymis (2) Caput epididymis
(3) Corpus-epididymis (4) Rete testis

Q.37 Common duct formed by union of vas-defrens and duct from seminal vesicle is :–
(1) Urethra (2) Tunica-vasculosa
(3) Ejaculatory duct (4) Spermatic cord

Q.38 Menstrual cycle is generally of :–
(1) 21 days (2) 28 days
(3) 30 days (4) 3-5 days

Q.39 In menstrual cycle ovum is released during –
(1) Beginning (2) Midway
(3) End (4) Any time

Q.40 Menstrual cycle is controlled by :–
(1) Estrogen and progesterone of ovary
(2) FSH and LH of pituitary
(3) Both 1 & 2
(4) FSH of pituitary

Q.41 Stages in menstrual cycle are :–
(1) Recovery and proliferative phase
(2) Proliferative and secretory phase
(3) Proliferative, secretory and menstrual phase
(4) Recovery phase, secretory phase and phase of menstrual flow

Q.42 Luteal phase is the other name of :–
(1) Follicular phase
(2) Proliferative phase
(3) Menstrual flow phase
(4) Secretory phase

Q.43 Follicular phase of menstrual cycle is the other name of :–
(1) Proliferative phase (2) Secretory phase
(3) Luteal phase (4) Menstruation

Q.44 Mesorchium is peritoneal covering of :–
(1) Ovary (2) Testis
(3) Kidney (4) Liver

Q.45 Phase of menstrual cycle in human that last for 7-8 days is-
(1) Follicular phase (2) Ovulatory phase
(3) Luteal phase (4) Menstruation phase

Q.46 Uterus of female reproductive system is–
(1) Primary sex organs
(2) Secondary sex organs
(3) Accessory sex organs
(4) External sex character

Q.47 Scrotum communicates with abdominal cavity through :–
(1) Urethra (2) Inguinal canal
(3) Vas-deferens (4) Epididymis

Q.48 Ostium is the aperture present in :–
(1) Oviduct (2) Fallopian funnel
(3) Ovisac (4) Cloaca

Q.49 Progesterone is :–
(1) Carbohydrate (2) Steroid
(3) Protein (4) Sterol

Q.50 Tunica albuginea is the covering around :–
(1) Ovary (2) Testis
(3) Kidney (4) Heart

Q.51 Eggs from ovary are released in :–
(1) Oviduct (2) Uterus
(3) Ovary (4) Coelom

Q.52 Development of foetus takes place in :–
(1) Vagina (2) Uterus
(3) Ovary (4) Oviduct

Q.53 Lower narrow end of uterus is called :–
(1) Urethra (2) Cervix
(3) Clitoris (4) Vulva

Q.54 The functional unit of testis of man is :–
(1) Uriniferous tubules
(2) Malpighian tubules
(3) Seminiferous tubules
(4) Acini or lobules

Q.55 Chorionic gonadotropin is secreted by :–
(1) Pituitary (2) Ovary
(3) Placenta (4) Uterus

Q.56 Vitelline membrane is a :–
(1) Primary egg membrane
(2) Secondary egg membrane
(3) Tertiary egg membrane
(4) None of these

Q.57 An egg of bird was coated with varnish and then incubated. The egg did not hatch because the developing embryo :–
(1) could not excrete and died
(2) Could not utilize yolk in the presence of excess amount of nitrogenous wastes
(3) Died because of depleted O_2 supply
(4) Died because of toxic effect of varnish

Q.58 Vaginal cavity of tunica vaginalis is found in –
(1) Ovaries of female (2) Testis of male
(3) Vagina of female (4) None

Q.59 Testesterone is secreted by :–
(1) Leydigs cells (2) Sertoli cells
(3) Pituitary (4) Testis

Q.60 Penile urethra traverses through :–
(1) Corpora cavernosa (2) Corpus spongiosum
(3) Corpus callosum (4) Corpus striatum

Q.61 Seminiferous tubules are composed of :–
(1) Spermatogonia (2) Glandular epithelium
(3) Sensory epithelium (4) Germinal epithelium

Q.62 In mammals, the testes are located in :–
(1) Abdominal cavity
(2) Thoracic cavity
(3) Extra-abdominal cavity
(4) Pericardial cavity

Q.63 Oviduct of frog is actually :–
(1) Bidder's canal (2) Vagina
(3) Mullerian duct (4) None

Q.64 Sperms and ova are :–
(1) Ectodermal in origin (2) Mesodermal in origin
(3) Endodermal in origin (4) All of the above

Q.65 Eggs of female from are stored temporarily before spawning in :–
(1) Oviduct (2) Ovisac
(3) Ureter (4) All

Q.66 Proximal part of oviduct is fimbriated funnel and distal part is :–

(1) Corpus luteum (2) Bartholin's gland
(3) Uterus (4) None

Q.67 Germinal epithelial cells are cuboidal and these are found in :–

(1) Testes (2) Ovary
(3) Both (4) None

Q.68 Subtentacular cells are found in :–

(1) Testis of mammal (2) Ovary of mammal
(3) Testis of Ascaris (4) Pancrease of frog

Q.69 In rabbit, the uterus is :–

(1) Bicornute (2) Multicornute
(3) Unicornute (4) Acornute

Q.70 Abnormal conditining when the mammary glands of man become female like is called–

(1) Feminization (2) Gonochorism
(3) Gynacomastism (4) Gynoecism

Q.71 Bundles of muscles in penis are

(1) Corpus cavernosa (2) Corpus spongiasum
(3) Both (4) None

Q.72 Corpus ablicans is found in ovary it is also found in–

(1) Liver (2) Pituitary
(3) Kidney (4) None

Q.73 Vivipary is found in–

(1) Frog (2) Lizard
(3) Snake (4) Rabbit

Q.74 Which of following animals do not show parental care over their youngs

(1) Mammals (2) Lizards
(3) Fowl (4) Bat

Q.75 Sexual reproduction in larval condition is known as–

(1) Paedogamy (2) Autogamy
(3) Isogamy (4) Anisogamy

Q.76 Degenerative process of follicles or eggs in ovary is called :–

(1) Metagenesis (2) Atresia
(3) Regression (4) None

Q.77 Progesterons is active during–

(1) Menstrual phase (2) Proliferative phase
(3) Follicular phase (4) Secretory phase

Q.78 Glans penis is covered by :–

(1) Areomembrana (2) Prepuce
(3) Metrium (4) None

Q.79 Lutein cells are found in :–

(1) Primary follicle (2) Corpus albicans
(3) Corpus luteum (4) All

Q.80 Pseudopregnancy is due to :–

(1) Polyembryony
(2) Absence of fertilisation after ovulation
(3) Harmonal disturbance
(4) All the above

Q.81 After fertilisation corpus luteum remains for

(1) 8 days (2) 28 days
(3) 80 days (4) 280 days

Q.82 If both male and female systems are present in one individual, the animal is called as :–

(1) Dioecious (2) Protandrous
(3) Unisexual (4) Monoecious

Q.83 Greater maturation of sperms in rabbit takes place in :–

(1) Testes (2) Vasa-efferentia
(3) Epididymis (4) Spermatic cord

Q.84 The bidder canal help to pass out :–

(1) Ova (2) sperms
(3) Both (4) None

Q.85 Which of the following is immortal–

(1) Germ cells (2) Pituitary cells
(3) Brain cells (4) All of these

Q.86 Gestation period is minimum in :–

(1) Rabbit (2) Man
(3) Elephant (4) Mouse

Q.87 The testis are abdominal in :–

(1) Elephant (2) shrew
(3) both (4) None

Q.88 Number of prostate glands in rabbit :–

(1) One (2) Two
(3) Many (4) None

Q.89 The expulsion of completely developed foetus from the uterus is known as :–

(1) Ovulation (2) oviposition
(3) Gestation (4) Parturition

Q.90 Inner layer of graffian follicle is :–
(1) Theca externa (2)Membrana granulosa
(3) Theca interna (4) Discus proligerous

Q.91 Kangaroo is :–
(1) Oviparous (2) Viviparous
(3) Ovo-viviparous (4) None

Q.92 In prototherians mammary glands are :–
(1) Absent
(2) Present in male only
(3) Present in female only
(4) Present in male and female both

Q.93 Central stroma of ovary is made up of :–
(1) White fibrous tissue
(2) Reticular connective tissue
(3) Adipose connective tissue
(4) None

Q.94 Mammalian follicle was first described by :–
(1) Leeuvenhock (2) R.D. Graaf
(3) Spallangi (4) Von Baer

Q.95 Frog is :–
(1) Reflex ovulator (2) Spontaneous ovulator
(3) Induced ovulator (4) None

Q.96 Amnion foetal membrane is absent in :–
(1) Fish (2) Frog (3) Both (4) None

Q.97 Germ-hill is found in :–
(1) sperm (2) Ovum
(3) Graffian follicle (4) All

Q.98 Antrum is filled with fluid and is found in :–
(1) Bone-marrow of bone
(2) Cavity of brain
(3) Graffian follicle of ovary
(4) Pericardium of heart

Q.99 One of the following is fibrous layer of follicle–
(1) Theca exterma (2) Theca interna
(3) Membrana granulosa (4) Vitelline membrane

Q.100 Fertilization in man and rabbit takes place in fallopian tube of oviduct in :–
(1) Proximal part (2) Distal part
(3) Basal part (4) None

Q.101 Scrotal sacs of man and rabbit are connected with the abdominal cavity by :–
(1) Ingunal canal (2) Haversian canal
(3) Vagina cavity (4) Spermatic canal

Q.102 Clitoris in female mammals is :–
(1) Homologous to penis
(2) Analogous to penis
(3) Functional penis in females
(4) None functional

Q.103 Eggs librated from ovary in :–
(1) Secondary oocyte stage
(2) Primary oocyte stage
(3) Oogonial stage
(4) Mature ovum stage

Q.104 Cryptorchidism is a condition of testes :–
(1) Unable to descend in scrotal sacs
(2) Unable to produce sperms
(3) Having been surgically removed
(4) Having remained undeveloped

Q.105 In mammals, the testes occur in scrotal sacs, outside the viscrea becasue of the :–
(1) Less space in abdominal cavity
(2) Presence of rectum
(3) Long vas-deferens
(4) Requirement of low temperature for spermatogenesis

Q.106 Number of polar bodies formed in rabbit in ovary is–
(1) 1 (2) 2 (3) 3 (4) 4

Q.107 Sertoli cells are found in :–
(1) Testis of cockroach (2) Liver of mammals
(3) Testis of mammals (4) Testis of frog

Q.108 Graffian follicle are found in :–
(1) Testis of mammal (2) Ovary of frog
(3) Ovary of cockroach (4) Ovary of mammals

Q.109 Sertoli cells are found in :–
(1) Seminiferous tubules
(2) Germinal epithelium
(3) Cauda epididymis
(4) Caput epididymis

Q.110 Cells of Leydig occur in :–
(1) Liver (2) Ovary
(3) Testis (4) Spleen

Q.111 Location and secretion of leydig cells are :–
(1) Liver – choleseterole
(2) Ovary – oestrogen
(3) Testis – Testosterone
(4) Pancrease – Glucagon

Q.112 A female gland corresponding to prostate of males is–
(1) Perineal gland (2) Bartholin's gland
(3) Bulbourethral gland (4) None

Q.113 Site of fertilisation in mammal is :–
(1) Ovary (2) Uterus
(3) Vagina (4) Fallopian tube

Q.114 Endomatrium is lining of :–
(1) Testis (2) Urinary bladder
(3) Uterus (4) Ureter

Q.115 A secondary character is :–
(1) Breast (2) Ovary
(3) Testis (4) Thyroid

Q.116 Percentage of syndromes increases in the offspring of a lady over 40 years. It is because :–
(1) Oocytes grow older (2) Ovaries are weak
(3) Placenta is weak (4) Lady becomes weak

Q.117 Seminal vesicle is present at the junction of–
(1) Prostate and urethra
(2) Prostate and vas-deferens
(3) Prostate and cowper's gland
(4) vas-deferns and testis

Q.118 Expanded proximal part of oviduct in female is :–
(1) Uterus (2) Fallopian tube
(3) Fimbriated funnel (4) Vestibule

Q.119 The excretory structure formed after ovulation (release of ovum from graphian follicle) is :–
(1) Corpus albicans (2) Corpus callosum
(3) Corpus leuteum (4) Corpus striatum

Q.120 Seminiferous tubules occur in :–
(1) Liver (2) Kidney
(3) Ovary (4) Testis

Q.121 Spermatogenesis and sperm differentiation are under the control of :–
(1) FSH (2) LH
(3) Testesterone (4)Parathyroid Harmone

Q.122 Development of sperm from spermatids take place in–
(1) Leyding's cells (2) Kuffer's cells
(3) Spermatogonia (4) Sertoli cell

Q.123 Seminal fluid has sperms and secretions of–
(1) Prostate, cowper's & Bertholin glands
(2) Seminal vesicle, Prostate & cowper's glands
(3) Seminal vescile, ureter & Prostate gland
(4) Follicles, ureters and prostate gland

Q.124 Cowper's gland are found in :–
(1) Male mammals (2) Female mammals
(3) Male amphibians (4) Female amphibians

Q.125 Corpus luteum is :–
(1) Excretory (2) Endocrine
(3) Digestive (4) Reproductive

Q.126 Enzyme hyaluronidase is synthesised in :–
(1) Head of sperm
(2) Golgibody of acrosome
(3) Lysosome of acrosome
(4) Tail of sperm

Q.127 Tail less sperm occurs in :–
(1) Frog (2) Ascaris
(3) Amphioxus (4) Rabbit

Q.128 Sertoli cells occurs in :–
(1) Human testis (2) Frog testis
(3) Human ovary (4) Frog ovary

Q.129 Loss of reproductive capacity in women after age of 45 years is :–
(1) Menstruation (2) Ageing
(3) Menopause (4) Menarche

Q.130 On fertilization, the urine of would be ..... other contains :–
(1) LH (2) Progesterone
(3) FSH (4) HCG

Q.131 Which one is primary sex organ :–
(1) Scrotum (2) Penis
(3) Testis (4) Prostrate

Q.132 Estrous cycle is indication of :–
(1) Breeding period (2) Estrogen secretion
(3) Pregnancy (4) Menopause

Q.133 A female gland correspounding to prostate of males is :–
(1) Bartholin's gland (2) Bulbourethral gland
(3) Clitoris (4) None

Q.134 Ovulation occurs under the influence of :–
(1) LH (2) FSH
(3) Estrogen (4) Progesterone

Q.135 Somatic chromosomes number is 40. What shall be chromosomal number in the cell of seminiferous tubules :–
(1) 40 (2) 20 (3) 10 (4) 40 and 20

Q.136 In 28 day human ovarian cycle, ovulation occurs on :–
(1) Day 1 (2) Day 5 (3) Day 14 (4) Day 28

Q.137 Progesterone is secreted by :–
(1) Corpus Luteum (2) Thyroid
(3) Thymus (4) Testis

Q.138 Release of oocytes from ovary is :–
(1) Gestation (2) Ovulation
(3) Parturition (4) Implantation

Q.139 Growth and maturation of graphian follicle is controlled by :–
(1) FSH-LH (2) FSH-LTH
(3) ACTH-LH (4) GH-ADH

Q.140 Monoestrous cycle animals have :–
(1) One ovulation each month
(2) One egg
(3) One breeding season in a year
(4) One menses each month

Q.141 Testis of rabbit occur :–
(1) One either side of dorsal aorta
(2) Inside body
(3) On side of kidneys
(4) In scrotal sacs

Q.142 Estrous cycle is characteristic of :–
(1) Human females
(2) Mammalian females
(3) Mammalian females other than primates
(4) Mammals

Q.143 Sugar fructose is present in the secretion of–
(1) Prostate gland (2) Perineal gland
(3) Cowper's gland (4) Seminalvesicle

Q.144 Spermatozoa are nourished during their development :–
(1) Sertoli cells (2) Interstitial cells
(3) Connective tissue cells
(4) None

Q.145 Sertoli cells are found in the–
(1) Frog's testis (2) Rabbit's testis
(3) Cockroach's testis (4) Liver of frog

Q.146 Acrosome is made up of–
(1) Mitochondria (2) Centrioles
(3) Golgi bodies (4) Ribosomes

Q.147 Achrosome aids the sperm to–
(1) Penetrate vittelline membrane of ovum
(2) Find ovum
(3) Swim
(4) Higher activity

Q.148 Secondary sex organ is :–
(1) Testis (2) Breast
(3) Beard (4) Vasa deferens

Q.149 Cessation of menstrual cycle is called :–
(1) Ovulation (2) Menopause
(3) Puberty (4) Implantation

Q.150 What would happen if vasa deferantia of man are cut:–
(1) Sperms are non nucleate
(2) Spermatogenesis does not occur
(3) Seman is with out sperms
(4) Sperm are non motile

ANSWER KEY

EXERCISE - 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	3	1	3	1	1	3	4	3	4	2	2	1	2	1	3	1	2	3
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	3	1	2	2	1	1	3	2	2	4	3	2	1	3	1	3	2	2	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	4	1	1	1	4	2	2	2	2	4	2	2	3	3	1	3	2	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	3	3	3	2	3	3	1	1	3	3	2	4	2	1	2	2	2	3	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	4	3	2	1	4	3	1	4	4	3	4	1	2	2	3	3	3	2	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	1	1	1	4	1	3	4	1	3	3	4	4	3	1	1	2	3	3	4
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	4	2	1	2	2	2	1	3	4	3	1	4	1	4	3	1	2	1	3
Ques.	141	142	143	144	145	146	147	148	149	150										
Ans.	4	3	4	1	2	3	1	4	2	3										

EXERSICE – 2

Q.1 Which one is primary sex organ ?
(1) Scrotum (2) Penis
(3) Testis (4) Protate

Q.2 Which is correct ?
(1) Menstrual cycle is present in all mammals
(2) Menstrual cycle occurs in human, apes and old monkey
(3) Estrous cycle occurs in all mammals
(4) Most mammals are ovoviviparous

Q.3 Yellow corpus luteum occurs in a mammal in
(1) Heart to initiate heart beat
(2) Skin to function as pain receptor
(3) Brain and connects cerebral hemispheres
(4) Ovary for secretion of progesterone

Q.4 A female gland corresponding to prostate of males is-
(1) Bartholin's gland
(2) Bulbourethral gland
(3) Clitoris
(4) None of the above

Q.5 What would happen if vasa deferentia of man are cut ?
(1) Sperms become non-nucleated
(2) Spermatogenesis does not occur
(3) Semen is without sperms
(4) Sperms are nonmotile

Q.6 When a sperm enters an egg of frog
(1) first polar body is formed
(2) first meiotic division occurs
(3) fertilization process is completed
(4) second meiotic division occurs

Q.7 Largest egg in Animal Kingdom is that of
(1) Whale (2) Elephant
(3) Albatrosses (4) Ostrich

Q.8 Human ovarian cycle is of 28 days, ovulation occurs on
(1) Day 1^{st} (2) Day 5^{th}
(3) Day 14^{th} (4) Day 28^{th}

Q.9 Germinal epithelium of ovary has
(1) Cuboidal cells (2) Columnar cells
(3) Squamous cells (4) Stratified cells.

Q.10 Growth and maturation of Graafian follicle is controlled by
(1) FSH – LH (2) FSH – LTH
(3) ACTH – LH (4) GH – ADH

Q.11 Oestrous cycle is characteristic of:
(1) Human females
(2) Mammalian females
(3) Mammalian females other than primates
(4) Mammals

Q.12 Sugar fructose is present in the secretion of :
(1) Prostate gland (2) Perineal glands
(3) Cowper's glands (4) Seminal vesicles

Q.13 Ovulation occurs under the influence of
(1) LH (2) FSH
(3) Estrogen (4) Progesterone

Q.14 During copulation a slimy alkaline fluid to lubricate vagina is secreted by
(1) perineal gland (2) Cowper's gland
(3) Prostate gland (4) None of these

Q.15 Which one is hermaphrodite ?
(1) Earthworm, Hydra and Leech
(2) Cockroach, Earthworm and Hydra
(3) Earthworm, Ascaris and Leech
(4) Ascaris, cockroach and Hydra

Q.16 Testis of Whale are
(1) Extra-abdominal (2) Half external, half internal
(3) Internal (4) None of these

Q.17 Prostate gland is present :
(1) On ureter (2) On kidney
(3) On testis (4) Around urethra

Q.18 Prostate gland produces a secretion for-
(1) Attracting sperms
(2) Stimulating sperm activity
(3) Inhibiting sperm activity
(4) None of the above

Q.19 Corpus luteum develops from
(1) Oocyte (2) Nephrostome
(3) Graafian follicle (4) None of the above

Q.20 If egg is not fertilized, the corpus luteum
(1) Reduces secretion of progesterone
(2) Changes in corpus albicans
(3) Enhances secretion of progesterone
(4) None of these

Q.21 Failure of testes to descend into scrotum is-
(1) Vasectomy (2) Cryptorchidism
(3) Impotency (4) Tubectomy

Q.22 Sertoli cells are involved in
(1) Excretion (2) Respiration
(3) Nutrition of sperms (4) All of the above

Q.23 In male mammals primary germ cell is-
(1) cortex of testis (2) medulla of testis
(3) germinal epithelium (4) apical part of embryo

Q.24 Secretion of progesterone by corpus luteum is initiated by :
(1) MSH (2) LH
(3) Testosterone (4) Thyroxine

Q.25 Graafian follicle of ovary secretes-
(1) Estrogen (2) Relaxin
(3) Progesterone (4) Cortisone

Q.26 Seminal vesicles are located in-
(1) Caput epidydimis (2) Uterus
(3) Below Cowper's glands (4) Glans penis

Q.27 Number of eggs released in the life time of a woman is approximately :
(1) 40 (2) 400
(3) 4000 (4) 20000

Q.28 Correct sequence of hormone secretion from beginning of menstruation is :
(1) FSH, progesterone, estrogen
(2) Estrogen, FSH, progesterone
(3) FSH, estrogen, progesterone
(4) Estrogen, progesterone, FSH

Q.29 From acrosome which secrets :
(1) hyaluronic acid (2) hyaluronidase
(3) TSH (4) fertilizin

Q.30 When embryonic development is completed in mother but the embryo not accept nutritent from mother. Which is known as :
(1) ovoviparous (2) viviparous
(3) oviparous (4) all of these

Q.31 Sertoli cells are associated with :
(1) Kidney of Rabbit (2) ovary of Frog
(3) Testis of Rabbit (4) Ovary of Rabbit

Q.32 Gametes formation in animlals is found in-
(1) ovary (2) gonads
(3) gall bladder (4) testis

Q.33 All mechanism of living organism divided in two parts:
(1) reproduction and evolution
(2) nutrition and metabolism
(3) synthesis and metabolism
(4) reproduction and internal autonomy

Q.34 Corpus leuteum secrets :
(1) LH (2) progesterone
(3) estrogen (4) FSH

Q.35 Glands secreting male sex hormone are :
(1) Leydig cells (2) Seminiferous tubules
(3) Vasa deferentia (4) Testes

Q.36 Cervix occurs in :
(1) Kideny
(2) Fallopian tube
(3) Between uterus and vagina
(4) Epididymis

Q.37 Graafian follicle contains
(1) Many oocyte
(2) Many sperm
(3) A single oocyte
(4) Site for egg fertilization

Q.38 Mullerian duct is
(1) Ureter (2) Urethra
(3) Sperm duct (4) Oviduct

Q.39 Progesterone level falls during :
(1) Gestation (2) Menopause
(3) Lactation (4) Mensturation

Q.40 Head of epididymis present at head of testis is called:
(1) Caput epididymis (2) Cauda epididymis
(3) Vas deferens (4) Gubernaculum

Q.41 Human female reaches menopause at the age of about-
(1) 25 years (2) 35 years
(3) 50 years (4) 70 years

Q.42 Orchidectomy is the surgical removal of :
(1) Liver (2) Kidney
(3) Ovary (4) Testis

Q.43 This is a method of birth control :
(1) IUDs (2) GIFT
(3) HTF (4) IVE-ET

Q.44 Sertoli cells occur in :
(1) Ovary (2) Kidney
(3) Testis (4) Thyroid

Q.45 Fertilization in Rabbit occurs in :
(1) Uterus (2) Fallopian tube
(3) Ovary (4) Water

Q.46 Process of fusion of haploid cells is-
(1) Cell cycle (2) Meiosis
(3) Mitosis (4) Syngamy

Q.47 Antrum is cavity of -
(1) Ovary (2) Graafian follicle
(3) Blastula (4) Gastrula

Q.48 Estrogen is secreted by :
(1) Corpus luteum
(2) Membranous granulosa of Graafian follicle
(3) Germinal epithelium of ovary
(4) Pituitary gland

Q.49 A normal human being will have :
(1) 22 pairs of chromosome
(2) 23 pairs of chromosome
(3) 44 pairs of chromosome
(4) 46 pairs of chromosome

Q.50 The human sprem cell contains :
(1) 46 chromosomes
(2) 44 chromosomes and 1X and 1Y chromosome
(3) 23 chromosomes only
(4) 23 chromosomes and 1X and 1Y chromosome

Q.51 The mobility of a mature sperm is controlled by the mitochondria located in the
(1) head (2) middle piece
(3) tail (4) in all of them

Q.52 In mammals corpus Inuteum is found in which organ?
(1) Brain (2) Ovary
(3) Liver (4) Eyes

Q.53 In Rabbit at the time of fertilization zygote is formed in :
(1) coelom (2) fallopian tube
(3) uterus (4) vagina

Q.54 Bartholin's glands are situated-
(1) On either side of vas deferens in human
(2) On the sides of the head of some amphibian
(3) At the reduced tail end of birds
(4) On either sides of vagina in human

Q.55 The site of fertilization in mammals is-
(1) Ovary (2) Abdominal
(3) Uterus (4) Fallopian tube

Q.56 Natural parthenogenesis is found in-
(1) Housefly (2) Honey bee
(3) Drosophila (4) All of these

Q.57 Spermatogenesis is induced by -
(1) FSH (2) ACTH
(3) ICSH (4) ATH

Q.58 Vivipary is found in-
(1) Coelenterata (2) Protozoa
(3) Rabbit (4) Pisces

Q.59 Testis fail to descent in scrotal sacs, this condition is called as-
(1) Cryptorhcidism (2) Hernia
(3) Castrection (4) None of these

Q.60 Sertoli cells are present in-
(1) Testis (2) Ovary
(3) Blood (4) Lymph

Q.61 In the urinogenital organs of rabbit which one of the following part is present in male but not in female?
(1) Vagina (2) Urethra
(3) Fallopian tube (4) Vasa deferens

Q.62 Which one of the following events is correctly matched with the time period in a normal menstrual cycle ?
(1) Release of egg : 5th day
(2) Endometrium regeneration : 5-10 days
(3) Endometrium secretes nutrients for implantation : 11-18 days
(4) Rise in progesterone level : 1 - 15 days

Q.63 Withdrawal of which of the following hormones is the immediate cause of menstruation?
(1) Progesterone (2) Estrogen
(3) FSH (4) FSH-RH

Q.64 Which part of ovary in mammals acts as an endocrine gland after ovulation?
(1) Stroma (2) Germinal epithelium
(3) Vitelline membrane (4) Graffian follicle

Q.65 In the human female, menstruation can be deferred by the administration of-
(1) Combination of FSH and LH
(2) Combination of estrogen and progesterone
(3) FSH only (4) LH only

Q.66 Compared to a bull a bullock is docile because of-
(1) Higher levels of cortisone
(2) Lower levels of blood testosterone
(3) Lower level of adrenaline/noradrenalin in its blood
(4) Higher level of thyroxin

Q.67 Outer coat of seminiferous tubules is composed of fibrous connective tissue called -
(1) Tunica propria (2) Lamina propria
(3) Plica semilunaris (4) Tunica albuginea

Q.68 At the time of sexual excitation, muscles in penis-
(1) Relaxed (2) Contracted
(3) Collapsed (4) None

Q.69 Pseudopregnancy is due to
(1) Polyembryony
(2) Absence of fertilisation after ovulation
(3) Hormonal disturbance
(4) All the above

Q.70 Secretion of which gland has high percentage of fructose -
(1) Prostate gland (2) Cowper's gland
(3) Seminal vesicle (4) Tyson

Q.71 If testes of a male rabbit are not transferred from abdominal cavity to testes sac then -
(1) Rabbit dies
(2) Absence of male characters
(3) Development of male reproductive system will not occur
(4) Sperms will not form

Q.72 Uterus-masculinus in mammals is derived from-
(1) Inguinal canal (2) Wolfian's duct
(3) Mullerian duct (4) Ejeculatory duct

Q.73 In mammals, failure of testes to descend into scrotum is known as -
(1) Paedogenesis (2) Castration
(3) Cryptorchidism (4) Impotency

Q.74 Clupein protein occurs in -
(1) Human sperms (2) Avian sperms
(3) Human ova (4) All the above

Q.75 Partitions of testis develop from -
(1) Tunica albuginea (2) Tunica vasculosa
(3) Tunica vaginalis (4) Rete testis

Q.76 Vas-deferens arises from -
(1) Cauda-epididymis
(2) Caput epididymis
(3) Corpus epididymis
(4) Rete testis

Q.77 Common duct formed by union of vas-deferens and duct from seminal vesicle is -
(1) Urethra (2) Tunica-vasculosa
(3) Ejaculatory duct (4) Spermatic duct

Q.78 Mesorchium is peritoneal covering of
(1) Ovary (2) Testis
(3) Kidney (4) Liver

Q.79 Scrotum communicates with abdominal cavity through -
(1) Urethra (2) Inguinal canal
(3) Vas-deferens (4) Epididymis

Q.80 Tunica albuginea is the covering around -
(1) Oviduct (2) Testis
(3) Kidney (4) Heart

Q.81 Testosterone is secreted by -
(1) Leydigs cells (2) Sertoli cells
(3) Pituitary (4) Testis

Q.82 Penile urethra traverses through -
(1) Corpora cavernosa
(2) Corpus spongiosum
(3) Corpus callosum
(4) Corpus striatum

Q.83 Seminiferous tubules are composed of -
(1) Spermatogonia (2) Glandular epithelium
(3) Sensory epithelium (4) Germinal epithelium

Q.84 Sustentacular cells are found in -
(1) Testis of mammal (2) Ovary of mammal
(3) Testis of Ascaris (4) Pancrease of frog

Q.85 Bundles of muscles in penis are -
(1) Corpus cavernosa (2) Corpus spongiosum
(3) Both (4) None

Q.86 Glans penis is covered by -
(1) Areomembrana (2) Prepuce
(3) Metrium (4) None

Q.87 Lutein cells are found in -
(1) Primary follicle (2) Corpus albicans
(3) Corpus luteum (4) All

Q.88 The testis are abdominal in -
(1) Elephant (2) shrew
(3) Both (1) & (2) (4) None

Q.89 Number of prostate glands in rabbit -
(1) One (2) Two
(3) Many (4) None

Q.90 Scrotal sacs of man and rabbit are connected with the abdominal cavity by -
(1) Inguinal canal (2) Haversian canal
(3) Vagina cavity (4) Spermatic canal

Q.91 Cryptorchidism is a condition of testes
(1) Unable to descend in scrotal sacs
(2) Unable to produce sperms
(3) Having been surgically removed
(4) Having remained undeveloped

Q.92 In mammals, the testes occur in scrotal sacs, out side the viscera because of the -
(1) Presence of urinary bladder
(2) Presence of rectum
(3) Long vas-deferens
(4) Requirement of low temperature for spermatogenesis

Q.93 In between spermatogonia are found -
(1) Germinal cells (2) Sertoli cells
(3) Epithelial cells (4) Lymph space

Q.94 Sertoli cells are found in -
(1) Testis of cockroach (2) Liver of mammals
(3) Testis of mammals (4) Testis of frog

Q.95 Which acessory genital gland occurs only in male mammal
(1) Bartholin's gland (2) Perineal gland
(3) Prostate gland (4) All

Q.96 Seminal vesicle is present at the junction of -
(1) Prostate and urethra
(2) Prostate and vas-deferens
(3) Prostate and cowper's gland
(4) vas-deferns and testis

Q.97 During differentiation the spermatids remain associated with -
(1) Leyding's cells (2) Kuffer's cells
(3) Spermatogonia (4) Sertoli cell

Q.98 Seminal fluid has sperms and secretions of -
(1) Prostate, cowper's & Bartholin glands
(2) Seminal vesicle, Prostate & cowper's glands
(3) Seminal vesicle, ureter & Prostate gland
(4) Follicles, ureters and prostate gland

Q.99 Sugar fructose is present in the secretion of -
(1) Seminal vesicle (2) Perineal gland
(3) Cowper's gland (4) Bartholin's gland

Q.100 Spermatozoa are nourished during their development by -
(1) Sertoli cells (2) Interstitial cells
(3) Connective tissue cells
(4) None

Q.101 Sertoli cells are found in the
(1) Frog's testis (2) Rabbit's testis
(3) Cockroach's testis (4) Liver of frog

Q.102 What whould happen if vasa deferantia of man are cut
(1) Sperms are non nucleate
(2) Spermatogenesis does not occur
(3) Semen is with out sperms
(4) Sperm are non motile

Q.103 If the epididymis is not presented then what will happen
(1) sperm life cycle is short
(2) Early cross the pathway
(3 Functional maturation is early
(4) Sperm will be incapable for fertilization

Q.104 In majority of pre mature babies testis is situated in
(1) Scrotal sac
(2) Abdominal cavity
(3) Descending pathway
(4) Come into scrotal sac but not attached properly

Q.105 After vasectomy what happens
(1) Absence of semen
(2) Sperm are dead or inactive
(3) Sperm immediately disapear in semen
(4) Sperm gradually disapear in semen

Q.106 Sertoli cells occur in -
(1) Human testis (2) Frog testis
(3) Human ovary (4) Frog ovary

Q.107 Which one is primary sex organ
(1) Scrotum (2) Penis
(3) Testis (4) Prostrate

Q.108 If somatic chromosomes number is 40. What shall be chromosomal number in the cell of seminiferous tubules -
(1) 40 (2) 20
(3) 10 (4) 40 and 20

Q.109 Testis of rabbit occur
(1) One either side of dorsal aorta
(2) Inside body
(3) On side of kidneys
(4) In scrotal sacs

Q.110 Meaning of oligospermia is
(1) Eggs are fertilized in less number
(2) Less number of sperms in semen
(3) More number of sperms formed
(4) Inactive sperm are formed

Q.111 In aged person inguinal canal becomes loose, and some part of intestine is pushed into scrotal sac, the disease is called
(1) Myctalopia (2) Hernia
(3) Achondroplasia (4) None

Q.112 Vagina of the female reproductive system is -
(1) Primary sex organs
(2) Essential sex organs
(3) Secondary sex organs
(4) None

Q.113 External/acessory sexual characters first appear in-
(1) Childhood (2) Puberty
(3) Foetus (4) Adulthood

Q.114 Puberty occurs in females at the age of -
(1) 8-10 years (2) 11-14 years
(3) 15-17 years (4) 18-20 years

Q.115 Mesovarium is peritoneal covering of -
(1) Ovary (2) Testis
(3) Kidney (4) Liver

Q.116 At puberty woman start producing
(1) Sperms (2) Urine
(3) Young ones (4) Ova

Q.117 Ostium is the aperture present in
(1) oviduct (2) Fallopian funnel
(3) Ovisac (4) Cloaca

Q.118 Progesterone is
(1) Carbohydrate (2) Steroid
(3) Protein (4) Sterol

Q.119 Eggs from ovary are released in -
(1) Oviduct (2) Kidney
(3) Ureter (4) Coelom

Q.120 Lower narrow end of uterus is called -
(1) Urethra (2) Cervix
(3) Clitoris (4) Vulva

Q.121 Vaginal cavity of tunica vaginalis is found in -
(1) Ovaries of female
(2) Testis of male
(3) Vagina of female
(4) None

Q.122 Oviduct of frog is actually -
(1) Bidder's canal (2) Vagina
(3) Mullerian duct (4) None

Q.123 Sperms and ova are -
(1) Ectodermal in origin
(2) Mesodermal in origin
(3) Endodermal in origin
(4) All of the above

Q.124 Proximal part of oviduct is fimbriated funnel and distal part forms the -
(1) Corpus luteum (2) Bartholin's gland
(3) Uterus (4) None

Q.125 Germinal epithelial cells are cuboidal and these are found in -
(1) Testes (2) Ovary
(3) Both (4) None

Q.126 In rabbit the uterus is -
(1) Bicornute (2) Multicornute
(3) Unicornute (4) Acornute

Q.127 Corpus albicans is found in ovary it is also found in-
(1) Liver (2) Brain
(3) Kidney (4) None

Q.128 Degenerative process of follicles or eggs in ovary is called -
(1) Metagenesis (2) Atresia
(3) Regression (4) None

Q.129 Process by which Graffian follicles are formed in the ovary is known as -
(1) Oogenesis (2) Luteirisation
(2) Folliculogenesis (4) All

Q.130 Central stroma of ovary is made up of -
(1) Fibrous connective tissue
(2) Reticular tissue
(3) Adipose connective tissue
(4) None

Q.131 Mammalian follicle was first described by
(1) Leeuvenhock (2) R.D. Graaf
(3) Spallangi (4) Von Baer

Q.132 Antrum is filled with fluid and is found in -
(1) Bone-marrow of bone
(2) Cavity of brain
(3) Graffian follicle of ovary
(4) Pericardium of heart

Q.133 One of the following is fibrous layer of follicle
(1) Theca externa (2) Zona pellucida
(3) Membrana granulosa
(4) Vitelline membrane

Q.134 Fertilization in man and rabbit takes place in fallopian tube of oviduct in -
(1) Proximal part (2) Distal part
(3) Basal part (4) None

Q.135 Eggs librated from ovary in human in
(1) Secondary oocyte stage
(2) Primary oocyte stage
(3) Oogonial stage
(4) Mature ovum stage

Q.136 Graffian follicle are found in
(1) Testis of mammal (2) Ovary of frog
(3) Ovary of cockroach
(4) Ovary of mammals

Q.137 Site of fertilization in mammal is -
(1) Ovary (2) Uterus
(3) Vagina (4) Fallopian tube

Q.138 Endometrium is lining of
(1) Testis (2) Urinary bladder
(3) Uterus (4) Ureter

Q.139 A secondary sexual character is
(1) Breast (2) Ovary
(3) Testis (4) Thyroid

Q.140 Expanded proximal part of oviduct in female is -
(1) Uterus (2) Fallopian tube
(3) Fimbriated funnel (4) Vestibule

Q.141 The Endocrinal structure formed after ovulation (release of ovum from graafian follicle is -
(1) Corpus albicans (2) Corpus callosum
(3) Corpus luteum (4) Corpus striatum

Q.142 Human beings are
(1) Ovoviviparous (2) Oviparous
(3) parthenogenetic (4) Viviparous

Q.143 At the time of birth, ovum is the form of
(1) Oogonia (2) Primary oocyte
(3) Sec. oocytes (4) Egg

Q.144 Cowper's glands are found in
(1) Male mammals
(2) Female birds
(3) Male amphibians
(4) Female amphibians

Q.145 Corpus luteum is
(1) Excretory (2) Endocrine
(3) Digestive (4) Reproductive

Q.146 A female gland corresponding to prostrate of males is
(1) Bartholin's gland (2) Bulbourethral gland
(3) Clitoris (4) None

Q.147 Progesterone is secreted by
(1) Corpus Luteum (2) Thyroid
(3) Thymus (4) Testis

Q.148 Growth and maturation of graafian follicle is controlled by -
(1) FSH-LH (2) FSH-LTH
(3) ACTH-LH (4) GH-ADH

Q.149 If cowpers gland is removed which of the following will be affected -
(1) Sexual attraction (2) Fertilization
(3) Hardness of penis (4) Copulation

Q.150 Atretic follicle is -
(1) Which are not developed completely and degenerate
(2) Other name of which corpus luteum
(3) Which excluded its oocytes
(4) None of the above

Q.151 For ovulation in reflex ovulation -
(1) Coitus in necessary
(2) Coitus is not necessary
(3) Plenty of food is necessary
(4) None

Q.152 Oral-contraceptives prevent the
(1) Fertilisation (2) Ovulation
(3) Implantation
(4) Entrance of sperms in vagina

Q.153 A polyoestrous mammalian example is -
(1) Man (2) Cat
(3) New age monkey (4) All the above

Q.154 Voice is high pitched in -
(1) Aged persons (2) Adult males
(3) Boys (4) Females

Q.155 First menstrual cycle starts at
(1) Parturition (2) Menopause
(3) Menarche (4) Implantation

Q.156 Gestation period of Rabbit is -
(1) 18 - 20 days (2) 28 - 32 days
(3) 48 - 50 days (4) 60 - 70 dyas

Q.157 Menstrual cycle is generally of -
(1) 21 days (2) 28 days
(3) 38 days (4) 40 days

Q.158 In menstrual Cycle ovum is released during -

(1) Beginning (2) Midway

(3) End (4) Any time

Q.159 Menstrual cycle is controlled by -

(1) Estrogen and progesterone of ovary

(2) FSH and LH of pituitary

(3) Both (1) and (2)

(4) FSH of pituitary

Q.160 Stages in menstrual cycle are -

(1) Recovery and proliferative phase

(2) Proliferative and secretory phase

(3) Proliferative, secretory and menstrual phase

(4) Recovery phase, secretory phase and phase of menstrual flow

Q.161 Luteal phase is the other name of -

(1) Follicular phase

(2) Proliferative phase

(3) Menstrual flow phase

(4) Secretory phase

Q.162 Follicular phase of menstrual cycle is the other name of -

(1) Proliferative phase (2) Secretory phase

(3) Luteal phase (4) Menstruation

Q.163 Cryptorchidism is a condition of testes

(1) Unable to descend in scrotal sacs

(2) Unable to produce sperms

(3) Having been surgically removed

(4) Having remained undeveloped

Q.164 Abnormal conditioning when the mammary glands of man become female like is called

(1) Feminization

(2) Gonochorism

(3) Gynacomastism

(4) Gynoecism

Q.165 Vivipary is found in -

(1) Frog (2) Lizard

(3) Snake (4) Rabbit

ANSWER KEY

EXERCISE - 2

Ques	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	2	4	4	3	4	4	3	1	1	3	4	1	4	1	3	4	3	3	2
Ques	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	3	3	2	1	1	2	3	2	1	3	2	4	2	4	3	3	4	4	1
Ques	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	4	1	3	2	4	2	2	2	4	2	2	2	4	4	2	1	3	1	1
Ques	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	2	1	4	2	2	1	1	3	3	4	3	3	1	1	1	3	2	2	2
Ques	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	2	4	1	3	2	3	3	1	1	1	4	2	3	3	2	4	2	1	1
Ques	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	3	4	3	4	1	3	4	4	2	2	3	2	2	1	4	2	2	4	2
Ques	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	3	2	3	3	1	2	2	3	1	2	3	1	1	1	4	4	3	1	3
Ques	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	3	4	2	4	2	4	1	1	2	1	1	2	2	4	3	2	2	2	3	3
Ques	161	162	163	164	165															
Ans.	4	1	1	3	4															

EXERCISE-3 PREVIOUS YEAR'S QUESTIONS

Q.1 The lytic enzyme present in semen is – **[Uttaranchal PMT 2004]**
(1) Ligase (2) estrogenase
(3) androgenase (4) hyaluronidase

Q.2 Progesterone hormone is secreted by – **[Jharkahnd 2004]**
(1) Corpus albicans (2) corpus collosum
(3) Corpus luteum in ovaries
(4) Corpus uteri

Q.3 Sertoli cells are involved in - **[Jharkhand-04]**
(1) Respiration (2) Nutrition of sperms
(3) Excretion
(4) Development of sex organs

Q.4 In mammals corpus luteum is found in which organ - **[Jharkahand-04]**
(1) Brain (2) Ovary
(3) Liver (4) Eyes

Q.5 Testosterone is secreted by - **[Bihar – 2004]**
(1) Leydig cells (2) Sertoli cells
(3) Seminiferous tubule
(4) None of these

Q.6 Most important component of oral contraceptive is - **[Bihar – 2004]**
(1) LH (2) GH
(3) Thyroxine (4) Progesterone

Q.7 Purpose of tubectomy is to prevent – **[Bihar 2004]**
(1) Fertilization (2) coitus
(3) Egg formation
(4) Embryonic development

Q.8 Progesterone is secreted by **[UP CPMT – 01]**
(1) Corpus aorta (2) Corpus albicans
(3) Corpus luteum (4) Corpus callosum

Q.9 In the urinogenital organs of rabbit which one of following part is present in male but not in female - **[UP CPMT – 05]**
(1) Urethra (2) Fallopian tube
(3) Vagina (4) Vasa deferens

Q.10 Bidder's canal is present in **[UP CPMT 06]**
(1) Female frog (2) Male frog
(3) Female rabbit (4) Male rabbit

Q.11 Which of the following causes abortion in ladies- **[MP PMT-07]**
(1) Virus (2) Bacteria
(3) Mycoplasma (4) None of these

Q.12 Accessory sexual character in female is promoted by - **[MP PMT 07]**
(1) Androgen (2) Progesterone
(3) Estrogen (4) Testosterone

Q.13 Sertoli cells are found in testis. These cells are– **[MP PMT 07]**
(1) Nurse cell (2) Reproductive cell
(3) receptor cell (4) None of these

Q.14 Cryptorchidism is a condition in which – **[MP PMT – 07]**
(1) Testis does not descend into scrotal sac
(2) Sperm in not found
(3) Male hormones are not reactive
(4) Ovaries are removed

Q.15 The cellular layer that disintegrates and regenerates again and again in humans is – **[MP PMT 04]**
(1) Endometrium of uterus
(2) Cornea of eye
(3) Dermis of skin
(4) Endothelium of blood vessels

Q.16 The functional maturation of sperms takes place in - **[MP PMT 05]**
(1) Oviduct (2) Epididymis
(3) Vagina (4) All of these

Q.17 Surgical removal or cutting and ligation of the ends of oviduct is known as - **[MPPMT 06]**
(1) tubectomy (2) Oviductomy
(3) Castration (4) Vasectomy

Q.18 The follicle that ruptures at the time of Ovulation promptly fills with blood, forming **[MP PMT 01]**
(1) Corpus haemorrhagicum
(2) Corpus luteum
(3) Corpus albicans (4) Corpus callosum

Q.19 In mammals the estrogens are secreted by the Graafian follicle from its **[MP PMT-01]**

(1) External theca (2) Internal theca

(3) Zona pellucida (4) Corona radiata

Q.20 Orchidectomy is the surgical removal of- **[MPPMT-2001]**

(1) Liver (2) Kidney

(3) Ovary (4) Testes

Q.21 Supporting cells found in the germinal epithelium of testis are called- **[MPPMT-2002]**

(1) Interstitial cells of leydig

(2) Sertoli cells

(3) Granular cells

(4) Phagocytes

Q.22 Atretic follicles are found in the- **[MPPMT-2002]**

(1) Fallopian tube (2) Uterus

(3) Labia majora (4) Ovary

Q.23 In mammals the female secondary sexual characters are developed mainly by the hormone- **[MPPMT-2002]**

(1) Relaxin (2) Estrogens

(3) Progesterone (4) Gonadotropins

Q.24 Cryptorchidism is a condition of testes **[AIIMS-83]**

(1) Unable to descend in scrotal sacs

(2) Unable to produce sperms

(3) Having been surgically removed

(4) Having remained undeveloped

Q.25 In between spermatogonia are found - **[CPMT 87]**

(1) Germinal cells (2) Sertoli cells

(3) Epithelial cells (4) Lymph space

Q.26 Which acessory genital gland occurs only in male mammal **[CPMT 91]**

(1) Bartholin's gland (2) Perineal gland

(3) Prostate gland (4) All

Q.27 During differentiation the spermatids remain associated with - **[MP PMT 88]**

(1) Leyding's cells (2) Kuffer's cells

(3) Spermatogonia (4) Sertoli cell

Q.28 Sugar fructose is present in the secretion of – **[Orrisa JEE 95]**

(1) Seminal vesicle (2) Perineal gland

(3) Cowper's gland (4) Bartholin's gland

Q.29 Spermatozoa are nourished during their development by - **[Orrisa JEE 95]**

(1) Sertoli cells (2) Interstitial cells

(3) Connective tissue cells

(4) None

Q.30 Sertoli cells are found in the **[CPMT – 83]**

(1) Frog's testis

(2) Rabbit's testis

(3) Cockroach's testis

(4) Liver of frog

Q.31 What whould happen if vasa deferantia of man are cut **[MP PMT 93]**

(1) Sperms are non nucleate

(2) Spermatogenesis does not occur

(3) Semen is with out sperms

(4) Sperm are non motile

Q.32 Sertoli cells occur in - **[Bihar PMT 91]**

(1) Human testis (2) Frog testis

(3) Human ovary (4) Frog ovary

Q.33 Which one is primary sex organ **[Rohtak PMT 93]**

(1) Scrotum (2) Penis

(3) Testis (4) Prostrate

Q.34 If somatic chromosomes number is 40. What shall be chromosomal number in the cell of seminiferous tubules - **[AFMC 94]**

(1) 40 (2) 20

(3) 10 (4) 40 and 20

Q.35 Testis of rabbit occur **[MP PMT 95]**

(1) One either side of dorsal aorta

(2) Inside body

(3) On side of kidneys

(4) In scrotal sacs

Q.36 Eggs librated from ovary in human in **[CBSE 89]**

(1) Secondary oocyte stage

(2) Primary oocyte stage

(3) Oogonial stage

(4) Mature ovum stage

Q.37 Graffian follicle are found in **[DPMT 82, BHU 85]**

(1) Testis of mammal
(2) Ovary of frog
(3) Ovary of cockroach
(4) Ovary of mammals

Q.38 Site of fertilization in mammal is – **[MP PMT 88, 95, BHU 89]**

(1) Ovary (2) Uterus
(3) Vagina (4) Fallopian tube

Q.39 Endometrium is lining of **[CPMT – 88]**

(1) Testis (2) Urinary bladder
(3) Uterus (4) Ureter

Q.40 A secondary sexual character is **[DPMT -82]**

(1) Breast (2) Ovary
(3) Testis (4) Thyroid

Q.41 Expanded proximal part of oviduct in female is– **[DPMT -85]**

(1) Uterus
(2) Fallopian tube
(3) Fimbriated funnel
(4) Vestibule

Q.42 The Endocrinal structure formed after ovulation (release of ovum from graafian follicle is – **[CPMT – 83]**

(1) Corpus albicans (2) Corpus callosum
(3) Corpus luteum (4) Corpus striatum

Q.43 Human beings are **[MP PMT 1993, 96]**

(1) Ovoviviparous (2) Oviparous
(3) parthenogenetic (4) Viviparous

Q.44 Cowper's glands are found in **[MP 94, 95]**

(1) Male mammals (2) Female birds
(3) Male amphibians
(4) Female amphibians

Q.45 Corpus luteum is **[CPMT – 91]**

(1) Excretory (2) Endocrine
(3) Digestive (4) Reproductive

Q.46 A female gland corresponding to prostrate of males is **[MP PMT 93]**

(1) Bartholin's gland
(2) Bulbourethral gland
(3) Clitoris
(4) None

Q.47 Progesterone is secreted by **[MP PMT 94]**

(1) Corpus Luteum (2) Thyroid
(3) Thymus (4) Testis

Q.48 Growth and maturation of graafian follicle is controlled by - **[MP 95]**

(1) FSH-LH (2) FSH-LTH
(3) ACTH-LH (4) GH-ADH

Q.49 Cryptorchidism is a condition of testes **[AIIMS 1983, WARDHA 2000, 02]**

(1) Unable to descend in scrotal sacs
(2) Unable to produce sperms
(3) Having been surgically removed
(4) Having remained undeveloped

Q.50 Spermatogenesis and sperm differentiation are under the control of **[CPMT -87]**

(1) FSH
(2) LH
(3) Progesterone
(4) Parathyroid Hormone

Q.51 Loss of reproductive capacity in women after age of 45 years is - **[JK CEE 92]**

(1) Menstruation (2) Ageing
(3) Menopause (4) Menarche

Q.52 During pregnancy, the urine of would contain **[CPMT – 93]**

(1) LH (2) Progesterone
(3) FSH (4) HCG

Q.53 Ovulation occurs under the influence of - **[CBSE – 94]**

(1) LH (2) FSH
(3) Estrogen (4) Progesterone

Q.54 In 28 day human ovarian cycle, ovulation occurs on - **[CBSE – 94]**

(1) Day 1 (2) Day 5
(3) Day 14 (4) Day 28

Q.55 Monoestrous cycle animals may have **[MP PMT-95]**

(1) One ovulation each month
(2) one egg
(3) one breeding season in a year
(4) one menses each month

Q.56 Estrous cycle is characteristic of **[CBSE-95]**
(1) Human females
(2) Mammalian females
(3) Mammalian females other than primates
(4) Mammals

Q.57 In the absence of preganancy, corpus luteum- **[MPPMT-1989]**
(1) Becomes active, secretes FSH and LH
(2) Produces lot of oxytocin and relaxin
(3) Degenerates after some time
(4) Is maintained by progesterone

Q.58 In the female Rabbit which structure is homologous to penis of male- **[RPMT-2001]**
(1) Cervix (2) Vagina
(3) Uterus (4) Clitoris

Q.59 10 oogonia yield 10 primary oocytes, then how many ova are produced on completion of oogenesis- **[RPMT-2001]**
(1) 5 (2) 10
(3) 20 (4) 40

Q.60 In Rabbit, ex-abdominal reproductive organs are- **[RPMT-2001]**
(1) Testes, Penis, Epididymis
(2) Testes, Vas deferens, Testes sac
(3) Testes, Vas deferens, Ejaculatinduct
(4) Testes sac, Seminal Vesicle, Epididymis

Q.61 Parturition duct in female is called- **[RPMT-2001**
(1) Uterus (2) Oviduct
(3) Vagina (4) Cervix

Q.62 In mammales, corpus luteum is found in which organ- **[RPMT-2002]**
(1) Brain (2) Ovary
(3) Liver (4) Eyes

Q.63 In rabbit at the time of fertilization zygote is formed in- **[RPMT-2002]**
(1) Coelom (2) Fallopian tube
(3) Uterus (4) Vagina

Q.64 Which temporary endocrine gland forms in ovary after ovulation- **[RPMT-2003]**
(1) Corpus callosum (2) Corpus albicans
(3) Corpus luteum (4) Corpus striata

Q.65 Oral contraceptives contain- **[CBSE-1998]**
(1) Progesterone (2) LH
(3) Oxytocin (4) Steroles

Q.66 Which substance can be used as male contraceptive in future- **[CBSE-1999]**
(1) FSH (2) LH
(3) Testosterone (4) progesterone

Q.67 Which induces the development of corpus luteum- **[CBSE-1999]**
(1) LH (2) Oestrogen
(3) FSH (4) LTH

Q.68 After ovulation follicles converted into- **[CBSE-1999]**
(1) Corpus luteum
(2) Corpus albicans
(3) Corpus cavernosa
(4) Corpus calosum

Q.69 What is the work of copper T – **[CBSE-2000]**
(1) To inhibit ovulation
(2) To inhibit fertilization
(3) To inhibit implantation of blastocyst
(4) To inhibit gametogenesis

Q.70 What is the work of progesterone which is present in oral contraceptive pills- **[CBSE-2000]**
(1) To inhibit ovulation
(2) To check oogenesis
(3) To check entry of sperms in to cervix and to make them inactive
(4) to check sexual behaviour

Q.71 Which gland secrets odourous secretion in mammals- **[CBSE-2000]**
(1) Bartholins (2) Prostate
(3) Anal gland (4) Liver-bile

Q.72 Mainly which type of hormones control the menstrual cycle in human beings- **[CBSE-2002]**
(1) FSH
(2) LH
(3) FSH, LH, Estrogen
(4) Progesterone only

Q.73 When both ovary are removed from rat then which hormone is decreased in blood- **[CBSE-2002]**

(1) Oxytocin
(2) Prolactin
(3) Estrogen
(4) Gonadotrophic releasing factor

Q.74 Bartholin's glands are situated- **[CBSE-2003]**

(1) On the sides of the head of some amphibians
(2) At the reduced tail end of birds
(3) On either side of vagina in humans
(4) On either side of vas deferens in humans

Q.75 Ovulation in the human female normally takes place during the menstrual cycle-**[CBSE-2004]**

(1) At the end of the proliferative phase
(2) At the end of the proliferative phase
(3) Just before the end of the secretory phase
(4) At the beginning of the proliferative phase

Q.76 In mammals, maturation of sperms take place at a temperature- **[MPPMT-1991]**

(1) Equal to that of body
(2) Higher than that of body
(3) Lower than that of body
(4) At any piece of mammalian sperm

Q.77 Onset of pregnancy- **[MPPMT-1991]**

(1) Stimulates testosterone secretion
(2) Inhibits further ovulation
(3) Leads to degeneration of ovary
(4) Inhibits fusion of egg and sperm nuclei

Q.78 Graffian follicles contain **[MPPMT-1992]**

(1) Corpus luteum
(2) Corpus albicans
(3) Theca externa and theca interna
(4) Oogonial cells

Q.79 Bartholin's glands occurs in- **[MPPMT-1992]**

(1) Females and help in vestibular lubrication
(2) Females and produce oestrogen for regulating secondary sexual characters
(3) Males and form liquid part of spermatic field
(4) Males and produce alkaline fluid for neutralising urethral acidity

Q.80 Loss of reproductive capacity in women after age of 45 years is- **[JK CEE 1992]**

(1) Mensturation (2) Ageing
(3) Menopause (4) Menarche

Q.81 Estrous cycle is indication of ? **[MPPMT-1993]**

(1) Breeding period (2) Estrogen secretion
(3) Pregnancy (4) Menopause

Q.82 Which is correct ? **[MPPMT-1993]**

(1) Menstrual cycle is present in all mammals
(2) Menstrual cycle is present in all primates
(3) Estrous cycle occurs in all mammals
(4) Most mammals are ovoviviparous

Q.83 Yellow corpus luteum occurs in a mammals in- **[MPPMT-1993,98; CBSE-95]**

(1) Heart to initiate heart beat
(2) Skin to function as pain receptor
(3) Brain and connects cerebral hemisphere
(4) Ovary for secretion of progesterone

Q.84 A female gland corresponding to prostate of males is ? **[MPPMT-1993]**

(1) Bartholin's gland
(2) Bulbourethral gland
(3) Clitoris
(4) None of the above

Q.85 What would happen if vasa deferentia of man are cut ? **[MPPMT-1993]**

(1) Sperms are non-nucleate
(2) Spermatogenesis does not occur
(3) Semen is without sperms
(4) Sperms are nonmotile

Q.86 Human sperm was discovered by- **[DPMT-1996]**

(1) Leeuwenhoek (2) Aristotle
(3) Graaf (4) Pander

Q.87 Prostate gland produces a secretion for- **[BHU-1996]**

(1) Attracting sperms
(2) Stimulating sperm activity
(3) Attractive egg
(4) None of the above

Q.88 Corpus luteum secretes- **[Pb.PMT-1997, AMU-2001]**

(1) LH (2) Estrogen
(3) Progesterone (4) FSH

Q.89 In case of nonfertilization, corpus luteum- **[CPMT-1997]**

(1) Stops secreting progesterone
(2) Changes to corpus albicans
(3) Starts producing progesterone
(4) None of the above

Q.90 After ovulation, Graafian follicle forms- **[CBSE-1999]**

(1) Corpus luteum (2) Corpus albicans
(3) Corpus artesia (4) Corpus callosum

Q.91 Seminal vesicles are located in- **[Manipal-1999]**

(1) Caput epidydimis
(2) Uterus
(3) Above Cowper's glands
(4) Glans penis

Q.92 Number of eggs released in the life time of a woman is approximately- **[Karnataka-1999]**

(1) 40 (2) 400
(3) 4000 (4) 20000

Q.93 Correct sequence of hormone secretion from beginning of menstruation is- **[AIIMS-1999,Orissa-04]**

(1) FSH, progesterone, estrogen
(2) Estrogen, FSH, progesterone
(3) FSH, estrogen, progesterone
(4) Esterogen, progesterone, FSH

Q.94 Graafian follicle contains- **[MPPMT-2000]**

(1) Many oocytes
(2) Many sperms
(3) A single oocyte
(4) Site for egg fertilisation

Q.95 Mullerian duct is- **[MPPMT-2000]**

(1) Ureter (2) Urethra
(3) Sperm duct (4) Oviduct

Q.96 Progesterone level falls leading to- **[MPPMT-2000]**

(1) Gestation (2) Menopasue
(3) Lactation (4) Mensturation

Q.97 Head of epididymis present at head of testis is- **[CPMT-2000]**

(1) Caput epididymis (2) Cauda epidiymis
(3) Vas deferens (4) Gubernaculum

Q.98 Human female reaches menopause at the age of about- **[AFMC-2000]**

(1) 25 years (2) 35 years
(3) 50 years (4) 70 years

Q.99 Glands secreting male sex hromone are- **[Pub. PMT-2000]**

(1) Leydig cells
(2) Seminiferous tubules
(3) Vasa deferentia
(4) Testes

Q.100 Estrogen is secreted by- **[Hr. PMT-2000]**

(1) Corpus luteum
(2) Graafian follicle
(3) Germinal epithelium of ovary
(4) Pitiutary

Q.101 Phase of menstrual cyle when ovulation occurs in- **[Wardha-2001]**

(1) Luteal (2) Menstrual
(3) Proliferative (4) Secretory

Q.102 Antrum is cavity for- **[Karnataka-2001]**

(1) Ovary (2) Graafian follicle
(3) Blastula (4) Gastrula

Q.103 Testes descent into scrotum in mammals for- **[AFMC-2001]**

(1) Spermatogenesis
(2) Fertilization
(3) Development of sex organs
(4) Development of visceral organs

Q.104 Which grouping has gestation period in decreasing order- **[Hr. PMT-2002]**

(1) Cow, Horse, Goat, Monkey and Swine/Pig
(2) Horse, Cow, Goat, Monkey and Swine
(3) Monkey, Cow, Horse, Goat and Swine
(4) Monkey, Horse, Goat, Cow and Swine

Q.105 Hormone controlling human menstrual cycle- **[CBSE-2002]**

(1) Estrogen (2) FSH
(3) LH (4) All the above

Q.106 Phase of menstrual cycle in human that lasts for 7-8 days is- **[AIIMS-2003]**

(1) Follicular phase (2) Ovulatory phase
(3) Luteal phase (4) Menstruation

Q.107 Menstruation is caused by- **[D.PMT-2003]**

(1) Increase in FSH level
(2) Fall in oxytocin level
(3) Fall in progesterone level
(4) Increase in oestrogen level

Q.108 The hormone that prevents ovulation and formation of corpus luteum is- **[B.V. 2003]**

(1) Progesterone (2) Estrogen
(3) LH (4) FSH

Q.109 Nutritive cells of seminiferous tubules are- **[Keral-2003]**

(1) Leydig cells
(2) Sertoli cells
(3) Atretic follicular cells
(4) Spermatogonial cells

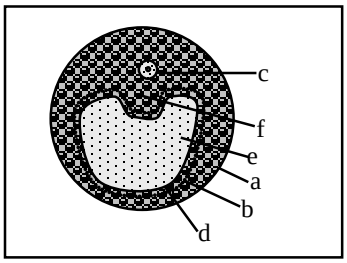
Q.110 The animal in which testes descent into scrotum only during breeding season- **[AFMC-2004]**

(1) Frog (2) Kangaroo
(3) Shrew (4) Bat

Q.111 In uterus endometrium, proliferates in response to- **[Kerala-2004]**

(1) Relaxin (2) Oxytocin
(3) Progesterone (4) Oestrogen
(5) LH

Q.112 In the diagram of section of Graafian follicle, different parts are indicated by alphabets. Choose the correct combination- **[Karnataka-2004]**



(1) a-membrana granulosa, b-thea interna, c-ovum, d-cumulus oophorus, e-antrum, f-theca, externa
(2) a-theca externa, b-theca interna, c-ovum, d-membrana granulosa, e-antrum, f-cumulus oophorus
(3) a-theca externa, b-theca interna, c-ovum, d-cumulus oophorus, e-antrum, f-membrana granulosa
(4) a - membrana granulosa, b-theca externa c-ovum, d-cumulus oophorus, e-antrum, f-theca interna

Q.113 Oral contraceptives are used by females to check **[DPMT 2010, CET Chd. 2010]**

(1) Implantation (2) Fertilization
(3) Ovulation
(4) Entry of sperms in vagina

Q.114 Role of Leyding cells is **[Manipal 2004, CET Chd. 2010]**

(1) Nourishment of sperms
(2) Provide motility to sperms
(3) Bring about maturation of sperms
(4) Synthesis of testosterone hormone

Q.115 Amniocentesis is employed for determining **[CPMT 2009]**

(1) Hereditary abnormality is embryo
(2) Cardiac ailments of embryo
(3) Errors in amino acid metabolism in embryo
(4) All the above

Q.116 Stage of sperm before entry into ovum/a pre-fertilisation process is **[JIPMER 2004, MHTCET 2008]**

(1) Maturation (2) Insemination
(3) Capacitation (4) Fertilization

Q.117 Testosterone is secreted by **[Bih. PMT 2004, JKCMEE/CET Chd. 2007]**

(1) Sertoli cells
(2) Leydig/interstitial cells
(3) Seminiferous cells
(4) All the above

Q.118 Pattern of cleavage in egg of Frog is **[CPMT 2005, Manipur 2009]**

(1) Meroblastic
(2) Holoblastic unequal
(3) Holoblastic equal (4) All the above

Q.119 In the urinogenital system one of the following part is present in males and not in females **[CPMT 2005]**

(1) Urethra (2) Fallopian tube
(3) Vagina (4) Vas deferens

Q.120 Number of sperms formed from four spermatocytes is **[CPMT 2005]**

(1) 4 (2) 1 (3) 16 (4) 32

Q.121 Fertilization was discovered by **[Wardha 2005]**

(1) Strasburger (2) Robert Brown
(3) Lamarck (4) Darwin

Q.122 Macrolecihal eggs are characterised by **[Manipal 2005]**

(1) Little yolk (2) Abundant yolk
(3) Entry of sperm (4) Pattern of cleavage

Q.123 In human females, ova are produced in **[MPPMT 2005]**

(1) Ovarian follicles (2) Oviduct
(3) Uterus (4) Vagina

Q.124 Hormone that prepares and maintains the uterus during pregnancy is produced by **[EAMCET 2005, WB 2005, MHTCET 2008]**

(1) Corpus albicans (2) Corpus luteum
(3) Graafian follicles (4) Corpora cardiaca

Q.125 At menopause there is rise in urinary **[Orissa 2005]**

(1) FSH (2) STH
(3) MSH (4) LH

Q.126 Delivery of developed foetus is **[Orissa 2005, Kerala 2010]**

(1) Ovulation (2) Oviposition
(3) Parturition (4) Abortion

Q.127 Abnormal condition when mammae of man become female like **[Orissa 2005]**

(1) Feminisation (2) Gynochorium
(3) Gynoesism (4) Gynaecomastia

Q.128 Which is not formed by Wolffian duct? **[DPMT 2005]**

(1) Epididymis (2) Vas deferens
(3) Ejaculatory duct (4) Oviduct

Q.129 Which are derivatives of endoderm? **[KCET 2005]**

(1) Muscles and blood
(2) Alimentary canal and respiratory organs
(3) Excretory and reproductive organs
(4) Skin and never cord

Q.130 Which are haploid? **[KCET 2005]**

(1) Spermatogonial cells
(2) Germinal epithelial cells
(3) Secondary spermatocytes
(4) Primary spermatocytes

Q.131 Sertoli cells secrete a hormone **[KCET 2005]**

(1) Gonadortropin (2) Testosterone
(3) Relaxin (4) Inhibin

Q.132 Germ cells in female gonad and male gonad begin undergoing meiosis simultaneously. What will be ratio of ova and sperms **[KCET 2005, Orissa 2008]**

(1) 1 : 1 (2) 1 : 2
(3) 1 : 4 (4) 2 : 1

Q.133 Grey crescent is the area **[CBSE 2005]**

(1) At the point of entry of sperm into ovum
(2) At the animal pole
(3) Just opposite the site of entry of sperm into ovum
(4) At the vegetal pole

Q.134 Which is correctly matched in a normal menstrual cycle? **[AIIMS 2005]**

(1) Endometrium regenerates – 5 to 10 days
(2) Release of egg – 5th day
(3) Endometrium secretes nutrients for implantation – 11 to 18 days
(4) Rise in progesterone level – 1 to 15 days

Q.135 Which of the following is immortal? **[BHU 2005]**

(1) Somatic cell (2) Germ cell
(3) Glomerular cell (4) Cells of pituitary

Q.136 Extra structure that provides nutritaion to embryo is **[BHU 2005]**

(1) Umbilicus (2) Amnion
(3) Choriom (4) placenta

Q.137 Spermatogonia develop through division **[Har. PMT 2006]**

(1) Ovary (2) Ovum
(3) Sperm (4) Zygote

Q.138 Spermatogonia develop through division **[Har. PMT 2005]**

(1) Amitosis (2) Mitosis
(3) Meiosis I (4) Meiosis II

Q.139 Graafian follicles occur in **[Har. PMT 2005]**

(1) Ovary (2) Testis
(3) Egg (4) Sperm

Q.140 Twin develops from **[Har. PMT 2005]**
(1) Defferent zygotes (2) Defferent ova
(3) Different sperms (4) Same zygote

Q.141 Ovulation occurs in and on **[Har. PMT 2005]**
(1) Ovary (2) About 14th day
(3) Both A and B (4) None of these

Q.142 Low level of progesterone and estrogen stimulates production of **[AMU 2005]**
(1) FSH-LH (2) LH
(3) GH (4) All the above

Q.143 Due to presence of large amount of yolk, zygote divides into two incomplete halves. This type of cleavage does not occur in **[Manipur 2005]**
(1) Peacok, Duck-billed Platypus and Crocodile
(2) Jungle Fowl, Dove and Duck
(3) Amphioxus, Salmander and Rana
(4) Hemidactylus, Calotes and Varanus

Q.144 Which is incorrect about the process of gestrulation **[Manipur 2005]**
(1) Movement and rearrangement of cells
(2) Rapid division of cells by mitotic cell division
(3) Formation of three germinal layers
(4) Formation of archenteron

Q.145 Withdrawal of which hormone is the immediate cause of menstruation **[CBSE 2006]**
(1) Estrogen (2) FSH
(3) FSH-RH (4) Progesterone

Q.146 Blastopore occurs in **[Bih. PMT 2006]**
(1) Gastrula (2) Blastula
(3) Blastocoel (4) Morula

Q.147 Mesoderm is formed through invagination of **[Guj. PMT 2006]**
(1) Ectoderm (2) Endoderm
(3) Inner mass of cells (4) Primitive streak

Q.148 Secretion of which structure prepares the inner wall of uterus for implantation **[Guj. PMT 2006]**
(1) Ovary (2) Corpus luteum
(3) Pituitary gland (4) Ovarian follicle

Q.149 Which of the following can reproduce without using mitosis **[KCET 2006]**
(1) *Amoeba* (2) *Hydra*
(3) *Sycon* (4) *Tapeworm*

Q.150 Which secretions are produced by spermatozoa at the time of fertilization **[KCTE 2006]**
(1) Fertilizin and spermlysin
(2) Only spermlysin
(3) Fertilizin and antifertilizin
(4) Antifertilizin and spermlysin

Q.151 Which reperesents a condition of highly reduced motility **[KCET 2006]**
(1) Azospermia (2) Polyspermy
(3) Oligospermia (4) Asthenospermia

Q.152 Oxytocin is helpful in **[COMED-K'S 2006]**
(1) Semen formation (2) Parturition
(3) Diuresis
(4) Molecular development

Q.153 Ectoderm forms **[COMED-K'S 2006]**
(1) Bones and muscles
(2) Lining of gut and respiratory organs
(3) Enamel of teeth and cornea of eye
(4) Gonads and blood vessels

Q.154 Cleidoic eggs occur in **[COMED-K'S 2006]**
(1) Fishes and reptiles
(2) Fishes and amphibians
(3) Amphibians and reptiles
(4) Birds and some mammals

Q.155 In organisms, shape of foetus is determined by **[RPMT 2006]**
(1) Organogenesis (2) Blastula
(3) Morphogenesis (4) Reproduction

Q.156 Energy centre of sperm is **[RPMT 2006]**
(1) Head (2) Middle piece
(3) Entire sperm (4) Tail

Q.157 Fusion of sperm and ovum is **[RPMT 2006]**
(1) Amphimixis (2) Regeneration
(3) Fertilization (4) None of the above

Q.158 Hormaphrodite animal is **[Manipur 2006]**
(1) Spider (2) Honey Bee
(3) *Ascaris* (4) Leech

Q.159 Embryonic connective tissue is formed from **[CET Chd. 2006]**
(1) Ectoderm (2) Endoderm
(3) Mesenchyma (4) Mesogloea

Q.160 Embryo at 16-called stage is called **[BHU 2006, CPMT 2008]**

(1) Morula (2) Blastula
(3) Blastomere (4) Gastrula

Q.161 Which one is the safest method of birth control **[KCET 2006]**

(1) Termination of nonwanted pregnancy
(2) Sterilisation techniques
(3) The rhythm method
(4) Use of physical barriers

Q.162 Under favourable conditions encysted Amoeba divids by multiple fission form many pseudopodiospores. The phenomenon is **[HPPMT 2007]**

(1) Sporulation (2) Fragmentation
(3) Regeneration (4) Budding

Q.163 Which one shows longitudnal binary fission **[Kerala 2007]**

(1) Euglena (2) Plasmodium
(3) Planaria (4) Paramecium
(5) Hydra

Q.164 Which one is wrong **[Kerala 2007]**

(1) Amnion is the outer layer containing amniotic fliud that acts as a shick absorber for soft embryo
(2) Amnion and chorion develop as upward projecting folds of somatopleure called amniotic folds
(3) In mammals, allantosis is not excretory in function
(4) Yolk sac is a foetal membrane that help in nourishment of embryo in general
(5) Chorio-allantoic membrane develops villi and contributes much to the development of placenta.

Q.165 Disintegration of corona radiata **[Guj. PMT 2007]**

(1) LTH (2) FSH
(3) Progesterone (4) LH

Q.166 Which one holds corona radiata **[MHTCET 2007]**

(1) Mucopolysaccharide
(2) Oligosaccharide
(3) Lipopolysaccharide
(4) Lipoprotein

Q.167 Greek word "sexus" means **[MHTCET 2007]**

(1) Disjunction (2) Disintegration
(3) Union (4) Both A and B

Q.168 A protective layer around testes is **[MHTCET 2007]**

(1) Tunica adventitia (2) Tunica vasculosa
(3) Tunica media (4) Tunica albuginea

Q.169 Sperm capacitation involves **[MHTCET 2007]**

(1) Change in shape
(2) Release of mitochondria
(3) Removal of membrane fatty acids
(4) Hyaluronic acid

Q.170 Accessory genital gland found only in males is **[KCET 2007]**

(1) Cowper's gland (2) Bartholin gland
(3) Perineal gland (4) Prostate gland

Q.171 Release of second polar body from human egg occurs **[COMED-K's 2007]**

(1) After entry of sperm
(2) After fertilization
(3) Before sperm entry
(4) With no relation to sperm entry

Q.172 Cell division that occurs in zygote is called **[JKCMEE 2007]**

(1) Meiosis (2) Mitosis
(3) Cleavage (4) Differentiation

Q.173 Layers of ovum from outside to inside are **[CPMT 2007]**

(1) Corona radiata, zona pellucida, vitelline membrane
(2) Zona pellucida, corona radiata, vitelline membrane
(3) Vitelline membrane, zona pellucida, corona radiata
(4) Zona pellucida, vitelline membrane, corona radiata

Q.174 Which layer of embryo is formed first **[CPMT 2007, 2009, MHTCET 2009]**

(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) Both B and C

Q.175 LH phase occurs during phase of menstrual cycle **[Orissa 2007]**

(1) Menstrual phase
(2) Begining of proliferative phase
(3) Just before end of proliferation phase
(4) At the middle of the cycle

Q.176 Transverse bainary fission occurs in **[DPMT 2007]**

(1) Euglena (2) Amoeba
(3) Hydra (4) Paramecium

Q.177 In which phase of cell division are oogonia arrested **[DPMT 2007]**
(1) Anaphase II (2) Anaphase I
(3) Interphase (4) Both A and B

Q.178 Capacitation of sperms occurs in **[DPMT 2007]**
(1) Female genital tract
(2) Vagina
(3) Vas efferens (4) Vas deferns

Q.179 Fertilization of ovum occurs in **[DPMT 2007]**
(1) Fimbriae of oviduct
(2) Isthmus of oviduct
(3) Amupulla of oviduct
(4) None of the above

Q.180 Function of Sertoli cells is controlled by **[DPMT 2007, AFMC 2008]**
(1) Estrogen (2) FSH
(3) Testosterone (4) ACTH

Q.181 Which one functions as endocrine gland after ovulation **[CBSE 2007]**
(1) Stroma
(2) Vitelline membrane
(3) Germinal epithelium
(4) Graafian follicle

Q.182 In human females, memstruation can be defrred by administration of **[CBSE 2007]**
(1) FSH and LH
(2) Estrogen and progesterone
(3) FSH only
(4) LH only

Q.183 Corpus spongiosum occurs in **[Har. PMT 2007]**
(1) Ovary (2) Penis
(3) Testis (4) Uterine wall

Q.184 Cytoplasm of ovum does not possess **[Har. PMT 2007]**
(1) Golgi complex (2) Mitochondria
(3) Centrosome (4) Ribosomes

Q.185 Which one takes part in formation of placenta? **[Guj. CET 2008]**
(1) Only trophoblast
(2) Only allantois
(3) Trophoblast and mesoderm
(4) Trophoblast, mesoderm and allantois

Q.186 Notochord, skeletal system and dermis of skin are derive from **[KCET 2008]**
(1) Mesoderm (2) Endoderm
(3) Ectoderm (4) All the above

Q.187 During embryogenesis archenteron is preceded by **[COMED-K's 2008]**
(1) Blastulation (2) Meuralation
(3) Gastrulation (4) Implantation

Q.188 Eggs produced in a year by an ovary of nonpregnant woman is **[COMED-K's 2008]**
(1) 12 (2) 6
(3) 24 (4) 48

Q.189 Sperms are produced in **[Orissa 2008]**
(1) Epididymis
(2) Interstitial cells
(3) Prostate gland
(4) Seminiferous tubules

Q.190 Which extraembryonic membrane in human prevents desiccation of embryo inside uterus? **[CBSE 2008]**
(1) Yolk sac (2) Amnion
(3) Chorion (4) Allantois

Q.191 Luteinising hormone is **[MHTCET 2008]**
(1) Lactotropic (2) Mammotropic
(3) Non-mammotropic (4) Both A and B

Q.192 Proximal centriole of sperm is found in **[MHTCET 2008]**
(1) Head (2) Neck
(3) Middle piece (4) Tail

Q.193 Which provides nutrition to maturing sperms? **[DPMT 2008, CPMT 2009]**
(1) Leydig cell (2) Scrotum
(3) Epididymis (4) Sertoli cells

Q.194 Extra structure which provides nutrition to embryo is **[BHU 2008]**
(1) Umbilicus (2) Chorion
(3) Placenta (4) Amnion

Q.195 Pick up the correct information about menstrual cycle control **[BHU 2008]**
A. Estrogen and progesterone of ovary
B. FSH of pituitary
C. FSH and LH of pituitary
D. Oxytocin
(1) 1, 2, 3 correct (2) 1, 2 correct
(3) 2, 4 correct (4) 1, 3 correct

Q.196 Pick up correct statement about organs with dual origin from embryonic layers **[BHU 2008]**

A. Hypophysis B. Adrenal glands

C. Sense organs D. Pancreas

(1) 1, 2, 3 correct (2) 1, 2 correct

(3) 2, 4 correct (4) 1, 3 correct

Q.197 LH and FSH are collectively called **[CPMT 2008]**

(1) Oxytocin (2) Somatotropins

(3) Gonadotropins (4) Luteotropins

Q.198 Which hormone level reaches peak during luteal phase of menstrual cycle? **[JKCMEE 2008]**

(1) Luteininsing hormone

(2) Progesterone

(3) Follicle stimulating hormone

(4) Estrogen

Q.199 Arrange the events in human female reproductive cycle **[KCET 2009]**

a-Secretion of FSH, b-Growth of corpus luteum, c-Growth of follicle and oogenesis, d-Ovulation, e-Sudden increase in level of LH

(1) $a \rightarrow c \rightarrow e \rightarrow d \rightarrow b$

(2) $c \rightarrow a \rightarrow d \rightarrow b \rightarrow e$

(3) $a \rightarrow d \rightarrow c \rightarrow e \rightarrow b$

(4) $b \rightarrow a \rightarrow c \rightarrow d \rightarrow e$

Q.200 Which one is initiated by secretion of trophoblast? **[COMED-K's 2009]**

(1) Blastulation (2) Implantation

(3) Cleavage (4) Gastrulation

Q.201 "Saheli", an oral contraceptive for females, was developed by **[CET Chd. 2009, HPPMT 2010]**

(1) AIIMS, Dehli (2) IICB, Kolkata

(3) SG PGI Lucknow (4) CDRI, Lucknow

Q.202 Foetal ejection reflex in human female is induced by **[CBSE 2009, 2010]**

(1) Release of oxytocin from pituitary

(2) Pressure exerted by amniotic fluid

(3) Differentiation of mammary glands

(4) Fully developed foetus and placenta

Q.203 Which is correctly matched? **[CBSE 2009]**

(1) Menstruation. Breakdown of myometrium and ovum not fertilised

(2) Ovulation. LH and FSH attain peak level, sharp fall in secretion of progesterone

(3) Development of Corpus luteum. Secretory phase and increased secretion of progesterone

(4) Proliferative Phase. Rapid regeneration of myometrium and maturation of Graafian follicle

Q.204 Seminal plasma of humans is rich in **[CBSE 2009, 2010]**

(1) Fructose and certain enzymes, poor in Ca^{2+}

(2) Fructose, Ca^{2+} and certain enzymes

(3) Fructose, Ca^{2+} and certain enzymes

(4) Glucose certain enzymes but no Ca^{2+}

Q.205 32-celled stage of human embryo is **[AMU 2009]**

(1) Smaller than fertilized egg

(2) Same size as fertilized egg

(3) Two times the size of fertilized egg

(4) Four times the fertilised egg

Q.206 Besides activating egg, another role of sperm is to carry **[Orissa 2009]**

(1) RNA (2) Ribosomes

(3) Mitochondria (4) DNA

Q.207 In females, hormone inhibin is secreted by **[AMU 2009]**

(1) Granulosa cells and corpus luteum

(2) Granulosa and theca cells

(3) Granulosa and cumulus oophorus cells

(4) Granulosa cells and zona pellucida

Q.208 Match the column and find the correct combination **[Kerala 2009]**

I	II
A. Hypothalamus	1. Sperm lysins
B. Acrosome	2. Estrogen
C. Graafian follicle	3. Relaxin
D. Leydig cells	4. Gn RH
E. Parturition	5. Testosterone

(1) A – 2, B – 1, C – 4, D – 3, E – 5

(2) A – 4, B – 1, C – 2, D – 5, E – 3

(3) A – 2, B – 1, C – 5, D – 4, E – 3

(4) A – 5, B – 1, C – 2, D – 3, E – 5

Q.209 Type of asexual reproduction found in *Hydra* is **[Kerala 2009]**

(1) Gemmule formation
(2) Sporulation
(3) Binary fission (4) Budding

Q.210 Accessory glands associated with genital organs of female are **[Kerala 2009]**

(a) Vestibular or Bartholin's
(b) Cowper's
(c) Amupullary (d) Vesicular
(1) a, b (2) a only
(3) b,c (4) d only
(5) c only

Q.211 Connective tissue around seminiferous tubles posses endocrine cells called **[MHTCET 2009]**

(1) Leydig cells
(2) Sertoli cells
(3) Pimary germ cells (4) Both A and B

Q.212 Multicellular, multinucleate, irregular mass of embryo which pass into uterine wall is **[MHTCET 2009]**

(1) Ectoderm
(2) Endoderm
(3) Syncytiotrophoblast
(4) Amnion

Q.213 Which gland is absent in reproductive system of Rabbit **[CPMT 2010]**

(1) Cowper's gland (2) Perineal gland
(3) Collateral gland (4) Prostate gland

Q.214 Various parts of male urethra are **[MHTCET 2010]**

(1) Prostatic, bulbourethral and ejaculatory
(2) Prostatic, membranous and penile
(3) Corpora cavernosa and corpus spongiosum
(4) Prostatic, bulbourethral and glans

Q.215 What is false? **[MHTCET 2010]**

(1) Menarche is beginning of menstruation
(2) Menstruation is shedding of endometrial lining
(3) Menopause occurs in the beginning of puberty
(4) Ovulation occurs under high titre of LH

Q.216 The cavity contained in Graafian follicle is **[MHTCET 2010]**

(1) Antrum (2) Centrocoel
(3) Blastocoel (4) Archenteron

Q.217 Morphogrnrtic movements take place during **[MHTCET 2010]**

(1) Formation of morula
(2) Blastulation
(3) Gastrulation
(4) Organogenesis

Q.218 Gastrula has a pore known as **[KCET 2010]**

(1) Zoospore (2) Oospore
(3) Gonospore (4) Blastopore

Q.219 In the absence of acrosome the sperm **[KCET 2010]**

(1) Cannot penetrate the egg
(2) Cannot get food
(3) Cannot get energy
(4) Cannot swim

Q.220 Hormone, human chorionic gonadotropin, is **[COMED-K's 2010]**

(1) Placenta
(2) Ovary
(3) Antherior pituitary gland
(4) Posterior pituitary gland

Q.221 Isogamy is found in **[CET Chd. 2010]**

(1) *Hydra* (2) *Monocystis*
(3) *Plasmodium* (4) *Planaria*

Q.222 Metadiscoidal placenta is found in **[CET Chd. 2010]**

(1) Humans (2) Cow
(3) Pig (4) Rabbit

Q.223 In humans the oocyte is maintained in a state of meiotic arrest by the secretion of **[AMU 2010]**

(1) Granulosa cells
(2) Zona pellucida
(3) Cumulus oophorus
(4) Theca

Q.224 Identical twins are also known as **[Orissa 2010]**

(1) Monozygotic twins
(2) Dizygotic twins
(3) Fraternal twins
(4) Both B and C

Q.225 In human the unpaired male reproductive structure is **[Kerala 2010]**

(1) Testis (2) Seminal vesicle
(3) Spermatic cord (4) None

Q.226 Mammalian blastula is known as **[MPPMT 2010]**

(1) Trophoderm (2) Blastocyst
(3) Foetal blastula (4) Oedema

Q.227 Acrosome of sperm contains **[MPPMT 2010]**
(1) Hydrolytic enzymes
(2) DNA
(3) Fructose
(4) Mitochondria

Q.228 Radial cleavage is found in **[MPPMT 2010]**
(1) Tunicates (2) Protozoans
(3) Coelenterates (4) Annelids

Q.229 In mesolecithal egg the cleavage is **[MPPMT 2010]**
(1) Meroblastic (2) Unequal holoblastic
(3) Equal holoblastic (4) None of the above

Q.230 Cavity formed during gastrulation is **[MPPMT 2010]**
(1) Primitive gut (2) Gastrocoel
(3) Archenteron (4) All the above

Q.231 Menstual phase is followed by **[HPPMT 2010]**
(1) Luteal phase (2) Follicular phase
(3) Fertilization (4) Implantation

Q.232 Which of the following cannot be considered as assisted reproductive technology **[HPPMT 2010]**
(1) Diaphragm (2) Lippe's loop
(3) Cervical cap (4) Vault

Q.233 Which of the following cannot be considered as assisted reproductive technology **[HPPMT 2010]**
(1) *In vitro* fertilization (IVF)
(2) Medical termination of pregnancy (MTP)
(3) Gamete intrafallopian transfer (GIFT)
(4) Intracytoplasmic sperm injection (ICSI)

Q.234 Internal cavity formed by cell division prior to gastrulation is **[DPMT 2010]**
(1) Enteron (2) Blastopore
(3) Blastocoel (4) Coelom

Q.235 Foetal movements and appearance of hair on head occur in ..... month of pregnancy **[CBSE 2010]**
(1) Fifth (2) Sixth
(3) Third (4) Fourth

Q.236 Part of fallopian tube closest to ovary is **[CBSE 2010]**
(1) Infundibulum (2) Cervix
(3) Ampulla (4) Isthmus

Q.237 In which of the following asexual reproduction, a maternal cell produces innumerable unicellular uninucleate offspring **[Guj. PMT 2010]**
(1) Sporulation (2) Fragmentation
(3) Parthenogenesis (4) Multiple fission

Q.238 Which one is not characterof heamochorial placenta **[Guj. CET 2010]**
(1) CO_2 and excretory products pass from foetus to mother's body
(2) O_2 and nutrients from mother's body enter the foetus
(3) Chorion villi are covered by blood sinuses of mother
(4) It protects foetus from mechanical shocks

Q.239 The figure given below shows a small part of human lung where exchange of gases takes place. Select the option which represents labelled part (A, B, C or D) correctly identiffed along with its function. **[CPMT 2011]**
(1) C : arterial capillary - passes oxygen to tissues
(2) A : alveolar wall - main site of exchange of respiratory gases
(3) D : capillary wall - exhange of O_2 and CO_2 takes
(4) B : red blood cells - transport of CO_2 mainly.

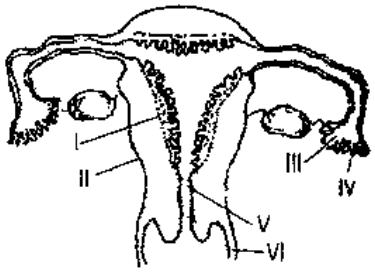
Q.240 A large proportion of oxygen remains unused in the human blood even after its uptake by the body tissue. this O_2**.** **[CPMT 2011]**
(1) Acts as a reserve during muscular exercise
(2) Raises the pCO_2 of blood to 75 mm of Hg.
(3) Is enough to keep oxyhaemoglobin saturation at 96%
(4) Helps in releaising more O_2 to the epithelial tissues.

Q.241 If for some reason, the vasa efferentia in the human reproductive system get blocked, the gametes will not be tranported from **[CPMT 2011]**
(1) Testes to epididymis
(2) Epididymis to vas deferens
(3) Ovary to uterus (4) Vagina to uterus

Q.242 The testes in humans are situated outside the abdominal cavity inside a pouch called scrotum. The purpose served is for **[CPMT 2011]**
(1) Maintaining the scrotal temperature lower than the internal body temperature
(2) Escaping any possible compression by the visceral organs
(3) Providing more space for the growth of epididymis
(4) providing a secondary sexual feature for exhibiting the male sex.

Q.243 The figure given below depicts a diagrammatic sectional view of the human female reproductive system. Which set of three parts out of I-VI have been correctly identified?

[CPMT 2011]



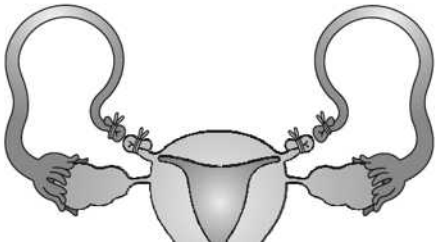
(1) (II) endometrium, (III) infundibulum, (IV) fimbriae

(2) (III) infundibulum, (IV) fimbriae, (v) cervix

(3) (IV) oviducal funnel, (V) uterus, (VI) cervix

(4) (I) perimetrium, (II) myometrium, (III) Fallopian tube

Q.244 What is the figure given below showing in particular ? **[AIPMT PRE 2012]**



(1) Uterine cancer (2) Tubectomy

(3) Vasectomy (4) Ovarian cancer

Q.245 Singnals for parturition originate from :

[AIPMT PRE 2012]

(1) Oxytocin released from maternal pituitary

(2) Placenta only

(3) Fully developed foetus only

(4) Both placenta as well as fully developed foetus

ANSWER-KEY

EXERCISE – 3

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	2	2	1	4	1	3	4	2	2	3	1	1	1	2	1	1	2	4
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	4	2	1	2	3	4	1	1	2	3	1	3	4	4	1	4	4	3	1
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	3	4	1	2	4	1	1	1	1	3	4	1	3	3	3	3	4	2	4
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	2	2	3	1	3	1	1	2	1	3	3	3	3	2	3	2	3	1	3
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	2	4	4	3	1	2	3	2	1	3	2	3	3	4	4	1	3	4	2
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	2	1	2	4	1	3	1	2	4	4	2	3	4	4	3	2	2	4	3
Que.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	2	1	2	1	3	4	4	2	3	4	3	3	1	2	4	3	2	1	2
Que.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	3	1	3	2	4	1	4	2	1	4	2	2	3	4	3	2	3	4	3	1
Que.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	2	1	1	3	4	1	3	4	3	4	1	3	1	3	4	4	2	1	3	2
Que.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
Ans.	4	2	2	3	4	1	3	2	4	2	3	2	4	3	4	1	3	2	1	2
Que.	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
Ans.	4	4	3	2	2	4	1	2	4	2	1	3	3	2	3	1	3	4	1	1
Que.	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Ans.	2	1	1	1	4	2	1	3	3	2	2	2	2	3	1	1	4	4	2	2
Que.	241	242	243	244	245															
Ans.	1	1	3	2	4															

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** In post natal life, oocyte development occurs in mature follicle.
R : After ovulation, graafian follicle transforms in corpus luteum.

Q.2 **A :** Placenta is combined structure of foetal tissue & maternal tissue.
R : Placenta formation is completed before 6 week

Q.3 **A :** Seminal vesicle is called as accessory sex organ of male.
R : Seminal vesicle conserve sperm energy & provide fuel to sperm.

Q.4 **A :** Testes are retroperitoneal organ in man.
R : Peritoneal layer covers the testes on dorsal side.

Q.5 **A :** Cervix contain most weak sphincter muscle in the body.
R : Cervix open into fallopian by os-external.

Q.6 **A :** In ovarian cycle corpus luteum is exocrine gland.
R : It secretes the pheromones.

Q.7 **A :** Failure of testes to descend into the scrotum causes sterility in man.
R : Higher temperature of the abdomen than in the scrotum is suitable for sperm development

Q.8 **A :** Primary mammalian follicle are called graffian follicle.
R : These were discovered & described by graaf.

Q.9 **A :** Corpus albicans is inactive structure which found in the ovary.
R : Corpus albicans secretes the progesteron hormone after ovulation.

Q.10 **A :** Placenta functions as a temporary endocrine gland during development of embryo
R : Placenta produces pheromones.

Q.11 **A :** Menarche starts at the age of puberty.
R : After birth oocyte is matured and developed in Graffian follicle.

Q.12 **A :** Corpus leuteum present in proliferative phase of menstrual cycle.
R : High concentration of present in proliferative phase.

Q.13 **A :** Testes are situated in the extra abdominal cavity.
R : Spermatogenesis process required less temperature as compared to body temperature.

ANSWER KEY

EXERCISE - 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13
Ans.	2	3	1	4	4	4	3	4	3	3	2	4	1

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

EMBRYOLOGY

INTRODUCTION :

Embryology term was coined by **Aristotle**. Study of embryogenesis is known as **Embryology**.

Development Biology : This branch deals with study of complete development of organism. Development continues till death.

Prenatal Development - Development before the birth. **Post-natal Development -** Development after the birth.

The pre-natal development of animals is known as **Ontogeny**. This is of two types-

(1) Zygotic : Animals develop by sexual reproduction.

The animals which are produced through zygote is known as *oozoids*.

Oozoids have more survival as compared to blastozoids. Oozoids have genetic variations.

The development of animals through zygote is known as embryogenesis.

(2) Blastematic : Animals develops by any asexual structure known as blastema. Eg. Buds in Hydra.

Animals which are produced through blastema are known as blastozoids.

Development of animals through blastema is known as blastogenesis.

HISTORY OF EMBRYOLOGY :

(1) Aristotle is known as "Father of Embryology" he first studied the development in chick and other embryos. He gave its description in his book "Historia Animalia".

(2) Leeuvenhock (1671) - He observed and described human sperm for the first time.

- According to Hartsoeker and Leeuvenhock there is a small model of developing animals present in the head of the sperm of that animal. This small model is called homunculus. Both these scientists are called spermists, and this theory is called **'' Theory of spermist ''.**

(3) Swammer Dame, Haller, Bonette & Malpighi : - According to these scientists, small model of animal is always present in the egg. These scientists are called Ovists, and their theory is known as 'Ovists theory'

(4) Schleiden & Schwann : - Both the scientists established the cellular structure of egg and sperm.

(5) Pander : - He described the presence of three germinal layers in chick embryo.

(6) Fredrich Wolff : - He first presented the **''theory of epigenesis''.**

(7) Muller : - He gave the recapitulation theory.

(8) Haeckel : - He gave the details of Recapitulation theory and named it as the **bio-genetic law.**

- Bio-genetic Law : - According to this each organism during its embryonal development, passes through all stages, through which its species has evolved or embryo repeats its ancestry. i.e. Ontogeny recapitulates its Phylogeny.

(9) ''Carl Ernest Von Baer'' : - He is known as the "father of modern embryology." He gave the Baer's Law which in turn proves the recapitulation theory.

According to this law, during embryonal development, the development of general structures takes place earlier and specific structures develop at last or later on.

(10) A. Weismann : - He gave the **theory of germplasm** or the **theory of continuity of germplasm.** According to him, there are 2 types of protoplasm in the body of animals : -

(i) Somatoplasm (ii) Germplasm

Somatoplasm dies but the germplasm is never destroyed, rather it is transferred to the progenies.

(11) Wilhelim : - He studied embryonal development in frog and gave the mosaic theory.

- He said that there are some presumptive areas in the eggs of frog. These areas form specific structures during embryonal development. This is termed as "Promorphology ." and these type of eggs are termed as the mosaic eggs.

(12) Hand Driesch : - He studied embryonal development is sea-urchin and gave the regulative theory.

- In the eggs of Sea-Urchin presumptive areas are not found i.e. promorphology is not found. So, each part of the egg is capable of forming the complete embryo. These type of eggs are termed as regulative eggs.

(13) Hans Driesch : - He studied embryonal development in sea-urchin and gave the regulative theory.

- In the eggs of Sea-Urchin presumptive areas are not found i.e. promorphology is not found. So, each part of the egg is capable of forming the complete embryo. These type of eggs are termed as regulative eggs.

(14) Boveri & Child : -

They gave the gradient theory to explain the mosaic development in eggs.

According to them, a metabolic gradient is present inside the eggs.

Different parts of the egg have different metabolic rates.

The rate of metabolism is faster at the animal-pole of the egg and is slower at the vegital pole of the egg.

(15) Spemann :- He gave the **''Theory of organizers''.**

- According to it embryo has some special type of tissues, which induce development of some specific structures.

These are termed as the **organizers.**

- These organizers secrete some special chemicals called **evocators** which induce the formation of specific structures.

- Spemann got the Nobel prize for his theory of organizers.

(16) R.V. Graff : -

- He studied a follicle in human ovary and termed it as **''Graafian follicle''**

FORMATION OF GAMETES / GAMETOGENESIS :

Follicle stimulating hormone stimulates gametogenesis. Besides this hormone vitamin E is also essential for gametogenesis. Deficiency of vitamin E leads to sterility. Vitamin A is also required for the formation of healthy gametes.

Gemetogenesis is divided in three stages :

(i) Multiplication phase (ii) Growth phase (iii) Maturation phase.

As there are two types of gametes, the spermatozoa and ova, gametogenesis can be studied under two broad headings : spermatogenesis and oogenesis. **Spermatogenesis** is the formation of spermatozoa, whereas **oogenesis** is the formation of ova. Both spermatozoa and ova originate from **primordial germ cells** or **PGCs**, which are extra-gonadal in origin. In humans, the PGCs originate during early embryonic development from the extra-embryonic mesoderm. Eventually, they migrate to the yolk sac endoderm, and ultimately, to the gonads of the developing embryo, where they undergo further development. You can recall that spermatogenesis occurs in the seminiferous tubules of the testes of oogenesis occurs in the follicles of ovary. Formation of gametes starts at puberty.

SPERMATOGENESIS :

Spermoatogenesis : i.e. formation of sperms. In most of the animals spermatogenesis takes place in testes, (exception-earthworm). Mammalian testes contain seminiferous tubules and wall of seminiferous tubule is composed of germinal epithelium. It contains some special types of cells called primordial germ cells and these cells start spermatogenesis. On the basis of origin, primordial germ cells are extra embryonic mesodermal. Besides these cells, germinal epithelium contains some large sized cell called sertoli cells. Occurrence of sertoli cells is the unique feature of mammalian testis. Sertoli cells provide nutrition of developing sperm i.e. developing sperms are embedded in cytoplasm of sertoli cells and absorb nutrition. After maturation sperms comes out from sertoli cells and librate in seminiferous tubules.

Liberation of sperms from Sertoli cells is called **spermiation.**

Liberation of sperms from testes is called **semination.**

Liberation of sperms from body of male is called **ejaculation.**

Mammalian sperms are transferred to vagina of female by the process called **insemination.**

Sertoli cells form 'blood testes barrier' and protect the sperm from immune system of the body. because antibody may attach on haploid cells and destroy them. (Sperms are haploid and other cells of body are diploid).

Sertoli cells function as an endocrine gland i.e. secrete three type of hormones :

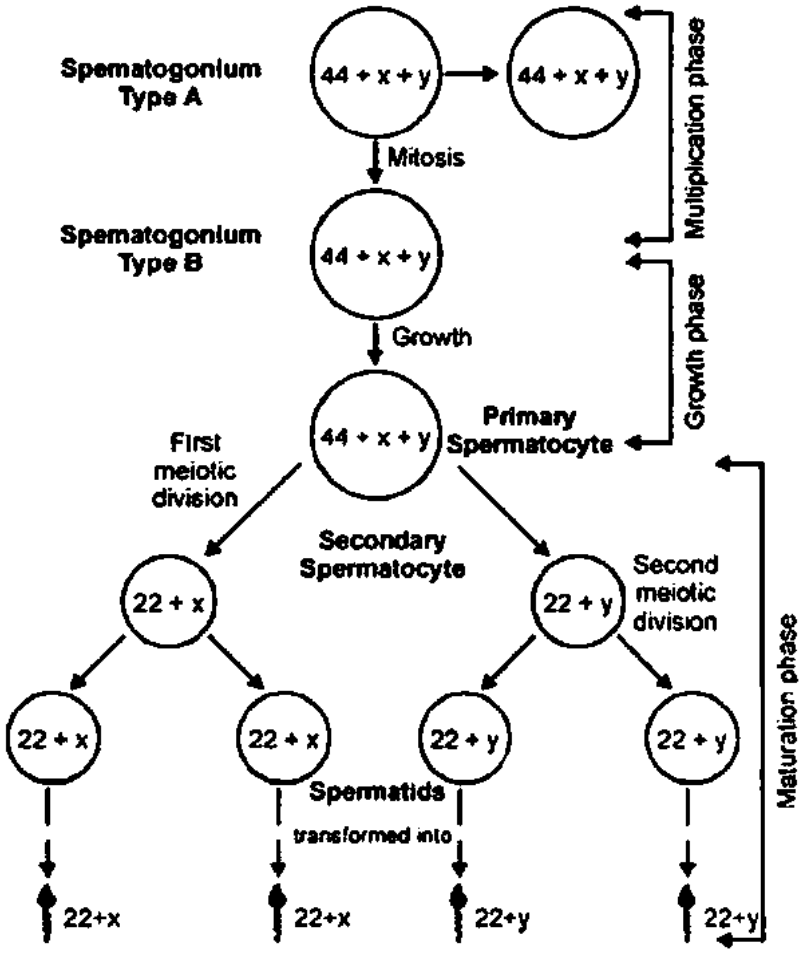
(i) Antimullerian hormone : function of this hormone is degradation of female gonads in male embryo. (In male seminal vesicle is the ruminant part of oviduct of female).

(ii) Inhibin hormone : Function of this hormone is to control excess secretion of pituitary gland to prevent the over-production of sperms.

(iii) Androgen binding protein : Function of this hormone is to concentrate testosterone in seminiferous tubules because testosterone is must for spermatogenesis in seminiferous tubules.

STEPS OF SPERMATOGENESIS :

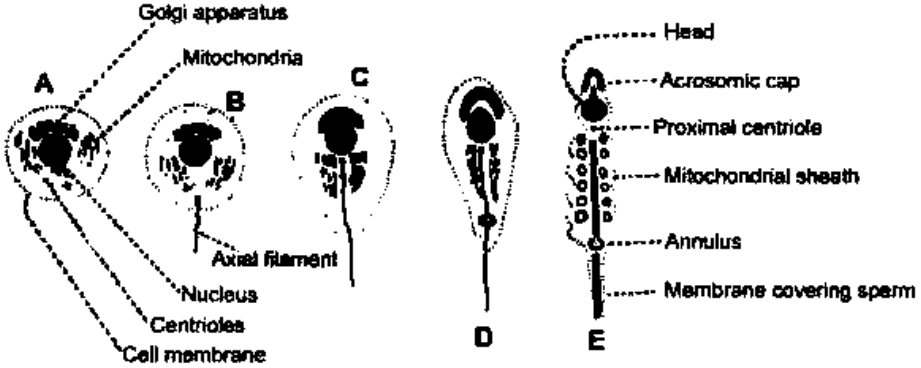
Spermatozoa are formed in the wall of the seminiferous tubules of the testes. The various cell-stages in spermatogenesis are as follows (the number of chromosomes at each stage is given in brackets)



An adult male produces over 10^{12} to 10^{13} sperm cells each day. These gradually move into the epididymis and the first portion of the vas deferens, where they undergo further maturation and are stored.

A. The *spermatogonia (type A)* or *germ cells* (44 X + Y) divide mitotically, to give rise to more spermatogonia of type A (spermatogenic lineage) and also spermatogonia of type B.
B. The *spermatogonia (type B)* (44 + X + Y) enlarge, to from primary spermatocytes (spermato cytogeneis)
C. The *primary spermatocytes* (44 + X + Y) now divide so that each of them forms two secondary spermatocytes. This is the first meiotic division. it reduces the number of chromosomes to half.
D. Each *secondary spermatocyte* has 22 + X or 22 + Y chromosomes. It divides to form two spermatids. This is the second meiotic division and this time there is no reduction in chromosome number.
E. Each *spermatid* (22 + X or 22 + Y) gradually changes its shape to become a spermatozoon. This process of transformation of a circular spermatid to a spermatozoon is called **spermiogenesis**/**spermateleosis**

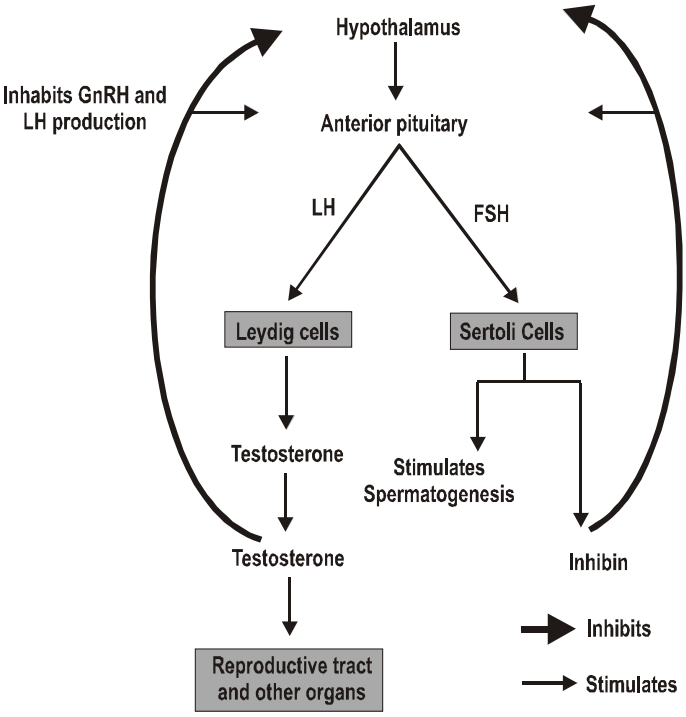
Spermiogenesis



In spermiogenesis first, of all nucleus of spermatid shift at one side. Except chromatin material, all the structures come out from nucleus as a result nucleus become small and light in weight. Then several golgi vesicles gathered just above the nucleus. Some of the Golgi vesicles develop granules called proacrosomal granules, such granule containing vesicle is called **proacroblast.** Rest of the golgi vesicles are called golgirest, the golgirest dissolve in cytoplasm. All the proacroblast fuse and form large vesicle called acroblast and it's granule is called acrosomal granule. Acroblast arranged just above the nucleus. Then cytoplasm of spermatid starts moving towards posterior side. As a result, plasma membrane shrinks and gets attached to acroblast and nucleus. Due to this head of sperm is formed. Now centriole starts forming axonema, then all the mitochondria of spermatid are arranged in spiral order around axonema. In this way middle piece of sperm is formed. Now axonema elongates towards posterior side and forms tail. Cytoplasm of spermatid continuously flows towards posterior side.

Harmone control of spermatogonesis

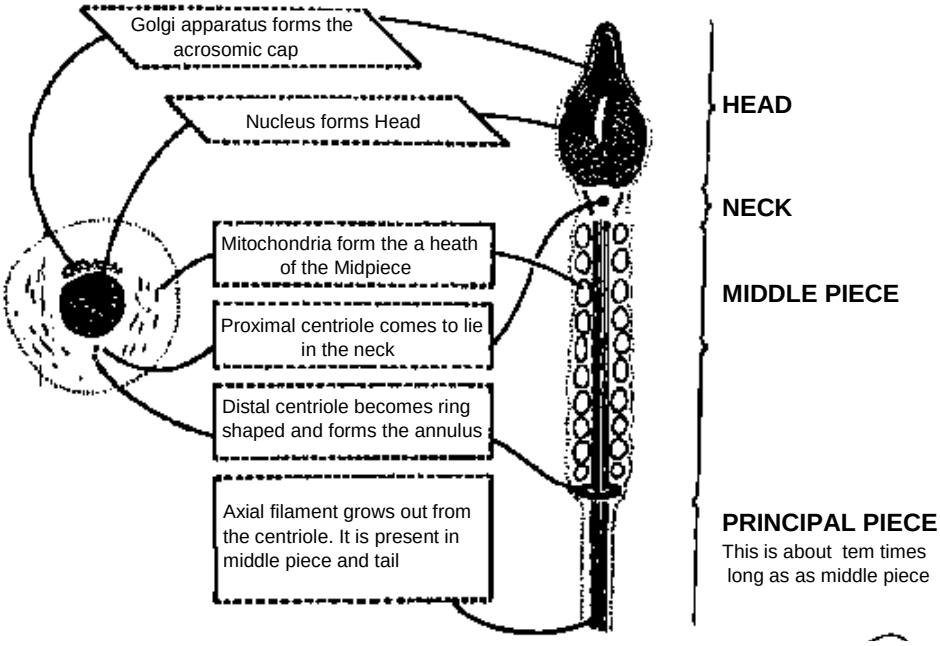
(a) Interstial cells of leydig produces testosterone that promotes sperms foramtion.
(b) These interstitial cells of leydig are triggered by ICSH = Interstitial cells timulating harmone produced by anterior lobe of pituitary. It is same as LH.
(c) Under the control of FSH and testosterone sertoli cells secrete androgen binding protein (ABP). It helps in concentrating testosterone in seminiferous tubules.
(d) Sertoli cells also produces inhibin that supress FSH.
(e) FSH acts on spermatogonia to stimulate sperm formation.
(f) FSH and LH production by pitutary is regulated by hypothalamus which produces GnRF - gonadotropin releasing harmone/factor.
(g) High level of testosterone negatively feed back the GnRF from hypothalamus.



Hormonal control of male reproductive system

Structure of sperm :

The spermatozoon has a head, a *middle piece* and a *tail.* The **head** is covered by cap the *acrosomic* cap, anterior nuclear cap, or *galea capitis*. Acrosome is a bag like structure filled with lytic enzymes called spermlysins. In the anterior part of middle piece neck is present. The **neck** is narrow : it contains a proximal & distal *centriole* (or Basal body). An axial filament begins just behind this centriole, it passes through the middle piece and extends into the tail. At the point where the middle piece joins the tail, this axial filament passes through a ring-like structure called the annulus (or ring centriole or zensons ring). That part of the axial filament which lies in the middle piece, is surrounding by a spiral *sheath* made up of mitochondria. (Nebenkern sheath)

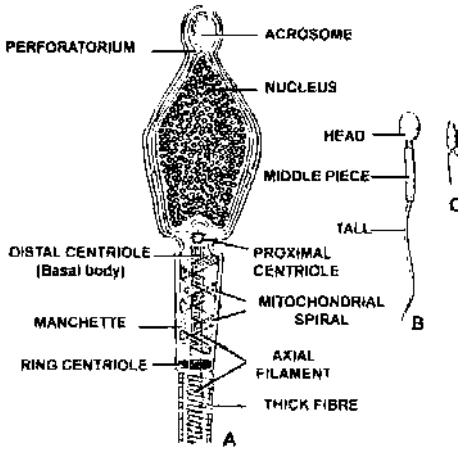


Nuclear part of head of spermatozoa consist of chromatin (mostly DNA) that is extremely condensed. It contains a basic nature protein called protamin.

The basal body is made up of nine segmented rod like structures each of which is continuous distally with one coarse fibril of the axial filament.

The axial filament, that passes through the middle piece and most of the tail, is actually composed of several fibrils arranged. There is a pair of central fibrils, surrounded by nine pairs (doublets) arranged in a circle around the central pair (9+ 2). This arrangement of one central pair of fibrils surrounded by nine doublets is covered by nine solid protein (making the arrangement as 9 + 9+ 2).

STRUCTURE OF A MATURE SPERMATOZOA



Structure of sperm

In the proximal tail part it is covered by only two solid protein fibres (therefore arrangement is 2 + 9 + 2), while end part of tail has no protein covering (therefore arrangement is 9 +2). Immediately outside the fibrils there is a fibrous health.

Middle piece (also called as the energy chamber) is surrounded by spirally arranged mitochondria (Nebenkern sheath). Finally, the entire sperm is enclosed in a plasma membrane.

In humans sperm formation is completed in 74 days.
In one ejaculation 4 ml semen have 400 million sperms.
If sperm count is less = Oligospermia.
If there are dead sperms = Necrospermia.
If there are no sperm = Azoospermia.

OOGENESIS :

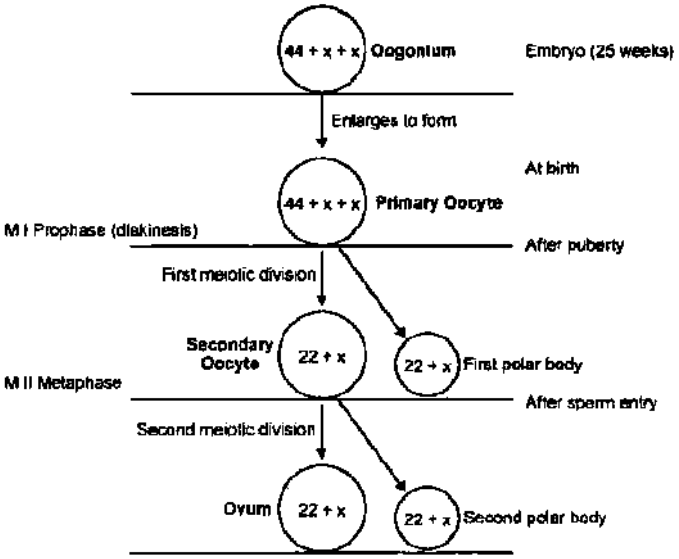


Fig. 2

Like spermatogenesis oogenesis process also can be divided into three stages :

(A) Multiplication **(B) Growth phase** **(C) Maturation phase**

(A) Multiplication phase : In this stage primordial germ cells or ovum mother cells repeatedly divide by mitosis to form large number of diploid oogonia.

This process completes in embryo stage of female in most higher animals.

(B) Growth phase : Like spermatogenesis, in this process oogonia grow in size and form primary oocytes. The growth phase is the longest phase oogenesis (except humans). During growth phase size of egg increases many times.

During growth phase several changes occur in egg and all these changes are classified in 2 sub-stages

- **Previtellogenesis**
- **Vitellogenesis**

Previtellogenesis :

During previtellogenesis, changes occur in nucleus and cytoplasm of egg.

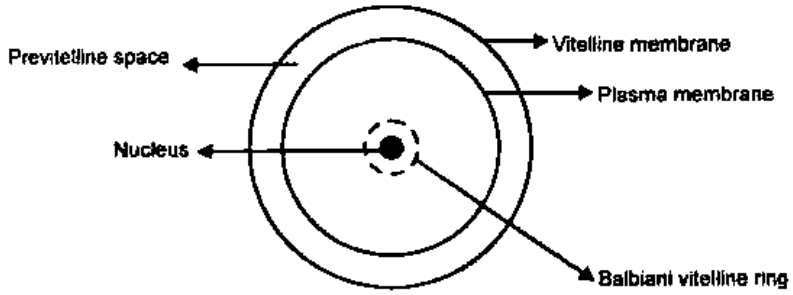
Changes in nucleus :

- Amount of nucleoplasm increases in nucleus.
- Number of nucleolus increase in nucleus.
- Formation of lamp brush chromosome starts.
- Activity of DNA increases in nucleus, as a result DNA become highly active and rapidly synthesizes different types of RNA. Increased activity of DNA is called as Gene redundancy/Gene amplification. Due to all these changes, size of nucleus increases and nucleus becomes vesicular. This vasicular nucleus is called germinal vesicle .

Changes in cytoplasm :

In cytoplasm, rate of protein synthesis increases. Cytoplasm rapidly synthesises different type of protein and enzyme. Due to more availability of protein and enzymes, synthesis of new protoplasm takes place and size of egg increases.

Number of cell organelles increase in cytoplasm, specially endoplasmic reticulum, golgi-body and mitochondria Mitochondria become very large in number so mitochondrial clouds are found in cytoplasm of egg.



Later on all these 3 cell organelle (golgi body, endoplasmic reticulum, mitochondria) are arranged in the form of ring around the nucleus, it is called as Balbiani vitelline ring. In the stage golgi body of egg secretes a membrane around the egg which is it called as vitelline membrane. A space appears in between plasma membrane of egg and vitelline membrane called as perivitelline space, It is filled with a fluid called perivitelline fluid.

At the end of previtellongenesis endoplasmic reticulum disappear. Golgi bodies gets converted into corticle granule. Corticle granules are filled with mucopolysacharide. Large number of change occur in mitochondria also.

☐ **Vitellogenesis :** During vitellogenesis egg stores food in the form of yolk.
Some part of yolk is synthesized in egg only, but major part of yolk is received from liver. Yolk received from liver is less viscous and is therefore soluble but this type of food cannot be stored for long periods (because it easily gets converted into simple form)

So mitochondria of egg with the help of kinase enzyme make the yolk more viscous and insoluble. 2 types of yolk is found :
Granular yolk occurs in the form of fine granules.
eg. Protostomia animals.
Yolk platelets occur in the form of plate disc like granule.
eg. Deuterostomia animals (higher animals)

Chemical composition of yolk :

1. Most abundant compound in yolk is phospholipid
   Most common phospholipids is lecithin.
2. Yolk contains different type of protein :
   – Simple protein : Albumin, Globin, Globulin
   – Phosphoprotein : Phosvitene, Ovovitelline
   – Lipoprotein : Lipovitelline
3. In yolk, least amount of substance found is carbohydrate.

(C) Maturation phase : Oogenesis (Fig.2) takes place in the ovaries. In contrast to males the initial steps in egg production occur prior to birth. By the time the foetus is 25 weeks old, all the oogonia that she will ever produce, are already formed by mitosis. Hundreds of these diploid cells develop into **primary oocytes**, begin the first steps of the first meiotic division, proceed up to diakinesis, and them stop any further development. The oocytes grows much larger and completes the meiosis I, forming a large **secondary oocyte** and a small **polar body** that receives very little amount of cytoplasm but one full set of chromosomes.

In humans (and most vertebrates), the first polar body does not undergo meiosis II, whereas the secondary oocyte proceeds as far as the **metaphase** stage of meiosis II. However, it then stops advancing any further, it awaits the arrival of the spermatozoa for completion of second meiotic division. Entry of the sperm restarts the cell cycle breaking down **MPF** (M-phase promoting factor and turning on the **APC** (Anaphase promoting complex). Completion of meiosis II converts the secondary oocyte into a fertilized egg or zygote (and also a second polar body)

Ova are derived from oogonia present in the cortex of ovary. Some important differences between oogenesis and spermatogenesis are

(i) Whereas one primary spermatocyte gives rise to four spermatozoa, one *primary oocyte* forms only one ovum.

(ii) When the primary spermatocyte divides, its cytoplasm is equally distributed between the two secondary spermatocytes formed. However, when the primary occyte divides, almost all its cytoplasm goes to the daughter cell which forms the *secondary oocyte*. The other daughter cell *(first polar body)*, receives half the chromosomes of the primary oocyte, but almost no cytoplasm.

• The first polar body is, therefore, formed merely to get rid of unwanted chromosomes.

TYPES OF EGGS :

(A) On the basis of amount of yolk

(i) Alecithal or Microlecithal or Oligolecithal eggs –

- The amount of yolk is very small or absent in these types of eggs. (oligolecithal, or microlecithal or alecithal).
- The term 'alecithal' (absence of yolk eg. Man) was given by Kent. And term microlecithal' (eg. Urchin) was given by Tori.

  Examples :- Egg of Amphioxus, Eutheria, Metatheria and sea – urchin.

(ii) Mesolecthal Eggs : - In this type of egg, the amount of yolk is moderate i.e medium ,neither more nor less.

Example : - Eggs of Amphibia, Petromyzon and lung-fishes.

(iii) Polylecithal or Macrolecithal or Megalecithal eggs : -

Eggs are with large amount of yolk. e.g. Bird's egg , Insect's egg.

(B) On the basis of distribution of yolk :

(i) Isolecithal or homolecithal eggs : The yolk is evenly or homogenously distributed in these eggs.

eg. : micro, oligo or alecithal eggs.

(ii) Telolecithal eggs : The yolk is concentrated in one part of the egg.

eg. Mesolecithal eggs of amphibia. (Moderately telolecithal)

Discoidal eggs : A type of telolecithal and megalecithal eggs. Where the yolk is in enormous quantity and concentrated in one part of the egg. Thus only a disc of cytoplasm called germinal disc remains in the egg which is located at the other pole of egg. (Heavily telolecithal)

eg. : Eggs of reptiles, birds and prototherian mammals.

(iii) Centrolecithal eggs : Megalecithal eggs where the enormous amount of yolk is located in the centre an cytoplasm is in the form of superficial layer around the yolk.

eg. : Insects egg.

(C) Classification of Eggs on the basis of Shell : -

On the basis of shell, eggs are of 2 types : -

(i) Cleidoic eggs : -

Eggs surrounded by a hard shell are known as cleidoic eggs. These eggs are found in those animal which have a terrestrial mode of life or which lay eggs on land.

These eggs have more amount of yolk. These are adaptations to terrestrial mode of life. Shell prevents the egg from dessication.

e.g. : - eggs of "Reptiles", "Birds", "Insects" and "Prototherians".

(ii) Non-Cleidoic eggs : -

Eggs which are not surrounded by a hard shell are called non-cleidoic eggs.

eg. : - all viviparous animals (Mammals) and all oviparous animals which lay eggs in water (Amphibians). Reptilia eggs are called leathery eggs.

STRUCTURE OF AN OOCYTE :

- The nucleus of egg is also called germinal vesicle.
- Oocyte is surrounded by membranes termed as the egg-membranes.
- Oocyte/Ovum along with the egg-membrane are termed as the egg.
- Egg = Ovum/Oocyte + Egg membrane.

Majority eggs are oval but the eggs of insects are long and cylindrical. Smallest eggs are of 50 in polychaeta and the largest eggs are of an Ostrich.

Classification of egg - membranes :

On the basis of origin, egg-membranes are of 3 types : -

(1) Primary egg membrane :

This membrane is secreted by the oocyte itself.

eg. Vitelline membrane, Zona Pellucida (mammals)

(2) Secondary egg membrane :

This is found outside the primary egg membrane and is secreted by the ovary.

(3) Tertiary egg membrane :

The is present outside the primary egg membrane. It is either secreted by the uterus or the oviduct.

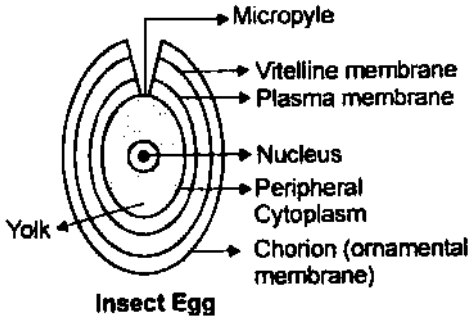
Functions of Egg-membranes

(i) To provide protection (ii) To check polyspermy (iii) To provide buoyancy to the amphibian eggs

Different types of eggs

(I) INSECT EGG

- Eggs of insects are megalecithal or polylecithal in them yolk is present in the centre, so the eggs are also centrolecithal.



Insect Egg

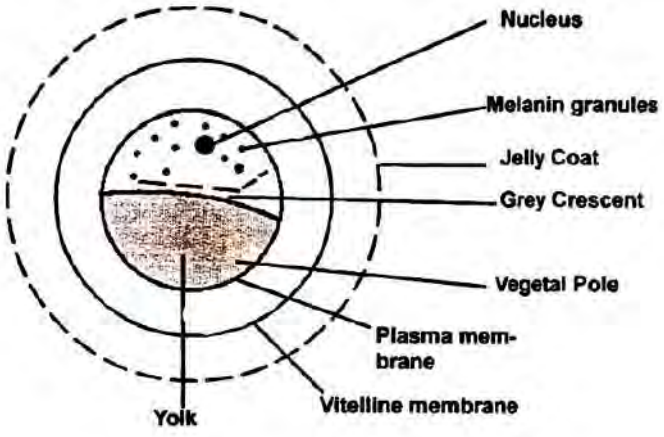
- Two egg membranes are present here, inner vitelline membrane (primary) and outer chorian (secondary).
- The sperm enters the egg through micropyle because on the head of insect sperm acrosome is absent.
- The Cytoplasm here is found in two parts :

(a) Central cytoplasm : - It is present in a very small amount in the centre of the egg. Egg nucleus is located in it.

(b) Peripheral Cytoplasm : - It is present in a very small amount along the periphery of the egg.

(II) FROG'S EGG

- Eggs of frog are moderately Telolecithal & Mesolecithal



Frog's Egg

Two types of egg membranes are found in frogs egg :

(i) Vitelline membrane : This is primary egg membrane which is secreted by the ovum around itself.

(ii) Jelly coat : This is tertiary egg membrane, secreted by oviduct. Jelly coat has air bubbles trapped in it due to which it floats on water. This group of frogs egg is called spawn, Jelly coat is bitter in taste so enemies do not eat it.

Secondary egg membrane is absent in frog's egg.

Internal part of the egg is divided in two parts :

(i) Animal pole : This part has cytoplasm, egg nucleus in also located in this part. In the cytoplasm melanin granules are found which prevent the egg from harmfull radiations. They also help in protection of egg by camouflage.

A sperm always enters into the ovum at some point in animal hemisphere. This point is normally other than the animal pole itself.

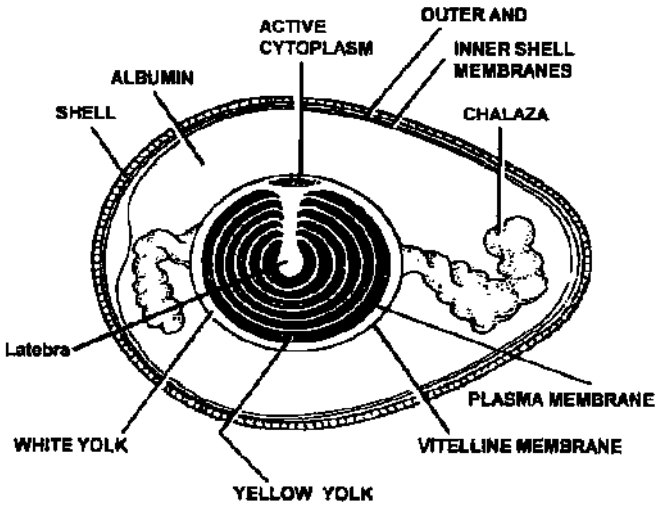
As the sperm enters into the ovum, taking some pigment granules with it, a grey, crescent shaped region appears in the equatorial zone geometrically opposite the sperm entrance point. This region is called **grey crescent.** It is formed due to movement of some pigment granules away from it towards sperm entrance point.

(It marks the dorsal side of future embryo). This area of sperm entrance point marks the anterior side of future embryo. The side diagonally opposite to it in the vegetal hemisphere marks the future posterior side. Thus the sperm entrance establishes the anteroposterior and dorsoventral axis as well as bilateral symmetry of future embryo.

(ii) Vegetal pole : yolk is concentrated in this part of egg.

(III) CHICK EGG

- These eggs are megalecithal or polylecithal and discoidal eggs.
- In these eggs, yolk is present in the centre of the egg in the form of a dense mass. The cytoplasm of the egg is in the form of a disc above the yolk, which is termed as the germinal-disc.
- Yolk is of 2 types i.e. yellow yolk and white yolk.
- Yellow – yolk has more amount of phospholipids and is secreted during the night. White yolk has less amount of phospholipids and is secreted during the day time. Central white part of yolk is called latebra.
- Both the types of yolk are arranged in alternate and concentric layers.
- Pander was the scientist, who discovered the 3 germinal layers i.e. Ectoderm Mesoderm and Endoderm in chick - egg.



Chick Egg

- Around the egg, porous shell of $CaCO_3$ is present which is secreted by the cells of the oviduct.
- In between the vitelline membrane and the shell membrane albumin is filled which is also called the white of egg. It contains 13% proteins.
- Thick albumin-fibres termed as "Chalaza" are present in the albumin part of egg.

(IV) EGG OF MAMMALS

- Mammalian eggs have very less amount of yolk, so the eggs are oligolecithal and isolecithal or microlecithal and homolecithal.
- The egg has 2 egg-membranes : -

(1) Zona Pellucida : - This is a transparent membrane like covering and is a primary membrane secreted by the ovum/oocyte itself.

(2) Corona radiata : - This is a layer of follicular cells" and these cells are attached to the surface of egg through "hyaluronic acid" This is a secondary membrane, which is secreted by the ovary. These eggs don't have tertiary membrane.

Mammalian eggs are approx 0.1 mm in size.

FERTILIZATION :

The process in which union of male and female gametes (formed by gametogenesis) and fusion of pronuclei of sperm and ovum takes place thus diploid zygote is formed, is called fertilization.

- **Fertilization has following processes : -** The union of male and female gametes is called **Syngamy**. Where as intermixing of their cytoplasm is called **plasmogamy**. The fusion of pronuclei of sperm and ovum is called **karyogamy.** The intermingling of their chromosomes is called **amphimixis.**

Due to fertilization , a diploid zygote is formed, by the union of two different types of gametes.

SITE OF FERTILIZATION :

(A) INTERNAL FERTILIZATION - Fertilization in the body (i.e., genital organs of animal) is called internal fertilization. In this type of fertilization, sperms are discharged by male directly into the genital tract of female after coitus.

- Whole process of fertilization takes place within the body of female. This is the most common adaptation in terrestrial animals.

Examples : - Aschelminthes, reptiles, birds and mammals.

(B)EXTERNAL FERTILIZATION - External fertilization takes place outside the body of females i.e., in water.

Example : - In most of the invertebrates, some protochordates, amphibian and most of the fishes.

TYPES OF FERTILIZATION :

(a) Self fertilization - This process takes place in the body of single animal i.e., fusion of male and female gametes produced by male and female organs of the same animal. This is called self-fertilization. This is possible only in bisexual or hermaphrodite animals.

Examples : - Animals of phylum porifera and most of the species *Hydra.*

(b) Cross-Fertilization – Fertilization takes place between two (male & female) different animals of same species.

This is called cross fertilization.

- This process is found in all unisexual animals. These animals are also called dioecious animals
- Cross-fertilization is also found in most of the bisexual or hermaphrodite animals because in these animals male genital organs develop first. This condition is called protandrous condition. In some of the species female organs develop first, this condition is called protogynous condition e.g. sponges.

MECHANISM - We can understand the process of fertilization in following steps.

1. Movement of sperms towards ovum.
2. Entrance of sperms in the ovum.
3. Activation of ovum.

Approach of sperm towards the egg – it is a chance factor, so sperms perform random (directionalless) movement. To increase the chances of approach of sperm towards egg there are mainly two adaption

(a) Number of sperms is very high : - e.g. In man 20 to 120 million sperms are present per cubic mm of semen.

(b) Egg is 1000 times larger than sperm

- Some special proteins are found on the surface of egg and sperm to help in fertilization.

According of **Lillie,** chemicals named as "fertilizins" are found on the surface of egg. Fertilins are glycoproteins or acid mucopolysaccharides. According to **Ballinsky,** an acidic protein named as Antifertilizin is present on the surface of sperms. "Fertilin" proteins are also present on sperm surface.

- Both the proteins are specific for a particular species. Antifertilizin present on sperm of a particular species will react with fertilizin of present on egg of the same species of animals.
- If we place some eggs of sea-urchin in sea-water, this sea water becomes viscous, this is called egg-water. When some sperms come in contact with this egg water, sperms adhere with each other. It is called agglutination.

Here the reaction of fertilizin (dissolved in water from egg) and antifertilizin of sperm is observed clearly.

- Fertilizins behave like lock and antifertilizins behave like keys.
- Fertilization is always intraspecific.
- According to Washerman and Sailing (1989) a specific pair of protein molecules is found on the surface of mammalian sperm, which can recognize specific carbohydrates and proteins in ZP_3 region of zona pellucida. The **bindin** protein of sperm reacts with these molecules to initiate the changes in acrosome. A specific sugar galactose remains attached with ZP_3 glycoprotein. The sperm fails to recognize the ovum of its own species, if this sugar is removed from zona pellucida.
- In addition to these glycoproteins, there are some hormones also, which help in fertilization.

The hormones present at the surface of sperm are called androgamones. These are of two types. Androgamone first & androgamone second.

- **Androgamones I** help in the energy conservation of sperms.

- **Androgamones II** dissolve the gelatinous coverting present all over the egg.
- Hormones present at the surface of egg are called gyanogamones these are of 2 types.

(a) Gyanogamones I - this hormone neutralizes Androgamone I and activates sperm to move

(b) Gyanogamones II - It makes sperm head sticky.

Enzyme of acrosome (Hyaluronidase and sperm lysins) dissolve the egg membrane. This is called **acrosomal reaction.** As a result sperm head make the contact with the plasma membrane of egg, now inner membrane of acrosome evaginates outside and form rigid tube is called **acrosomal filament.** Acrosomal filament provide stimulus to plasma membrane of egg and due to stimulus of sperm, egg is induce for fertilization. Mammalian sperms do not form this type of filament because mammalian sperms are highly active and provide stimulus to plasma-membrane of egg without any filament. Mammalian sperms acquire activity at two places. First-epididymis and second-vagina. Vaginal secretion make the sperm highly active and sperm acquire capacity of fertilization is called **capacitation.**

Activation of egg : Due to stimulus of sperm an enzyme is induced in plasma-membrane of egg it is called adenyl cyclase enzyme and function of this enzyme is to catalyze C-AMP in egg cytoplasm. C-AMP is the second messenger. Cyclic AMP receive stimulus from plasma membrane of egg and transfers it in egg cytoplasm and induces all the response of egg for sperm.

All the response of egg for sperm are collectively called **gyanogenesis.**

Due to stimulus of sperm, permeability of plasma membrane of egg increases specially for k^+ and Ca^{2+} ions. Function of Ca^{2+} ions is to inactivate the cytostatic factors in egg. As a result egg is now ready for cleavage (In egg cytoplasm special type of protein called cytostatic factor are present these factor prevent the cleavage in unfertilized egg)

Due to stimulus of sperm, $H^+ – Na^+$ pump activates and induces the plasma-membrane of egg. Function of this pump is to continuously influx H^+ ions and outflux Na^+ ions. As a result concentration of H^+ ion increases in egg cytoplasm and develops an acidic medium. In acidic medium, proteolytic enzyme become active and liberate the m-RNA from informosome. These m-RNA become active and rapidly synthesize different types of protein and enzymes. Due to more availability of protein and enzymes metabolic activity of egg increases.

Response of egg : (1) Due to stimulus of sperm, meiosis-II is induced in human egg by excluding second polar body becoming mature ovum.

(2) At the point of contact with sperm and plasma-membrane of egg a cone-like structure is formed called **reception cone.** After some time reception cone sinks in egg cytoplasm along with sperm (entry of sperm is a type of phagocytosis). With the entry of sperm all the cortical granules burst and secrete a membrane around the egg is called fertilization membrane **(cortical reaction).** It is secreted on inner surface of primary egg membrane and perivitelline space become more wide and amount of perivitelline fluid is also increase. Function of perivitelline fluid and fertilization membrane is to prevent the entry of sperm in egg. so normally only one sperm enter inside the egg (monospermy). Sometimes more than one sperm enter inside the egg **(polypermy).** Two types of polyspermy are found in nature.

(1) **Pathological polyspermy :** In it the nuclei of all the sperms fuse with egg nucleus. In such type of condition embryo development does not occur. (Due to polyploidy condition)

(2) **Physiological polyspermy :** In physiological polysermy nucleus of only one sperm fuses with egg nucleus and rest of the sperm die in egg cytoplasm. Dead sperm are called merocytes. In physiological polyspermy normal embryo development occurs.

Polyspermy is absent in human beings. Polyspermy mostly occurs in megalecithal eggs.

Fate of sperm in egg - In majority of animals, only head and middle piece enter inside the egg and tail is left outside.

- In mammals, whole sperm enters in the egg.
- In some animals, only head of sperm enters in the egg tail and middle piece remain outside e.g. *Hydra, Neries* etc. After entering inside the egg, sperm rotates by 180°. All the structure of sperm dissolve in egg cytoplasm except sperm nucleus and proximal centriole.
- The centriole of egg itself degenerates at the time of second maturation division. So proximal centriole of sperm starts division, it divides into 2 daughter centrioles, which migrate towards opposite pole and start forming spindles.

Fat of sperm nucleus : -

- The nucleus of sperm absorbs water from egg cytoplasm and becomes enlarged. Now it is called **male pronucleus.**

After meiosis – II egg nucleus occur in the form of scattered vesicles then it is called as karyomeres and after some time ll the karyomeres assembled to form complete nucleus is called female pronucleus.

- Male pronucleus and female pronucleus migrate through definite routes and come close to each other. These routes are called fertilization path. (It has following parts)

(1) Sperm penetration path - Male pronucleus for some distance, moves at the equator of egg. This is called sperm penetration path.

(2) Sperm copulation path - Male pronucleus starts migrating towards female pronucleus.

(3) Egg copulation path - Female pronucleus migrates towards male pronucleus. Both the pronuclei come close to each other.

(4) Cleavage path - Both the pronuclei move together to their final position which is somewhere in animal pole. At this final position nuclear membrane of both the pronuclei degenerate and chromosomes of male and female pronuclei form pairs. The mixture of male and female chromosomes is called amphimixis.

- Amphimixis was discovered by **O.Hertwig** in the eggs of sea – urchin.
- **Newport** was of all first observed the entry of sperm into the egg.

Significance of Fertilization

1. Oocyte completes its second maturation division on coming in contact with the sperm.
2. Amphimixis process leads to the formation of diploid zygote to restore the normal diploid number of the chromosomes.

3. The centriole of sperm after entering into egg induces the egg to undergo cleavage.
4. The paternal and maternal characters are transmitted to the off springs through the process of fertilization.
5. The peripheral changes occurring in the egg prevent the further entry of sperm into the ovum, thus checking polyspermy.

PARTHENOGENESIS OR VIRGINAL DEVELOPMENT

- The development of embryo without fertilization is called parthenogenesis. The animals which are formed by unfertilized eggs are called parthenotes.
- The discovery of parthenogenesis was done by **Charles Bonet** in the eggs of sea-urchins.
- Parthenogenesis is of two types –

  (a) Natural (b) Artificial

(a) Natural parthenogenesis -

Some animals show parthenogenesis by nature e.g. Honey bees, wasps, ants, grass-hoppers, ticks, mites and sea-urchins. Natural parthenogenesis is of 2 types : -

(i) Haploid parthenogenesis or Arrhenotoky : - In this case eggs are formed by meiosis. Eggs are haploid, they have the power of fertilization sometimes male animals are developed by unfertilized eggs. In Honeybees, unfertilized eggs develop into males (drones), and fertilized eggs develop into queen and soldiers. Thus male honey bees are always haploid and queen with soldiers are always diploid.

(ii) Diploid parthenogenesis or Thelytoky : - In this case, eggs are formed without meiosis division. Eggs are diploid they do not have the power of fertilization.
Diploid eggs give rise to female generation only. Male members are absent in these species.

Examples : - *Lacerta sexicola armenica* (lizard), Caresius aratus gibelio (Fish).

Diploid parthenogenesis may also be divided into two types –

(A) Ameiotic Thelytoky - In this type of parthenogenesis, during oogenesis first meiotic division does not take place but second meiotic division occurs as usual. In this situation the ovum still remains diploid. These ova, when reproduce parthenogenetically give rise to diploid off springs. For example, *Trichoniscus, Daphnia, Daphnia pulex* etc.

(B) Meiotic thelytoky - If the eggs are formed by normal oogenesis process, but by one or other reasons the eggs retain their diploid chromosomal number, then the parthenogenesis is called meiotic thelytoky. It may happen because of autofertilization. Some species of order – Lepidoptera exhibit this type of parthenogenesis.

- In some animals parthenogenesis alternates with normal sexual reproductive cycle. This is called cyclic parthenogenesis e.g., Honey bee.
- In some animals, development of animals is always by parthenogenesis and sexual reproduction is absent in these species. This is called complete parthenogenesis. Males are absent.

Example - Lacerta sexicola armenica (lizard)

(b) Artificial parthenogenesis : -

This type of parthenogenesis is done by artificial methods. Artificial parthenogenesis is done by putting eggs in different atmospheres or by giving special stimulus to the eggs. Different artificial methods used for this purpose are as follows -

(1) If we place eggs in brine or salt solution, KCl solution. Then eggs show parthenogenesis e.g. eggs of sea-urchins.

(2) By short exposure of radiations on eggs or exposure of silk insect egg to sunlight.

(3) If eggs are given shocks of temperature.

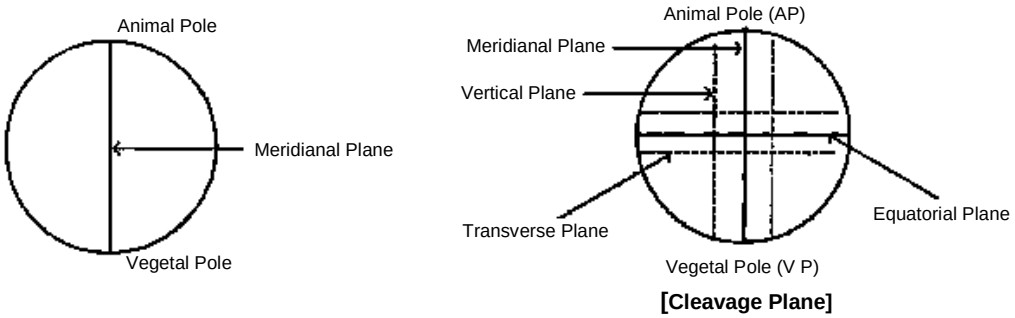
(4) If eggs are pierced by needle dipped in the blood of some animal. The eggs of frog show parthenogenesis by this method.

CLEAVAGE

- The term 'Cleavage' was given by **''Von Baer''.**
- In fertilized egg or activated egg, the egg undergoes repeated cell divisions which occur rapidly producing a multicellular structure without changing its size. All these mitotic cells divisions collectively called cleavage or segmentation. Due to the process of cleavage, a single celled zygote, through a successive mitotic cell divisions changes into a complex multicellular structure. Cells produced as a result of cleavage are termed as blastomeres. The total size of the embryo remains the same. Though the number of blastomeres as a result of mitotic cell divisions increases, the size of blastomeres gradually decreases are compared to parent cell. Interphase stage is very short in cleavage. In interphase only DNA duplication and histone protein synthesis takes place up to some extent. In the interphase of cleavage only 'S' phase is present, G_1 & G_2 phases are absent. Protein synthesis and RNA synthesis do not occur during this interphase. Nucleolus is absent in the nucleus of blastomeres. Size of blastomeres decreases during cleavage. When size of blastomere becomes equal to that of size of somatic ells, the divisions of cleavage are stopped. Only normal cell division take place. Cleavage can be observed till onset of gastrula stage. After gastrulation, cleavage is completely checked. Nucleous appears first in gastrula stage. The consumption of oxygen is increased during cleavage.

CLEAVAGE PLANE :

- The traveling path of cleavage furrow in fertilized egg is called cleavage plane. Different animal eggs show different cleavage planes : -



[Cleavage Plane]

PATTERNS OF CLEAVAGE :

(a) Radial Cleavage - In this pattern, cleavage furrows are straight and form right angle with each other. In this case I, II cleavages are meridianal, which are at right angle to each other. III cleavage is equatorial In this way 8-celled octate is formed. In radial cleavage, 4 blastomeres of upper tier and 4 blastomers of lower tier are on sampe plane i.e, Blastomeres are arrangement in radial symmetry in the beginning.

(b) Biradial Cleavage - In this pattern, first two cleavages are meridianal and at right angle to each other all III cleavage is vertical. In 8-celled stage 4 blastomeres of central zone are bigger and 4 blastomeres of peripheral region are smaller.

Examples : - In the eggs of Ctenophora.

(c) Bitareal Cleavage - In this patterhn, first two cleavages are meridianal in same plane and III Cleavage is transverse. i.e., embryo shows bilateral symmetry in 8-celled stage. The blastomeres of one side are smaller and blastomeres of other side are larger.

Examples : - In the eggs tunicata, cephalochordata, amphibian and amphioxus.

(d) Spiral Cleavage - The cleavage furrow passes obliquely. In this pattern 4 blastomeres of lower tier rotate clockwise or anticlock wise. If this rotation is clockwise, then it is called dextral spiral cleavage e.g. In Mollusca. If this rotation of lower tier blastomeres is anti-clockwise, then pattern is called sinistral spiral cleavage, e.g. In helminthes and annelida.

CLASSIFICATION OF CLEAVAGE :

On the basis of fate of blastomeres : -

A. Determinate Cleavage - In this pattern of cleavage, the fate of blastomeres is fixed, determined i.e. each blastomere forms a particular portion of embryo. If (by certain reason) any blastomere is damaged or destroyed, then the part of embryo (which would have development from that blastomere) will be absent e.g., Nematoda, Annelida, Mollusca and Some chordates like amphibian & ascidians.

B. Indeterminate Cleavage - In this type of cleavage, the fate of blastomeres is not definite. All the blastomeres form all the parts of embryo. If some blastomeres are lost, no loss is observed in this embryo. If in the early stages of cleavage, the embryo is cut into small pieces, then each piece of embryo will develop into a complex embryo, and all the embryos are identical. So identical twins are monozygous. This is the basis of embryo cloning.

CLASSIFICATION OF CLEAVAGE :

On the basis of amount of Yolk : -

☐ A scientist named **Balfour** gave a law. According to him, rate of cleavage is inversely proportional to amount of yolk present in the egg. The yolk present in egg, disturbs the rate of cleavage. The rate of cleavage is slow in that part of egg, in which amount of yolk is more, and the rate of cleavage is faster in the portion of egg in which yolk is in lesser amount. Mostly cleavage is of 2 types : -

A. Complete or holoblastic : - When cleavage furrow passes through the egg completely. As a result of this the whole egg divides. Holoblastic cleavage is found in all the eggs except megalecithal eggs. The whole egg divides into blastomeres. No part of egg remains undivided. It is of 2 types : -

(a) Equal holoblastic cleavage - In those eggs, in which amount of yolk is less and it is distributed evenly in the egg, cleavage occurs in whole egg, blastomeres (So formed) are of same size. All the parts of egg show same rate of cleavage.

Example : - It is found in microlecithal and isolecithal eggs.

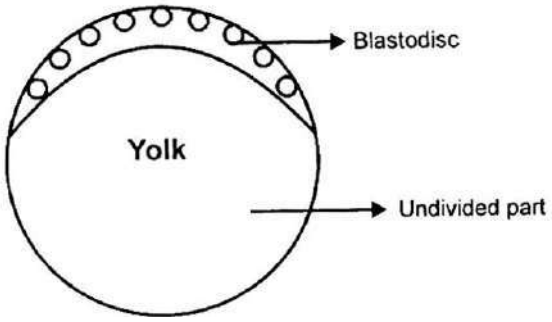
(b) Unequal holoblastic cleavage - In those eggs in which amount of yolk is medium and it is distributed unevenly in the egg. The blastomeres are bigger and less in number where the concentration of yolk is higherin the egg. The part of egg which contains small amount of yolk, blastomeres here formed are smaller and more in number. The bigger blastomeres are called megamere and smaller blastomere are called micromeres.

Examples : - Unequal holoblastic cleavage is present in mesolecithal and telolecithal eggs and human eggs.

B. Meroblastic cleavage - This cleavage is found in megalecithal eggs, in which amount of yolk is large. Cleavage does not occur in that part of egg, where yolk is present cleavage occurs only Cytoplasmic part, yolk remains undivided. Meroblastic cleavage is of 2 types on the basis of distribution of yolk in egg.

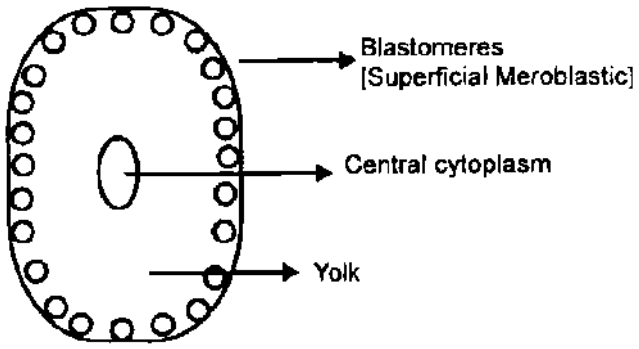
(a) Discoidal meroblastic cleavage - Cleavage occurs only in blastodisc of egg. This is mainly found in megalecithal or polylecithal eggs, because in these eggs, cytoplasm is found in the form of a disc.

Examples : - Reptilian eggs and birds eggs.



(b) Superficial meroblastic cleavage – In insect egg, central cytoplasm shows free central division, due to which so many nuclei are formed. All these nuclei migrates towards peripheral cytoplasm. Cleavage occurs only in peripheral region. As a result of this, a superficial layer of blastomeres is formed around the yolk. This type of cleavage is also called superficial meroblastic cleavage.

Example - In centrolecithal eggs.



Significance of Cleavage -

1. There is no change in shape and size developing embryo till blastula stage comes. Till then it remains just like undivided egg in shape.
2. As a result of cleavage, unicellular zygote changes into multicelluar structure.

HUMAN EMBRYOLOGY :

Fertilization -

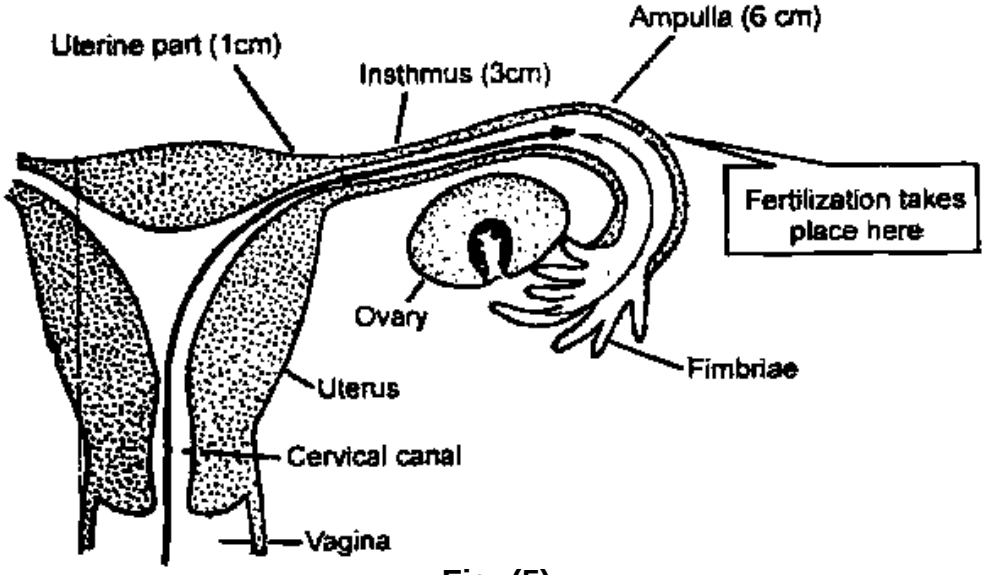


Fig. (5)

Fertilization is the union of two opposite types of gametes, spermatozoa and ova. The semen is a mixture of spermatozoa and accessory fluids. Once deposited with in the vagina, the spermatozoa proceed on their journey into and through the uterus and on up into the oviducts. Although spermatozoa can swim several millimeters each second, their trip through the uterus and to the oviducts requires on increase in their motility.

On the first hand, ejaculation of semen in the vagina triggers motility of spermatozoa. This is aided further by muscular contraction of the walls of the uterus and the oviducts. An additional increase in sperm motility occurs due to activation of the sperm by the viscous liquid secreted from the secreted cells of the epithelial lining of oviduct mucosa. This phenomenon of sperm activation in mammals is known **capacitation**. It takes about 5-6 hours for capacitation.

Before fusion of a spermatozoan with the egg, the spermatozoa are to penetrate a few barriers, the **egg membranes,** which cover the egg. The activated spermatozoa undergo **acrosomal reaction** and release varies chemicals, like **hyaluronidase** that acts on the **ground substances** of follicle cells, **corona penetrating enzyme** that dissolves **corona radiata,** and **zona lysine which perforates the zona pellucida**. All these chemicals are contained in the acrosome, located at the tip of the sperm head, and are collectively termed **sperm lysins.** An average human ejaculate of 3-4 ml of semen contains 80-100 million spermatozoa. Out of these, only one will succeed in entering the egg and fertilizing it. Fertilisation of egg with only one spermatozoan is known as **monospermy.**

While the ovarian follicle is growing, the oogonium within it undergoes maturation. The oogonium enlarges to form a primary oocyte. The primary oocyte undergoes the first meiotic division to shed off the first polar body and becomes a secondary oocyte (fig. 5.2A). At the time of ovulation, the second meiotic division is in progress and a spindle has formed for separation of the second polar body (fig. 5.2B)

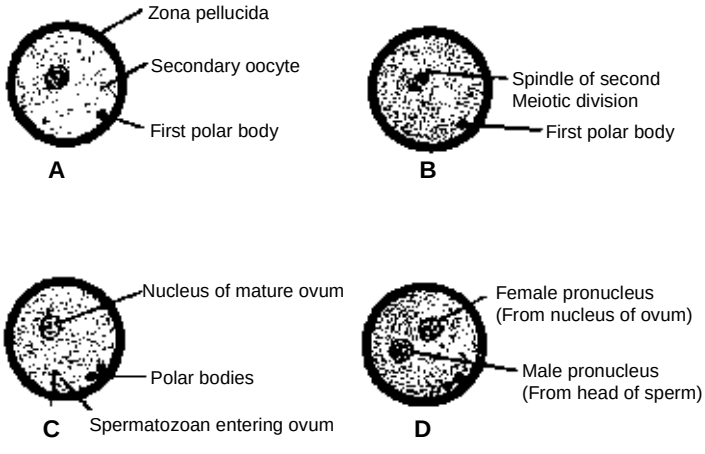


Fig 5.2

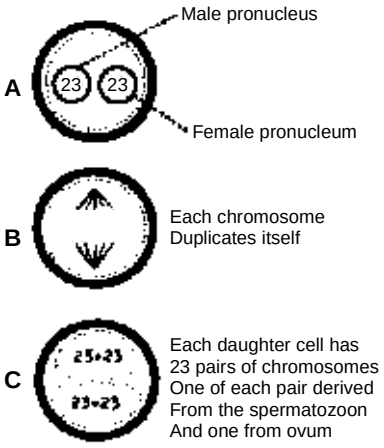


Fig 5.3

At this stage the 'ovum' enters the infundibulum of the uterine tube and passes into the ampulla (fig. 5)
Fertilization of the ovum occurs in the ampulla of the uterine tube. One spermatozoon pierces the zona pellucida and enters the ovum. In response to egg sperm binding two things happen (1) **depolarization** of egg membrane (2) **cortical reaction** i.e. formation of fertilization membrane to prevent **polyspermy.** (After one spermatozoon has entered the ovum other spermatozoa cannot enter it). After the entry of the spermatozoon, the second polar body is extruded. The chromosomes of the ovum now assume the shape of a nucleus called the *female pronucleus.* At the same time the head of the spermatozoon (which it will be remembered is formed from the nucleus) separates from the middle piece and tail, and transforms it self into the *male pronucleus* (Fig. 5.2 D).
The male and female pronculei meet, but they do not fuse to form one nucleus. Their nuclear membranes disappear and their chromosomes become distinct. It will be recalled that each pronucleus has 23 chromosomes so that the fertilized ovum now has 46 chromosomes in all (fig 5.3 A).

- Each of these 46 chromosomes splits into two (fig. 5.3B). Meanwhile, a spindle has formed, and one chromosome of each pair moves to each end of the spindle (as in mitosis). Leading to the formation of two daughter cells fig. (5.3C). This is called the two-cell stage of the embryo. Note that stricktly speaking there is no one-cell stage of the embryo (fig. 6A)
- Important points note at this stage are that :
  (i) the two daughter cells are still surrounded by the zona pellucida :
  (ii) each daughter cell is much smaller than the ovum. As subsequent divisions occur the cells become smaller an smaller until they acquire the size of most cells of the body.

CLEAVAGE :

The two cells formed as described above undergo a series of divisions. One cell divides first so that we have a '3-cell' stage of the embryo (fig.6B) followed by a '4-cell' stage (fig. 6C), a 5-cell, stage etc. This process of subdivision of the ovum into smaller cells is called cleavage. These cells are called blastomeres.

- As cleavage proceeds the ovum comes to have 16 cells. It now looks like a mulberry and it called the
  morula (fig. 6D). It is still surrounded by the zona pellucida. If we cut a section across the morula

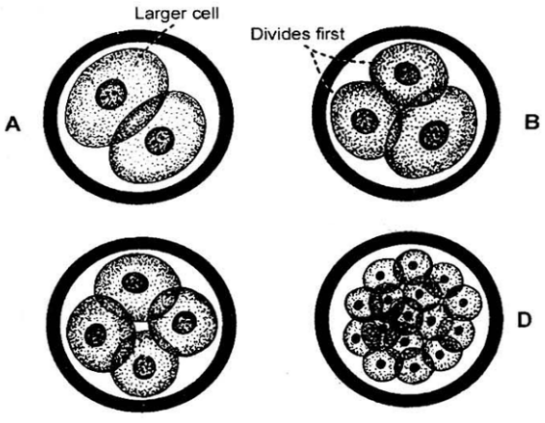


Fig 6

we see that it consists of an *inner cell* mass that is iscompletely surrounded by an outer layer of cells, *(Compaction).* The cells of the outer layer will later give rise to a structure called the *trophoblast* (fig. 7A). The inner cell mass gives rise to the embryo proper, where as the cells of the trophoblast help to provide nutrition to the embryo.

- Some fluid now passes into morula from the uterine cavity, and partially separates the cells of the inner cell mass from those of the trophoblast (fig. 7B). As the quantity of fluid increases, the morula acquires the shape of a cyst. The cells of the trophoblast become flattened and the inner cell mass comes to be attached to the inner side of the trophoblast on one side only (fig. 7C). The morula has now become a blastocyst. That side of the blastocyst to which the inner cell mass is attached is called the *embryonic* or animal pole. While the opposite side is the vegetable or *abembryonic pole.*

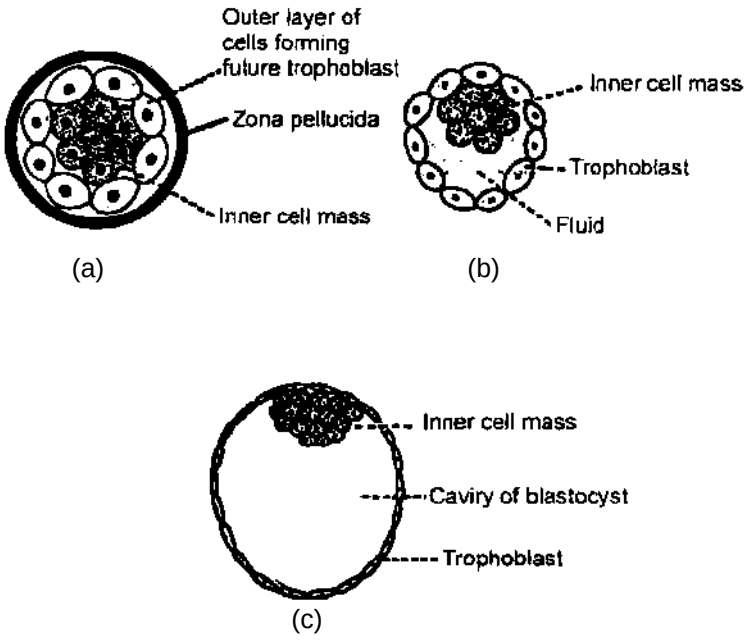


Fig. 7

Function of the zona pellucida -

- The trophoblast has the property of being able to stick to the uterine (or other) epithelium and its cells have the capacity to eat up other cells. As the embryo travels down the uterine tube, and the upper most part of the uterine cavity ; it is prevented from 'Sticking' to the epithelium by the zona pellucida.

FORMATION OF GERM LAYERS (GASTRULATION) :

As the blastocyst develops further, it gives rise not only to the tissues and organs of the embryo, but also to a number of structures that support the embryo and help it to acquire nutrition. At a very early stage in development, the embryo proper acquires the form of a three-layered disc. This is called embryonic disc (also called embryonic area, embryonic shield, or germ disc) The three layes that constitute this embryonic disc are.

(i) Endoderm (endo = inside)

(ii) Extoderm (ecto = outside)

(iii) Mesoderm (meso = in the middle)

- These are the *three germ layers.* All the tissues of the body are derived from one or more of these layers. We have seen that the blastocyst is a spherical cyst lined by flattened trophoblastic cells, and that inside it there is a mass of cells, the inner cell mass, attached eccentrically to the trophoblast Further changes are as follows

(a) Some cells of the inner cell mass differentiate (i.e. they become different from others) into flattened cells, that come to line its free surface (fig. 8A). These are called hypoblast and constitute the *endoderm*, which is thus the *first germ* layer to be formed.

(b) The remaining cell of the inner cell mass become columnar (fig. 8D). These are called are called epiblast and form the second germ layer, the *ectoderm.* The embryo is now in the form of a disc having two layers.

(c) A space appears between the ectoderm (below) and the trophoblast (above). This is the amniotic cavity (fig. 8C), filled by *amniotic fluid,* or liquor animal. The roof of his cavity is formed by *amniogenic cells* (cells of Rauber) derived from the trophoblast, while its floor is formed by the ectoderm.

(d) Flattened cells arising from the endoderm, spread and line the inside of the blastocystic cavity. In this way, a cavity, lined on all sides by cells of endodermal origin, is formed. This cavity is called the *primary yolk* sac (fig. 8D)

(e) The cells of the trophoblast give origin to a mass of cells called the *extra-embryonic mesoderm* (or primary mesoderm). These cells come to lie between the trophoblast and the flattened endodermal cells lining the yolk sac, thus separating them from each other. These cells also separate the wall of the amniotic cavity from the trophoblast (fig. 9A).

This mesoderm is called extra-embryonic because it lies out side the embryonic disc. It does not give rise to any tissues of the embryo itself.

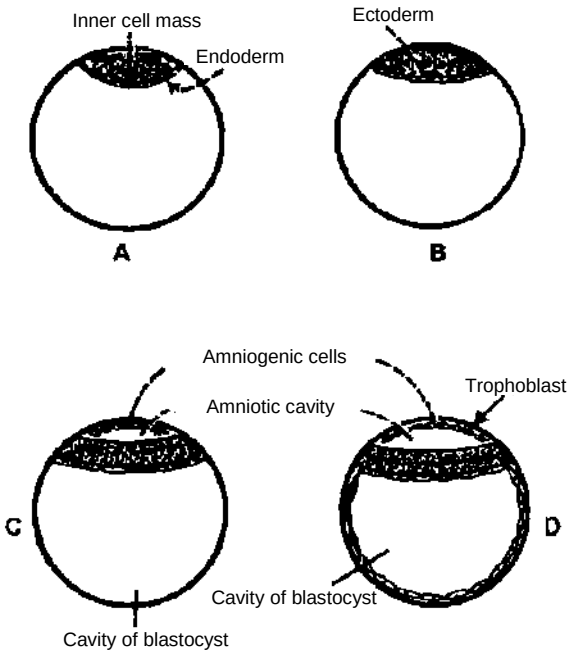


Fig. 8

(f) Small cavities appear in the extra-embryonic mesoderm. Gradually these join together to from larger spaces and, ultimately, on large space is formed. This cavity is called the *extra-embryonic coelom* (fig. 9B), it will be seen that the extra-embryonic coelom does not extend into that part of the extra-embryonic mesoderm which attaches the wall of the amniotic cavity to the trophoblast. The development embryo, along with the amniotic cavity and the yolk sac, is now suspended in the extra-embryonic coelom, and is attached to the wall of the

blastocyst (i.e. trophoblast) only by this unsplitted part of the extra-embryonic mesoderm. This mesoderm forms a structure called the *connecting stalk.*

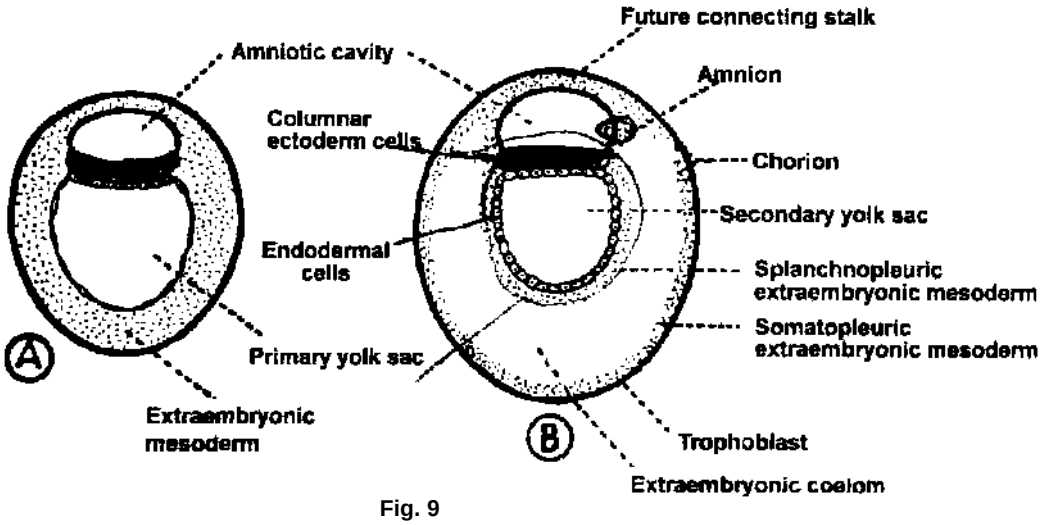


Fig. 9

(g) **Formation of chorion and amnion :** At this stage, two very important membranes are formed. One is formed by the parietal extra-embryonic mesoderm (on the inside) and the overlaying trophoblast (on the outside) this is called the chorian (fig. 9B). The other is the amnion which is constituted by the amniogenic cells forming the wall of the amniotic cavity (excluding the extodermal floor). These cells are derived from the trophoblast. We have already seen that the amnion is covered by the unsplit extra-embryonic mesoderm, and that the connecting stalk is attached to it.

(h) With the appearance of the extra-embryonic mesoderm, and later of the extra-embryonic coelom, the yolk sac becomes much smaller than before and is now called the *secondary yolk sac.* This alteration in size is accompanied by a change in the nature of the lining cells. They are no longer flattended but become cubical (fig. 9B).

(i) At this stage, the embryo proper is a circular disc composed of two layers of cells : the upper layer (towards amniotic cavity) is the ectoderm, the cells of which are columnar, while the lower layer (towards yolk sac) is the endoderm, made up of cubical cells (fig. 10)

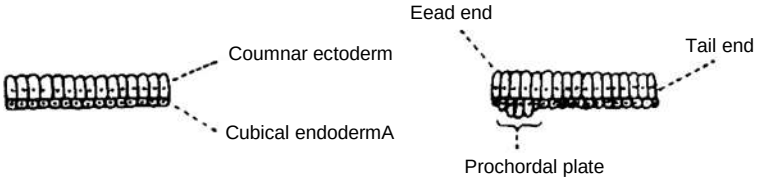


Fig.10

(j) At one circular area a near the margin of the disc, the cubical cells of the endoderm become columnar. This area is called the prochordal plate. The appearance of the *prochordal plate* determines the central axis of the embryo (i.e. enables us to divide it into right and left halves), and also enables us to distinguish its head and tail ends (fig. 10)

(k) Soon after the formation of the prochordal plate some of the ectodermal cells lying along the central axis, near the tail end of the disc, begin to proliferate, and form an elevation that bulges into the amniotic cavity. This elevation is called the *primitive streak* (fig. 11). The primitive streak is at first a rounded or oval swelling primitive streak later forms the Henson's node.

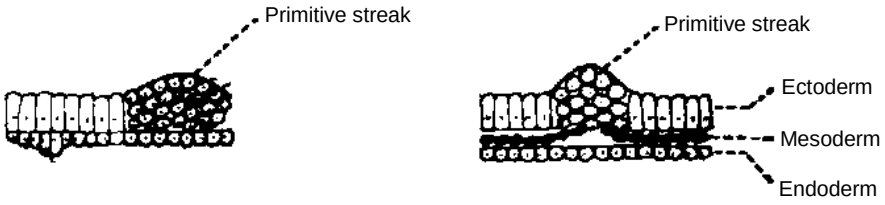


Fig. 11

(i) The cells that proliferate in the region of the primitive streak pass sideways, pushing themselves between the ectoderm and endoderm (fig. 11). These cells from the *intra-embryonic mesoderm* (or secondary mesoderm) which is the third germ layer.

Notochord

The notochord is a midline structure, that develops from mesoderm in dorsal region.

Importance of the notochord

The notochord is present in all animals that belong to the phylum Chordata. In some of them e.g. **Amphioxus,** it persists into adult life and forms the central axis of the body. In others, including man, it appears in the embryo but only small remainants of it remain in the adult. Notochord elongates considerably, and lies in the midine, in the position to be position to be later occupied by the vertebral column. However, the notochord does not give rise to the vertebral column.

Neurulation : i.e formation of neural tube. After neurulation there occur three type of ectoderm.

(i) Somatic ectoderm (ii) Neural tube ectoderm (iii) Neural crest ectoderm.

Anterior part of neural tube differentiate brain and rest of the neural tube differentiate in spinal cord so central nervous system is formed by neural tube.

TERATOGENY :

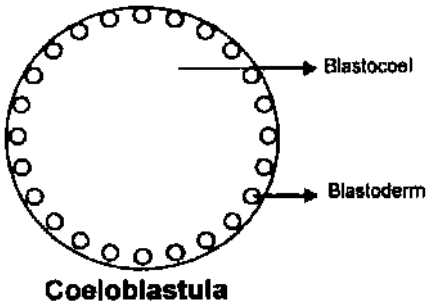
☛ During the first 3 months of pregnancy the basic structure of baby is formed. This involves cell division, cell migration, and differentiation of cells into the many types found in the body. During this period, the developing baby called foetus is very sensitive to anything that interferes with developmental steps. Eg.

Virus infection of mother by rubella (German measles) virus or pexposure to certain chemicals may cause malformation in the developing embryo. Such agents are called teratogens (Monster Forming agents).

GENRAL STAGES OF EMBRYONIC DEVELOPMENT

1. **Morula -** As a result of segmentation or cleavage activities, unicellular zygote changes into a solid ball like multicellular structure. In the later stage of cleavage, clusters of sticky, cohering, protruding (otuside) blastomeres are produced, which look like mulberry. This stage is termed as morula stage.
2. **Blastulation -** Cleavage continues in solid ball like morula and new formed blastomeres start rearranging themselves. Cell-aggregation starts in blastomeres, due to the movement of these blastomeres a cavity appears in the embryo, it is called as blastocoel. This cavity is schizogenous cavity in origin i.e. it is formed by the separation of cells. Cell aggregation is also known as cohesion. Blastomeres arrange

themselves in the form of a layer around the blastocoel, this layer is termed as blastoderm. The embryonic stage is now called blastula, and its formative activites is called blastulation.



Coeloblastula

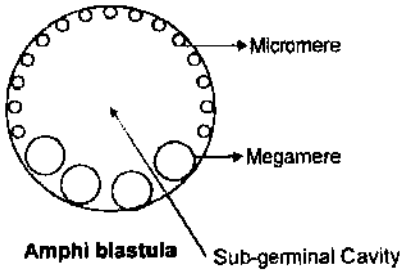
Types of blastula

The shape of blastula depends on so many factors e.g. size of eggs, amount of yolk, distribution of yolk in the eggs, frequency of cleavage and number of cleavage divisions. According to these factors, we can classify blastula of different animals in different categories.

(a) Coeloblastula (b) Stereoblastula (c) discoblastula

(d) Blastocyst (e) Superficial blastula or Periblastula

(a) Coeloblastula - Blastocoel is wide and clear in this blastulation, it is completely surrounded by blastomeres on all the sides i.e, blastocoel cavity is situated totally inside the embryo. Blastomeres are very small in size as compared to blastocoel.

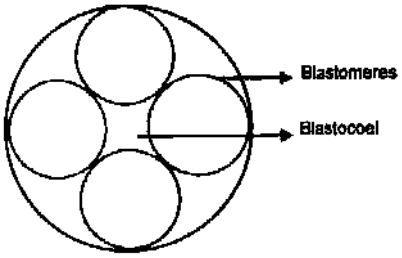


Amphi blastula

Example : - Eggs of **Amphioxus,** coelenterate, amphibia, sponges etc.

Coeloblastula of amphibians is called amphiblastula because in it blastocoel cavity is accentric in position and is more towards the animal pole (amount of yolk is more towards the vegetal pole). Amphiblastula of sponges is a free swimming larva, its blastomeres are flagellated. This larva swims freely with the help of these flagella. It is a unique feature in sponges.

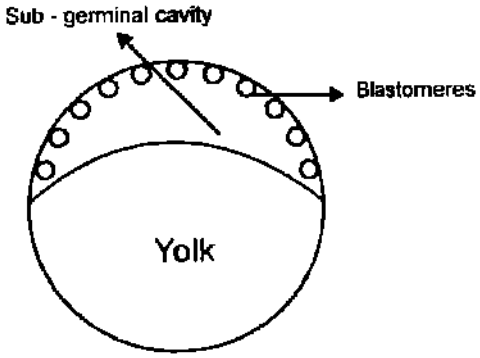
(b) Stereoblastula - In this blastula, blastocoel is very narrow or obliterated. Blastomeres are large as compared to blastocoel. It is almost solid.



[Stereoblastula]

Example - eggs of Neries, and members of phylum Mollusca.

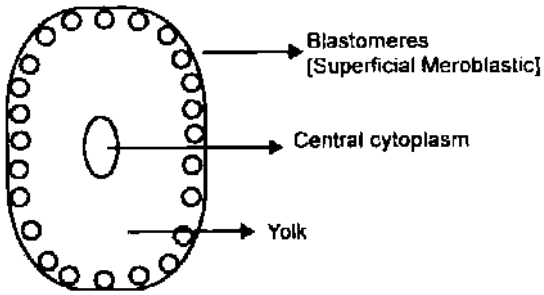
(c) Discoblastula - It is found in those animals which have discoidal eggs. There is a cavity present in between blastomeres and yolk, it is called subgerminal cavity. It is a type of cavity, which is surrounded by yolk on one side and by blastomeres on the other side.



[Discoblastula]

Examples - eggs of reptiles, birds and prototheria.

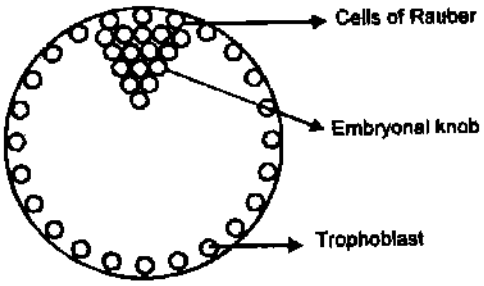
(d) Superficial blastula or periblastula - In centrolecithal eggs, cleavage occurs only in peripheral region. The layer of blastomeres surrounds the centrally situated yolk. Blastocoel is absent in this type of blastula. In place of blastocoel, subgerminal cavity is found.



[Periblastula]

Example - Eggs of insects.

(e) Blastocyst - blastula or Eutherian & Metahterian mammals is called blastocyst, because blastula is in the form of a cyst.



[Blastocyst]

Blastula - of mammals is called blastocyst. In blastocyst all the embryonal cells occur in the form of solid mass called embryonal knob. Embryonal knob (inner cell mass) is covered by protective layer called trophoblast and it's cell just above the embryonal knob are trophoblast called cells of Rauber (amniogenic cells). There occurs a cavity in between embryonal knob and trophoblast called albumin cavity. It is filled with nutritive fluid absorbed from the wall of uterus. So albumin cavity is also nutritive-cavity.

SPECIAL POINT :

1. The growth phase is the longest phase during male gametogenesis. But in human oogenesis, maturation phase is longest.
2. The acrosome of sperm are produced by golgibodies.
3. The smallest sperm is of crocodile and its size of 0.02 mm & largest sperm is of Discoglossus (2 mm)
4. 74 days are required to complete the cycle of spermatogenesis in human being.
5. In 1 ml of semen, 20 to 120 millions of sperms are present in human being.
6. Deficiency in the number of sperms result in sterility which is known as oligospermia.
7. Absence of sperms in semen is known as azoospermia .
8. Formation of yolk in oogenesis takes place in the growth phase.
9. Largest egg is of Ostrich (16 cm long with its shell).
10. Although normal number of sperm are present in semen but if these are completely non motile. The condition is known as necrospermia.
11. Smallest egg in birds is of humming bird.
12. Due to high mortality rate in lower animals, the production of egg is more.
13. Sequence of egg production is as follows.
    Mammals < Aves < Reptiles < Amphibian < Pisces.
14. Cat and rabbit both are induced ovulator.
15. The life span of eggs in female reproductive organs in human being is 48 hrs.
16. The nucleus of egg is known as germinal vesicle.
17. At the age of 45-50 yrs. In female the ovulation process will stop which is known as menopause.
18. The spermiation (release of sperms from sertoli cells) in all sertoli cells occurs simultaneously.
19. Cortical granules are absent in rat.
20. Mosaic type of cleavage is found in the parasite *Echinococcus* granulosus.

Special features of some animals :

(a) Sperms of some animals are not having flagella :

eg. (1) Ascaris - sperm is amoeboid

(2) Cray fish - star shaped, tail less sperm

(3) In crab and lobuster the sperm are tail less and have three sharp process.

(b) Biflagellated sperm :

eg. In toad fish *(Opsansus)* head of many sperms unite together and form sperm boats

In Gastropods, the sperms are hexaflagellated.

Smallest sperm – Crocodile (0.02 mm)

Largest sperm – *Discoglossus* (2 mm) in chordates and Drosophila in entire animal kingdom.

Shape of head part of sperms :

(i) Spherical – eg Teleostei

(ii) Lance shaped – eg Amphibia and Reptiles
(iii) Spiral end – eg. Birds
(iv) Spoon shaped – eg. Mammals (in man)
(v) Hook like – eg. Rat.

Germinal layers and their derivatives

The following description gives an account of the respective organs formed by the three germ layers. Most of the organs are the product of combination of more than one germ layers.

Organs derived from ectoderm

1. Skin (epidermis) and their pigment cells.
2. Mucosal membrane of lips, cheek gums, basal portion of mouth, some part of palate, nasal apertures.
3. Lower part of anal canal.
4. Glans penis.
5. Labia majora and outer part of labia minora.
6. Anterior epithelium of cornea, epithelium of conjunctiva, ciliary body and iris of eyes.
7. Outer face of tympanic membrane, epithelium of labyrinth.
8. Glands :
   (i) Exocrine –
   (A) Sweat glands (B) sebaceous glands (C) parotid glands
   (D) mammary glands (E) lacrimal glands ;
   (ii) Endocrine –
   (A) Hypophysis cerebri (B) adrenal medulla
9. Hairs, nails, enamel of teeth
10. Lens of eyes.
11. Nervous system.

Derivatives of mesoderm

1. Connective tissues, superficial and deep fascia, ligaments, tendons, dermis of skin. (from dermatome)
2. Specialized connective tissues like adipose tissue, reticular tissues, bones, cartilages.
3. Teeth.
4. All muscles.
5. Heart, all blood vessels and blood cells.
6. Kidneys, ureters, urinary bladder, posterior urethra of female, upper glandular part of prostate.
7. Ovaries, uterine tubes.
8. Testes, epididymis, vas defeens and seminal vesicle, ejaculatory duct.
9. Pleural cavities, peritoneal cavity and pericardial cavity.
10. Joints.
11. Cornea, sclera, choroid ciliary body and iris related material.
12. Microglia, duramater etc.

Derivatives of endoderm

1. Epithelial part of mouth, some part of palate, tongue, tonsils, pharynx, oesophagus, stomach, small and large intestine, upper part of anal canal.
2. Pharyngo-tympanic tube, middle ear, inner face of tympanic membrane.
3. Respiratotry tract.
4. Gall bladder, pancreatic duct.
5. Major protion of urinary bladder, complete urethra of female except posterior part, complete urethra of male except anterior and posterior part.
6. Whole inner part of vagina including inner face of labia minora.

7. Glands :

(i) Exocrine –

(A) Liver (B) Pancreas

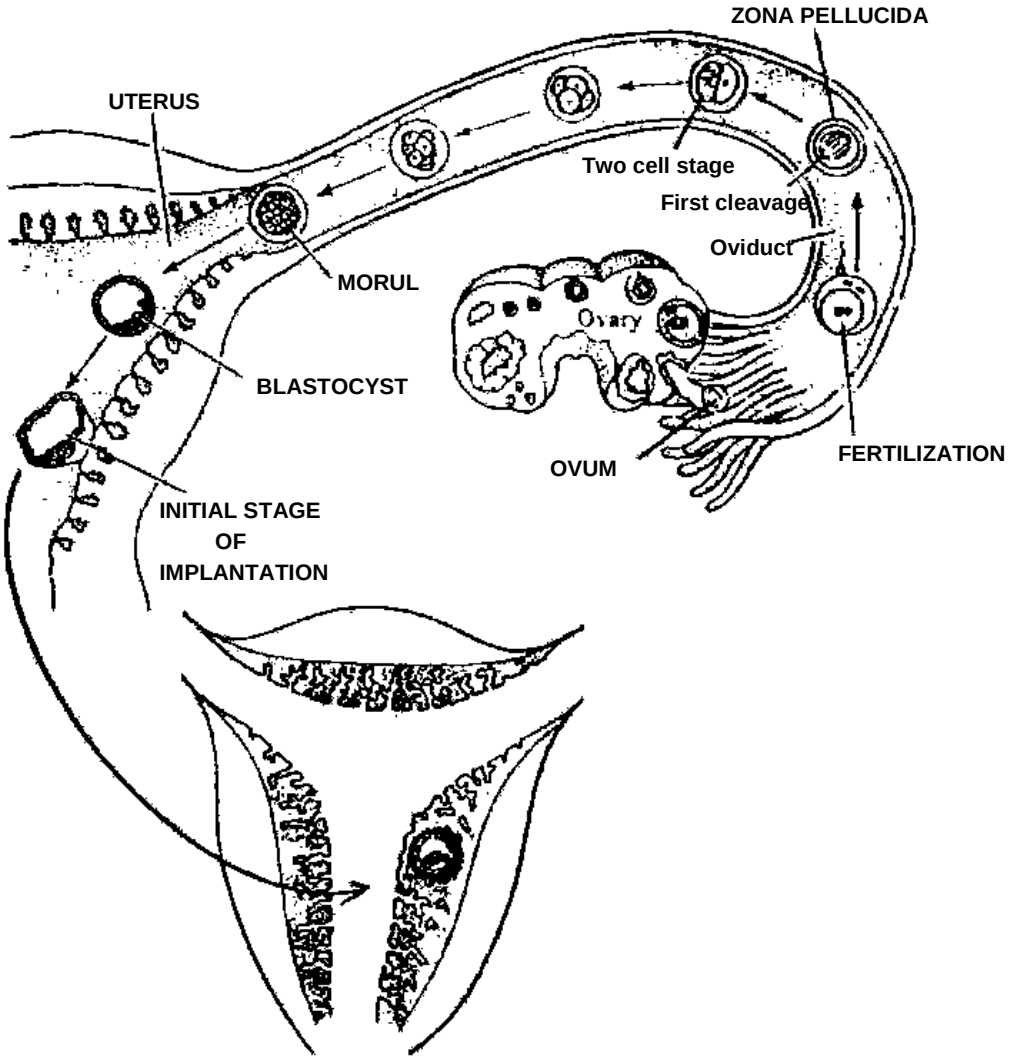
(ii) Endocrine –

(A) Thyroid (B) parathyroid (C) thymus (D) islets of Langerhans

In addition to the above, the glands of gastrointestinal tract, major part of prostate etc. are also formed by endoderm.

Implantation

The attachment of developing embryo to the appropriate body layer or surface to obtain nutrition is called implantation. This phenomenon is a common event in most mammals (except prototheria) in which embryo (blastocyst stage) after reaching in uterus attaches itself with the wall of the uterus. In other animals like fishes, reptiles, birds, prototherian mammals etc., this nutritive connection is established with the yolk present in egg. In higher mammals including men, the blastocyst on its contact with endometrium of uterus gets completely buried in the wall of the uterus.



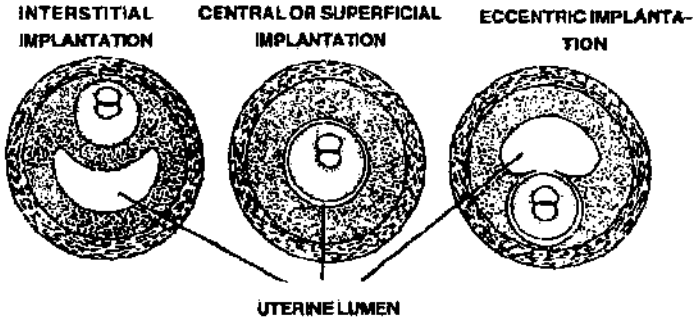
Initially the oocyte after its release from ovary, comes into fallopian tube where the process of fertilization is completed, Just after fertilization, embryonic development starts and a blastocyst is formed after cleavage and morulation. In human being, the blastocyst gets attached with the uterine endomdetrium in

about four days after entering in uterus. At the same time, the cells of endometrium of implantation area separate out and adhere with embryonic cells with the help of certain enzymes secreted by the cells of trophoblast. In human, the site of implantation is generally mid-dorsal or mid-ventral part of uterus. Implantation of blastocyst takes about 7-8 days after fertilization in human and by 12^{th} day it is completely buried in the wall of the uterus. The place of entry through which the embryo enters into the wall, is completely closed by a fibrous and cellular plug, known as **closing coagulum.**

Types of Implantation

On the basis of the position of attachment in the uterus, implantation is of three types -

1. **Central or Superficial implantation -** In this type the blastocyst attaches superficially with the wall of uterus, and remains suspended in the lumen of the uterus. This type of implantation occurs in lower chordates, e.g. cow, pig, dog etc.



2. **Interstitial implantation –** The blastocyst is buries deeply inside the wall of uterus and covered by endometrial tissues lying under epithelium. This type of implantation occurs in human being.

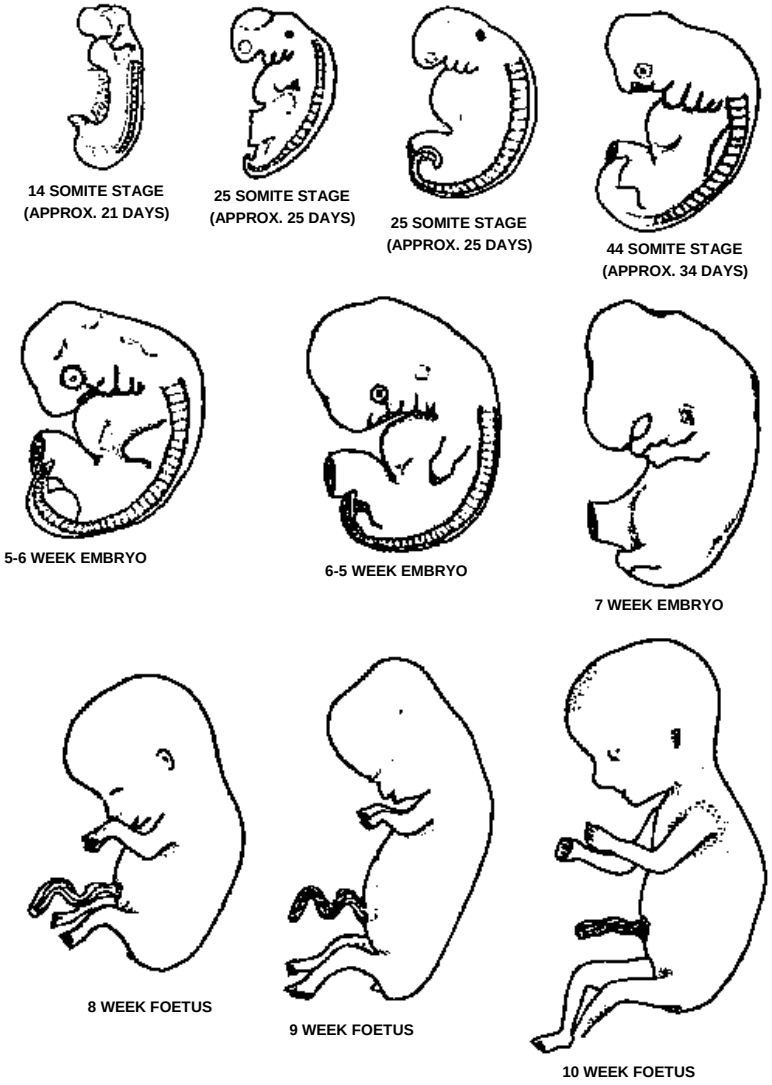
3. **Eccentric implantation –** It occur in rat, squirrel etc. In this type of implantation , the blastocyst settles in the flods of epithelium of uterus. After some time it is completely surrounded by these folds.

Summary of developmental stages in human

Day 1	–	Fertilization; the diameter of fertilization egg is about 0.15 mm.
Day 2	–	Two cells stage
Day 3	–	16 cell stage, morula
Day 4	–	Entry of blastocyst in the lemen of uterus, disappearance of zona pellecida, diameter of blastocyst is about 0.3 mm.
7-8 days	–	Partial entry of blastocyst inside the endometrium of uterus; implantation
Day 12	–	Complete entry of blastocyst into endoderm, extra-embryonic mesoderm, amnion and yolk sac.
Day 14	–	primitive streak formation.
Day 18	–	Formation of 3-5 pairs of somites.
Day 19	–	Neural groove, neural plate, notochordal plate, and 6-8 pairs of somites formed.
Day 24	**–**	Indication of the formation of head and tail region; 21-23 pairs of somites formed, formation of heart continues at ventral side.
Day 28	**–**	Heart starts beating, neural tube formed, 3 pairs of visceral arch and 30-31 pairs of somites formed. Blood islands appear
Day 32	**–**	30-39 pairs of somites formed.
7 Weeks	**–**	Jaws, fingers and external ears begin to appear. The CR length (crown-rump length; the length from head to the bottom of hips) is 19-20 mm.

8 Weeks – The embryo is completely surrounded by amnion, fingers and toes clearly visible, almost all organs formed with continuing development, at the end of 8th week the embryo appears like a little human, now called as foetus; C-R length is 28 to 30 mm.

5 months – Blood formation starts in bone marrow Decidua capsularis and parietalis connect together, hairs appear.



Embryonic development in human

9 months – placenta attains maximum size, nails on fingers appear. In the next 10 days the foetus is ready to born as a little bady.

The above mentioned timing are approximate time periods. Some times, due to some reasons, certain babies are born before stipulated time. The babies born in 7th month may also survive as normal babies.

EXTRA EMBRYONIC MEMBRANES AND PLACENTA

Extra embryonic membranes

In chordates like reptiles, birds and prototherian mammals, shaped blastula is a disc structure called as blastodis. The cellular layer formed of blastomeres remains as blastoderm. The central part of blastoderm gives rise to embryo proper, while the peripheral portion does not take past in the formation of embryo. This peripheral part is known as extra embryonic region. This region takes part in the formation of certain

membranes called extra embryonic membranes. These extra embryonic membranes provide facilities for nutrition, respiration and excretion to the embryo. Extra embryonic membranes are of four types –

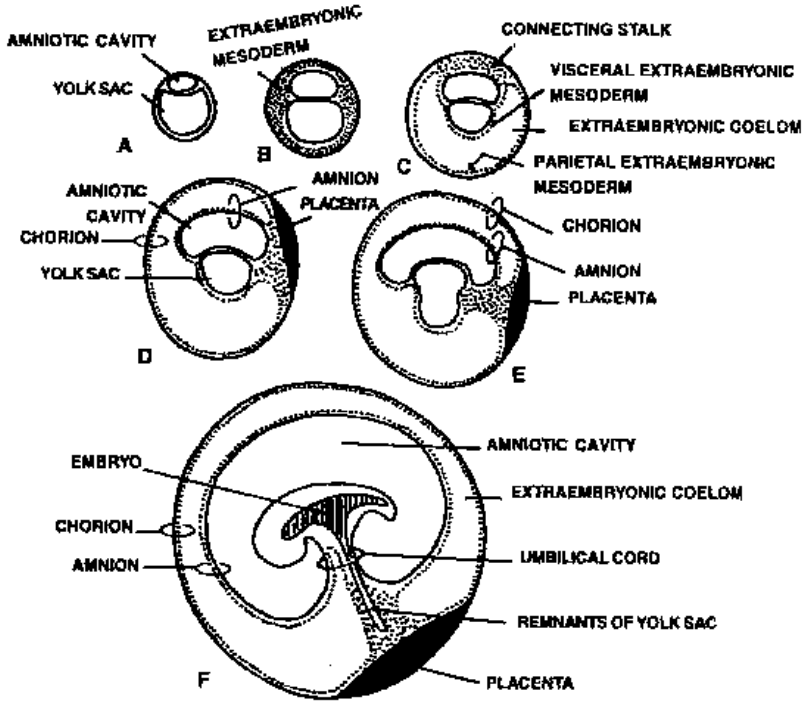
1. Amnion 2. Chorian 3. Yolk sac 4. Allantois

On the basis of presence of absence of amnion, two groups of vertebrates are categorised.

1. **Amniota -** This group is characterized with the presence of amnion in the embryos of its members. For example members of class Reptilia, Aves and Mammalia.
2. **Anamniota -** Animals of this group are devoid of amnion in their embryos. For example class cyclostomata, pisces and amphibia.

Extra embryonic membranes in human

The process of gastrulation in embryo results into the formation of endoderm or hypoblast, ectoderm or epiblast, amniotic cavity, yolk sac, extra embryonic parietal and visceral mesoderm, connecting stalk etc. Extra embryonic membranes are also formed during this process. Each extra embryonic membrane is derived from two layers.



Formation of extraembryonic membranes in human

1. **Amnion -** It is formed by the layer of amniogenic cells present around the amniotic cavity and the extra embryonic mesoderm. Extra embryonic mesoderm layer surrounds the amnion. The connecting stalk is also attached with it. With a gradual increase in size the amnion covers the embryo from all sides. After about eight weeks of fertilization, amnion is completely incorporated into connecting stalk, which finally forms the umbilical cord. Embryo, in this stage, is called as foetus remains hanging in amniotic fluid.
2. **Chorion -** It is formed by the extra embryonic parietal layer of mesoderm and the cell of trophoblast. After implantation of blastocyst, the trophoblast gives out several figner like processes, the chorionic villi which get embedded into uterine endometrium Mesoderm also contributes in the formation of these villi. After a period of four these villi disappear from all parts except the connecting stalk where they grow rapidly and participate in the formation of placenta.

3. **Yolk sac -** Yolk sac is formed by the cells of extra embryonic visceral mesoderm and endoderm. Initially the sie of yolk sac is larger as compared to that of the embryo. About eight weeks after fertilization, the yolk is reduced in size and changes into a tubular structure. Ultimately a placenta is developed with the incorporation of yolk sac and mesodermal connecting stalk with the amnion and chorion.
4. **Allantois -** It is a solid and cylindrical mass formed by embryonic mesoderm. A small cavity lined by endodermal cells develops in it. The mesoderm of allantois forms many small blood vessels in this region. These vessels connect the embryo with placenta and ensure nutritional and respiratory supply to embryo. In human, allantois does not function to store the excretory wastes as it does in reptiles and birds.

PLACENTA

The eggs of viviparous animals are unable to develop into their embryos outside the uterus independently. This is because of the very little or negligible amount of yolk present in these eggs, which can not fulfill the nutritional and other physiological demands of a developing embryo. Here the embryo depends upon maternal tissues for shelter, nutrition, respiration etc. These animals therefore, have developed adaptation, respiratory and other physiological requirements from mother's body.

Placenta is found in all viviparous (exept sub-class-prototheria; oviparous) animals.

Structure of Placenta

Placenta is not a simple membrane. It is made up of the tissues from two different sources –

Maternal tissue - These include uterine epithelium, connective tissues and blood capillaries.

Embryonic tissue - These include extra embryonic membranes (mainly chorion). Yolk sac and allantois may also take part in placenta formation. Embryonic connective tissues and blood capillaries are also constituents of it.

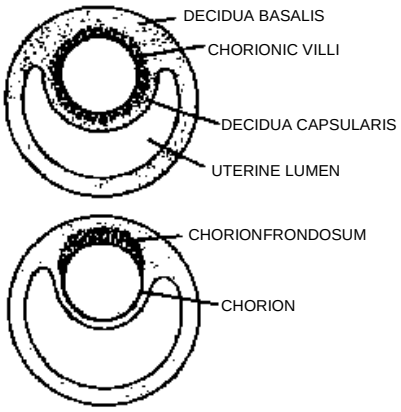
On the basis of extra embryonic membranes, the placenta is of three types.

1. **Yolk sac placenta -** It is formed by yolk sac and uterine epithelium. For example, Elasmobrancs (Sharks), **Mustelus** etc.
2. **Choria-vitelline placenta -** It is formed by chorion and yolk sac combinely. Hence it is called as choriovitelline placenta. For example, **Didelphis, Macropus** and other metatherian mammals.
3. **Chorio-allantoic placenta -** This type of placenta is formed by embryonic chorion and allantoic membranes. It is also referred to as a true placenta. It is found in eutherian mammals.

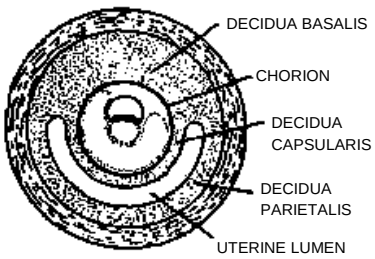
Chorio- allantoic placenta in mammals.

1. In this type of placenta, allantoic mesodern and the mesoderm of umbilical cord jointly form the blood vessels of umbilical cord. The endodermal part of the allantois remains as a very small cavity.
2. To obtain nutrition from maternal blood several finger like processes or villi are formed by chorion which penetrate deeply into the crypts of uterus. Initially the villi are scattered over the whole surface of chorion but later they become restricted in the deciduas besalis region. The chorionic villi on the remaining surface

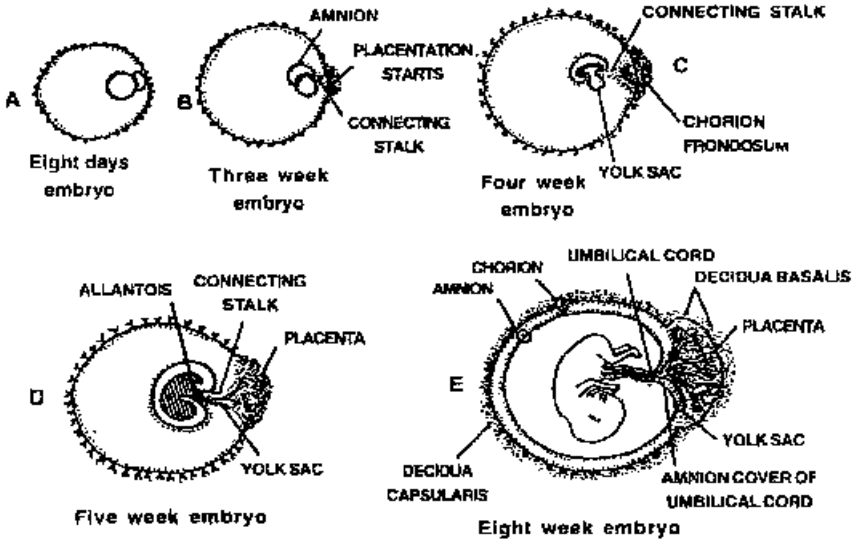
disappear shortly. The part of chorion, which helps in placenta formation is known as **chorionic frondosum.**



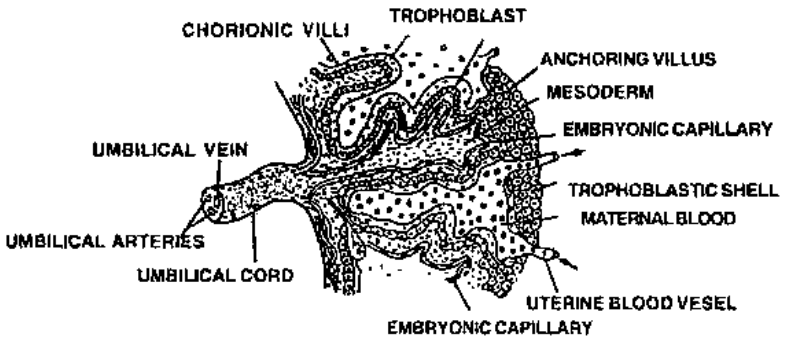
Formation of chorionic villi



Subdivisions of decidua



Placentation and formation of umbilical cord in human



A part of placenta in human

Classification of Placenta

On the basis of different characters, the placenta are classified in following manner –

1. On the basis intimacy

After implantation, the wall of uterus is called as deciduas, instead of endometrium. The part of deciduas, where placenta is formed is called **deciduas basalis** whereas, the part separating the embryo

from lumen of uterus is called **deciduas capsularis.** The remaining part of lumen of uterus is called **deciduas parietalis.** Decidua also comes out from uterus at the time of parturition. On the basis of intimacy between embryo and uterine wall the placenta is classified into three classes –

(i) Non-deciduate or Semi placenta - In this type of placenta, there is no close and rigid association between embryo and the wall of uterus. Hence, at the time of parturition, there is no bleeding as the chorionic villi are easily pulled out from the crypts of uterus. For example, cow, buffalo, horse, pig.

(ii) Contra-deciduate placenta - There is a close association between embryonic and maternal tissues. However at parturition, the damaged maternal and embryonic tissues along with the part of placenta remain inside the uterus which are absorbed is situ by leucocytes. For example – Parameles, Talpa etc.

(iii) Deciduate placenta - This type of placenta is found in human, dog, hare etc. It is characterized with a very close association between chorionic villi and uterine wall. At the time of birth, the mucosal covering of the uterus is also damaged and discarded outside. This results in an extensive bleeding at child birth. This placenta is known as a true placenta.

2. On the basis of implantation

Three types of placenta are found on the basis of implantation.

(i) Superficial - When the placenta is situated in the lumen of uterus. For example, Parameles, pig, cow, cat etc.

(ii) Eccentric - The placenta is situated in the fold or pocket of the cavity of uterus. For example - rat, squirrel etc.

(iii) Interstitial – This type of placenta is found in man, guinea pig, apes etc. The chorionic sac (placenta) penetrates deep inside the wall of uterus. Hence, the association between embryo and maternal part becomes very close.

3. On the basis of distribution of villi

On this basis, the placenta are of four types.

(i) Diffused placenta – The villi are scattered on the whole surface of placenta. For example pig, horse, lemur etc.

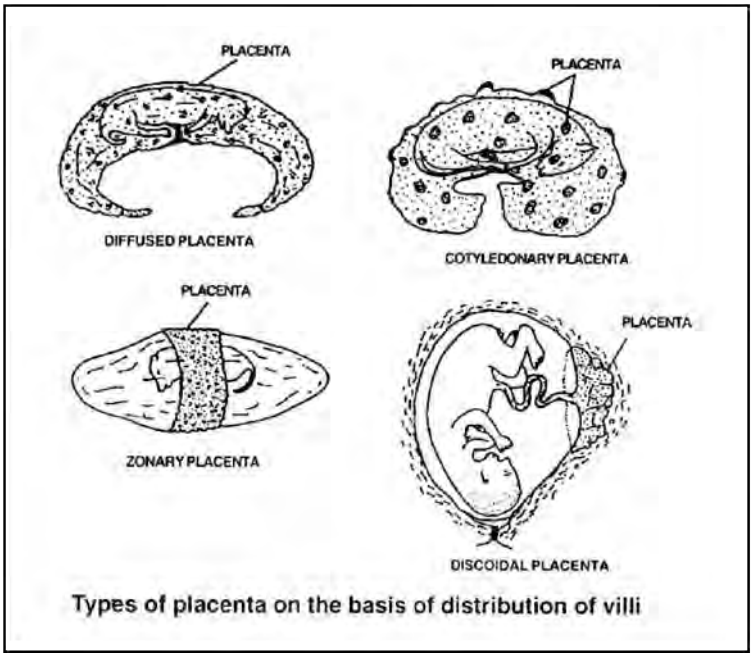
(ii) Cotyledonary placenta – The villi are distributed in small isolated groups on the chorionic surface. These groups of villi are called as cotyledons. For example, cow, buffalo, sheep, deer etc.

(iii) Zonary placenta - This type of placenta have the villi distributed in a belt shaped zone which is large sized and circular.

Zonary placenta is of two types –

(a) Complete zonary placenta - The belt of villi is complete and ring shaped in it. For example - dog, cat, lion etc.

(b) Incomplete Zonary placenta - The belt of villi is incomplete in it. For example - raccoon.



Types of placenta on the basis of distribution of villi

(iv) Discoidal placenta - In this type of placenta, whole of the chorionic surface is covered by villi in initial stage, but the villi disappear later from later from most area except the region of implantation, that is only a disc like region is left with villi. Discoidal placenta is also of two types –

(a) Mono discoidal placenta - The villi are present only on dorsal surface in single circular disc like area. For example – human, hare etc.

(b) Bi discoidal placenta - If the villi are distributed in two disc like areas, the placenta is called as bidiscoidal, eg. Monkeys.

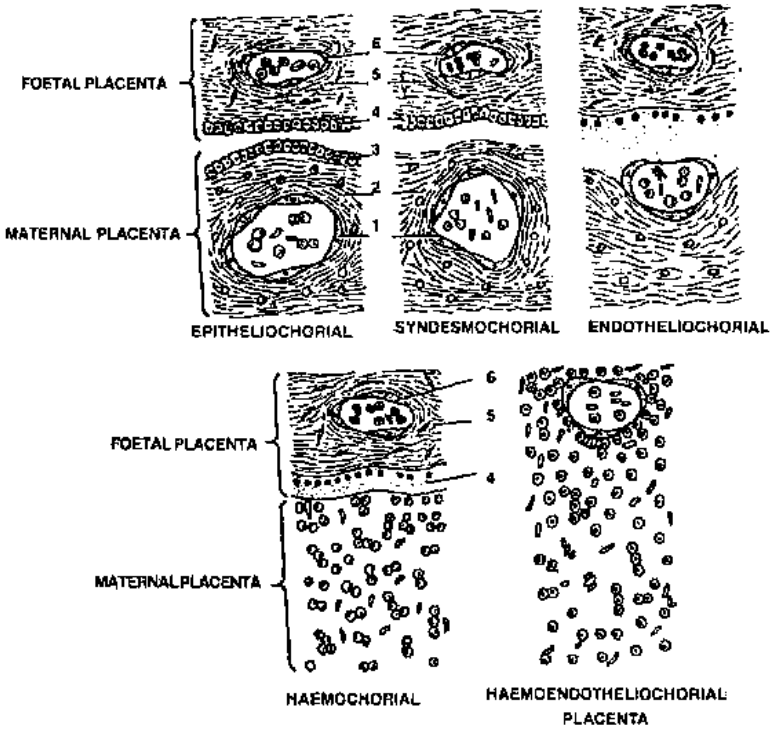
4. On the basis of histology

The blood of maternal and embryonic do not mix together through placenta. The blood circulations of the two sides are kept separated by one or more layers described below –

1. Maternal endothelium
2. Uterine connective tissue } Maternal layes
3. Uterine epithelium

4. Trophoblast/Chorion
5. Chorionic connective tissue } Foetal layes
6. Endothelium of embryonic blood vessels

The transportation of various materials takes place by diffusion through these six layers the intimacy between maternal and embryonic tissues in different mammals is determined by the presence or absence of these layers in placenta. Therefore, on the basis of presence or absence of the above layers, the placenta is of five types.



Types of placenta on the basis of histology

1. **Epitheliochorial -** It is the most primitive type of placenta in which all the six layers. mentioned earlier, remain intact. For example pig, horse etc.
2. **Syndesmochorial -** In this type of placenta the uterine epithelium is eroded by chorionic villi, so only two maternal layers remain functional. Therefore, along with three foetal layers, total five layers are preent in this placenta. For example - sheep, goat, cow etc.
3. **Endotheliochorial -** Here uterine connective tissue layer is also damaged along with uterine epithelium layer. Therefore only four layers (3 foetal and one maternal) are found in this placenta eg. dog, cat, etc.
4. **Haemochorial –** All the three maternal layers are penetrated in this placenta. The chorionic epithelium comes in direct contact with uterine blood sinusoids. For example – man, monkey, bat etc.
5. **Haemoendotheliochorial/Haemoendothelial :** It is the most typical placental in which the trophoblastic epithelium of embryo is also eroded along with all three maternal layers. The foetal capillaries are in direct contact with maternal blood. For example rat, guinea pig, rabbit etc.

   The placenta of human mainly secretes two steroid hormones like **estradiol** and **progesterone,** and two protein hormones like **human chorional gonadotropin** HCG and **human placental somatomammotropin HCS** large amount of –HCG, hormone is secreted, during early pregnancy, from the placenta. Because of this reason its quantity increases in the urine of pregnant lady. On the basis of this fact, pregnancy test is performed. The above hormones are also held responsible for keeping the corpus luteum active, protection of embryo, prevention of abortion and growth of mammary glands.

Functions of placenta

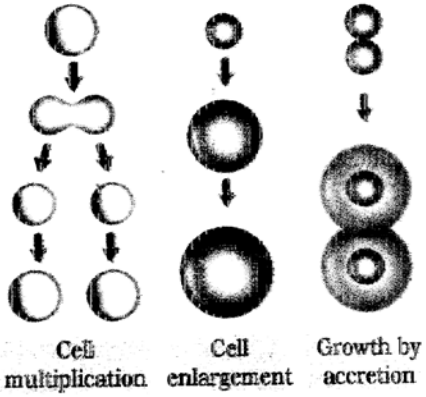
1. Exchange of important materials between foetal and maternal blood.
2. The essential materials are exchanged by diffusion, pinocytosis or active transport.
3. The small molecules like O_2, CO_2, H_2O etc. and other inorganic substances like chlorides, phosphates, sodium, potassium, magnesium etc. are also diffused through placenta.
4. Large molecules like lipids, polysaccharides, carbohydrates proteins etc. are obtained by pinocytosis process.
5. The nutritional substances are supplied to embryo from the mother through placenta.
6. Placenta also serves as a respiratory medium for exchange of O_2 and CO_2 between embryo and mother.
7. The nitrogenous and metabolic wastes from foetus are released into the blood of mother by diffusion through placenta.
8. The antibodies for measles, chickenpox, polio etc. present in the blood of mother reach the embryo through placenta.
9. Pathogenic viruses may also enter in embryo through placenta.
10. If a female takes some harmful chemicals, liquor, drugs etc. during pregnancy, these may cross the placenta and on reaching into foetus may cause deformity during organogenesis. (eg. Thallidomide)
11. Placenta itself secretes some hormones like progesterone, estrogen, lactogen, HCG, HCS etc.
12. Progesterone, maintains and supports the foetus during the whole pregnancy period. At the time of parturition, relaxin is secreted by placenta which lubricates and widens the birth canal to facilitate child birth.

GROWTH

(1) The multicellular animals life starts with a single cell zygote. It regularly undergo cleavage - mitotic divisions and produces the multicellular body.

(2) Growth is an irreversible change in shape, size, mass volume etc in organism. General aspects of growth are cell proliferation, development and morphogenesis.

(3) From embryonic life till death there is a regular growth. Skin shed stratum corneum parts and replace them, RBC and alimentary canal mucosa is also replaced. Many larva shows metamorphosis i.e. changes to adults, various animals can regenerate lost parts.



Strategies of growth

(4) During growth **protoplasmic** and **apoplasmic** substances increases. Anabolism is more than catabolism.

(5) Growth occurs by three ways –

(a) Cell proliferation or enlargement but no division eg. Neurons, Muscles.

(b) Cell division occurs but no overall growth eg. Blastula, gasturla.

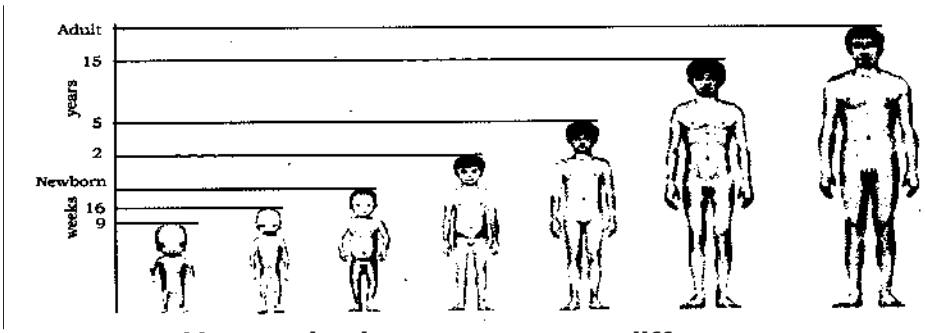
(c) Both cell proliferation and division. It is most common.

(6) **Degrwoth :** In this constituent proteins of protoplasm is used or oxidised.

(7) **Embryonic growth :** During early stages of development clevage divisions produces blastula and later form gastrula. Primitive organ rudiments are still in **prefunctional state**. After there complete development there starts **functional state**.

(8) **Post embryonic growth :** Animals shows different rate of grwoth. In humans embryo size is

– At the time of implantation – 150 µm
– First nine months – 50 µm
– One year after birth – 50 cm
– Upto 7 years - growth rate is slow.
– From 9-18 years growth rate is again rapid.
– 22 - 23 years stops.
– At 9 weeks the head size is 1/3 of lengths



Human body parts grow at different rates

(9) Cellular growth occurs in cell cycle.

$G_1 \longrightarrow$ Growth phase-I - Most of the general growth.

S $\longrightarrow$ Synthesis phase - DNA replication occurs

$G_2 \longrightarrow$ Growth phase-II - Growth and proparation for division.

(10) **Types of growth :**

(a) Auxetic growth : Only volume increases, no divisions occurs eg. Rotifers, Nematoda, tunicata.

(b) Multiplicative growth : Number increases but no overall growth eg. early embryos.

(c) Accretionary growth : Both volume and number increases. ECM and ECF production is also included in it.

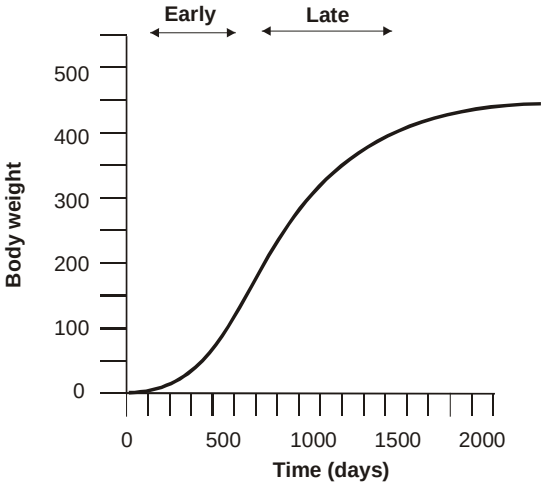
(11) **Reserve cells :** These are undifferentiated cells which divides and replace differentiated cells. eg. regular RBC formation by reserve cells of bone marrow.

(12) **Growth curve :** In case of animals weight is taken as a criteria of growth. When weight is plotted against time we get grwoth curves it have three phases-

(a) Lag phase - slow but progressive growth.

(b) Log or exponential phase - rapid growth.

(c) Stationary phase - almost no growth.



Growth curve of a 500-kg animal

(13) **Hormonal control of growth :**

Many growth factors are known to be important–

(a) FGF - Fibrolbast growth factors – limb development in chick.

(b) IGF - Insulin like growth factor - In mammal growth.

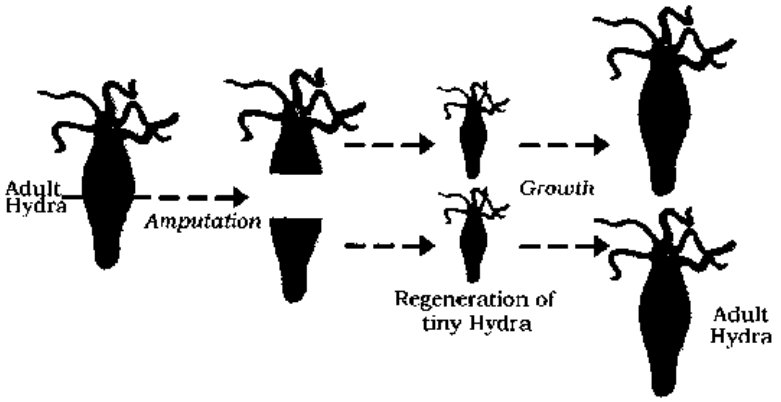
(c) GH - Growth hormone and its inhibitor somatostatin.

(d) Sex hormones.

(14) Cells must receives signals through growth factors or other proteins for division and survival. In absenceof these signals internal death programme is activated and cells commit sucide by **Apoptosis.**

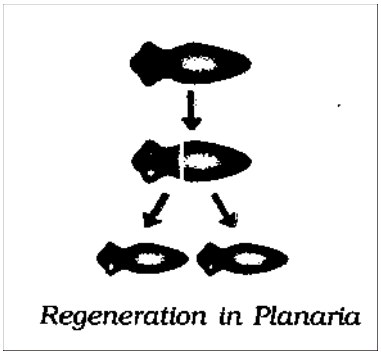
REGENERATION

1. There occurs regular replacement of cells in multicellular organisms. Skin and inner lining of intestine is also regulatory replaced.
2. At the place of wound healing new cells are added. This repair also occurs regularly in animals if injury occurs.
3. This ability of fuly developed organism is replace lost parts by growth or remodelling os somatic tissue is called as regeneration.
4. Regeneration is also a developmental process that involves growth, morphogenesis and differentiation in post embryonic life.



Regeneration in Hydra

5. Hydra, Planaria, sponges there is a greater power of regeneration.
6. Nematodes have very slow and low regeneration ability few Annelida can renew all of the anterior and posterior body segments after an amputation.
7. Many arthropods such as spiders, crustacea, and insect larvae can regenerate lost appendages, eye stalks, eyes. Parts of head and foot in gastropods.
8. Echinoderms can regnerate arms, sea cucumber can regenerate respiraton free and alimentary canal.
9. In Ascedians blood cells can give rise to a fully functional organism.
10. Fish can regenerate scales, fins.
11. Amphibians can regenerate tail, limb, external gills, nwet can regenerate eye lens from pigmented epithelium of Iris.
12. Autotomy is removal of body parts in order to protect from predators. eg. tail regeneration of Lizard.
13. Mammals can regenerate a part of liver of Kidney. They can restore fractured bone.



Regeneration in Planaria

Types of Regeneration : It is of two types –

(1) **Morpholaxis :** When whole new organism is developed from the small fragment. eg. in Hydra, Porifera.

(2) **Epimorphosis :** When a lost part is regenerated such as tail or limb regeneration. These occurs dedifferentiation of undifferentiated mass of cell.

Mechanism of forelimb regeneration in Newt :

(1) Due to injury if limb is cut or amputed in laborotatomy it regenerates by epimorphosis.

(2) A group of dedifferentiated cells along the epidermal covering develops. It is called as regeneration blastema or regeneration bud.

(3) These cells redifferentiated and forms rudiment of limb, further organogenesis completely develops the new limb.

Compensatory regeneration : If liver or kidney cells divide but do not dedifferentiate. They divide and produce similar type of cells i.e.

Factors controlling amphibian limb regeneration :

Many growth factors helps and triggers regeneration.

(a) Glial growth factor - GGFs

(b) Fibroblast growth factor FGFs

(c) Insulin like factor IGFs (Important for cartilage growth)

(d) Tranferrin : It is an iron transport protein required for mitosis in all dividing cells.

AGEING : SENESCENCE

(1) It is observed after certain stage cells and organism as whole shows decline in vigor, rate of physiological functions. Entropy overcomes then biological control.

(2) Ageing is time-related deterioration of physiological functions necessary for

(3) Science of ageing is **Gerontology**.

(4) **Maximum life span :** Maximum age reached by the member of any species. In human it is about 121 yrs. (shirechlyo lzumi of Japan)

(5) **Average lifwe span :** The average number of years survived by most of the members of a species.

(6) **Life expectancy :** The number of years an individual can expect to live. (56 yrs. in India) It increases with the improvement in sanitation, discovery of antibiotics and medical care.

Affects of Ageing on Different body parts :

(a) **Heart :** Size slightly merease O_2 consumption reduces to 10% in man.

(b) **Lungs :** Vital capactiy may decline by 40% between the ages of 20 - 70.

(c) **Brain :** Few neurons are lost and few damages Dendrites and

(d) **Kidney :** Waste filter capacity decreases. Bladder capacity declines.

(e) **Body fat :** Its accumulation increases. It is more distributed in deeper parts. In females at hips and thigh. In males in abdominal area.

(f) **Muscles :** Muscle mass reduces upto 22 percent in woman and 23 percent in men.

(g) **Sight :** Accomodation and resotution of eye decreses.

(h) **Hearing :** Gradually declines

Theories of Ageing

Ageing is a deteriation of body physiology also gradually loose efficiency this is called as senescene in animals.

These are two main gruop of theories

(A) Programmed theories it includes :

(a) Endocrine theory

(b) Programmed senescence theory

(c) Immunological theory

(B) Damage or error theories :

(a) Living theory (b) Free radicals theory

(c) Cross linking theory (d) Wear and tear theroy

(e) Error catastroph theory (f) Somatic mutation theory

(A) Programmed theory : It includes all those distrubing mechanism which are result of a biological time table.

(a) **Endocrine theory :** According to it biological clock acts through hormones. GH, sex harmones, melatonia, thymosin reduces with age. **Dehydroepiandros terone** (DHEA) a weak male harmone from adrenal gland also reduces.

(b) **Programmed senescence theory :** According to it certain genes switch on the process of ageing. Research shows that B and T cell lymphocytes have receptors for self antigens.

(c) **Immunological theory :** It states gradual reduction in immunity due to degeneration of thymus.

(B) **Damage and Error theories :**

(a) **Living theory :** According to it regular metabolism bring ageing. Rate of oxygen basal metabolism reduces life.

(b) **Free radicals theory :** Free radical is a molecule with an unpaired highly reactive electron. These are produced in metabolism. It damages various biomolecules proteins, DNA and mitochondria. These also triggers cancer, atherosclerosis, cataract and neurodegeneration.

(c) **Cross linking theory :** Accumulation of cross-linked proteins damages tissues. In **non enzymatic glycosylation** or **glycation** glucose joins to protein and leads to protein interwinding. **AGES Advanced glycosylation and products** makes the tissue tough and deteriate them, stiffening of arteries, eye coludness, nerve and kidney function reduces. Diabetes have also some relation to such deterioration.

(D) **Wear and Tear theory :** Regular functioning of cell reduces its efficiency. DNA undergo demage by O_2, U.V. rays. DNA repairing process slows down.

(E) **Theory of error catastrosphe :** Protein synthesis mechanism gradually become abnormal. Abnormal proteins lead to aging.

(F) **Somatic mutation theory :** Mutation in body cells produces abnormal proteins that causes ageing.

DEATH

It is a final breakdown of body's vital function. There are many causes of death.

(a) Heart, liver lungs, Kidney becomes weak and metabolic disorders finally lead to death.

(b) Immune system reduces functioning and reduced resistance makes the body pro to various disease.

EXERCISE - 1

A. SPERMATOGENESIS

Q.1 Temperature in scrotum necessary for sperm formation should be-

(1) 2ºC above body temperature

(2) 2ºC below body temperature

(3) 4ºC above body temperature

(4) 4ºC below body temperature

Q.2 Number of sperms present in a single ejaculation of semen contains-

(1) 10,000 (2) 100,000-1000,000

(3) 30-40 million (4) 300-400 million

Q.3 Centrioles of sperm control-

(1) Movement of tail

(2) Haploid number of chromosomes

(3) Help in fertilization

(4) None of the above

Q.4 The function of mitochondria in sperm is-

(1) To control the movement of sperm

(2) To provide energy of movement of sperm

(3) To provide energy to nucleus

(4) None of the above

Q.5 The function of hyaluronidase is-

(1) To form one of reception in egg

(2) To puncture the vitelline membrane of egg

(3) It is not produced in human sperm

(4) None of the above

Q.6 Testosterone is secreted by-

(1) Leydig's cells (2) Sertoli cells

(3) Pituitary (4) Testis

Q.7 Axial filament of sperm is formed by-

(1) Distal centriole (2) Proximal centriole

(3) Mitochondrial spiral (4) DNA

Q.8 Sertoli cells are found in the-

(1) Frog's testis (2) Rabbit's testis

(3) Cockroach's testis (4) Liver of frog

Q.9 Tail-less sperm occurs in-

(1) Frog (2) Ascaris

(3) Amphioxus (4) Rabbit

Q.10 Which is the correct sequence in spermatogenesis?

(1) Spermatogonia → Spermatids → Secondary spermatocytes → Primary spermatocytes → sperms

(2) Spermatogonia → Spermatids → Primary spermatocytes - Secondaryspermatocytes Sperms

(3) Primary spermatocytes → Secondary spermatocytes → Spermatids Spermatogonia → Sperms

(4) Spermatogonia →Primary spermatocytes → Secondary spermatocytes → Spermatids → Sperms

Q.11 How many sperms are produced from one primary spermatocyte ?

(1) 8 (2) 6

(3) 2 (4) 4

Q.12 How many sperms are formed from a secondary spermatocyte ?

(1) 4 (2) 8

(3) 2 (4) 1

Q.13 Longest phase of prophase of spermatogenesis is-

(1) Leptotene (2) Zygotene

(3) Pachytene (4) Diplotene

Q.14 Duration of spermatogenesis in man at 50ºC -

(1) Not possible (2) 3.5 months

(3) 2.5 months (4) 1 month

Q.15 Spermatogonia as a result of growth phase forms-

(1) Sperms

(2) Spermatids

(3) Primary spermatocyte

(4) Secondary spermatocyte

Q.16 The cells formed as a result of second maturation division in spermatogenesis-

(1) Polocytes (2) Spermatocytes

(3) Spermatids (4) Sperm

Q.17 Spermiogenesis changes

(1) Spermatogonium to primary spermatocyte

(2) Primary spermatocyte to secondary spermatocyte

(3) Secondary spermatocyte to spermatid

(4) Spermatid to sperm.

Q.18 Enzyme secreted by sperm is

(1) Sperm trypsin (2) Sperm lysin

(3) Male hormone (4) Sperm gastrin

Q.19 Sperms produce an enzymatic substance for dissolving egg coverings. It is called

(1) Hyaluronic acid (2) Hyaluronidase

(3) Androgamone (4) Diastase

Q.20 The apical part of the sperm which comes in contact to the ovum during fertilization-

(1) Acromione (2) Acromegaly

(3) Acronia (4) Acrosome

Q.21 Smallest sperm is of -

(1) Frog (2) Man

(3) Discoglossus (4) Amphioxus

Q.22 The sperms of birds are-

(1) Amoeboid (2) Spiral

(3) Hook shaped (4) None

Q.23 Sperm boat is formed in-

(1) Locust (2) Ant

(3) Fishes (4) Ascaris

Q.24 Sperms in the sperm bank are stored at-

(1) 4ºC (2) –4ºC

(3) –179ºC (4) –1000ºC

B. OOGENESIS

Q.25 Secondary oocyte is-

(1) Haploid (2) Diploid

(3) Polyploid (4) None of the above

Q.26 Eggs from ovary are released in-

(1) Oviduct (2) Kidney

(3) Ureter (4) Coelom

Q.27 Vitelline layer around the egg is deposited by-

(1) Ovary (2) Oviduct

(3) Egg itself (4) Coelom

Q.28 Vitelline membrane is a -

(1) Primary egg membrane

(2) Secondary egg membrane

(3) Tertiary egg membrane

(4) None of these

Q.29 An egg of bird was coated with varnish and then incubated. The egg did not hatch because the developing embryo-

(1) Could not excrete and died

(2) Could not utilize yolk in the presence of excess amount of nitrogenous wastes

(3) Died because of depleted O_2 supply

(4) Died because of toxic effect of varnish

Q.30 Human females possess 44 + XX chromosomes. The secondary oocyte shall have-

(1) 44 + XX (2) 22 + X

(3) 22 (4) 44

Q.31 Noncellular layer is-

(1) Theca interna

(2) Membrana granulosa

(3) Corona radiata

(4) Zona pellucida

Q.32 Corona radiata is derived from-

(1) Membrana granulosa

(2) Cumulus ovarious

(3) Theca interna

(4) Theca externa

Q.33 What is the total number of polar bodies formed during oogenesis in the ovary ?

(1) 4 (2) 3

(3) 1 (4) 2

Q.34 In oogenesis, divisions are mitotic except during the formation of-

(1) Ogonia

(2) Primary oocytes

(3) First polar body

(4) Secondary polar body

Q.35 Megalecithal eggs occurs in-

(1) Frog (2) Mammals

(3) Birds (4) Cockroach

Q.36 The amount of mDNA in a primary oocyte in comparison to nuclear DNA is-

(1) Less (2) More

(3) Equal (4) Not fixed

Q.37 What is the total number of polar bodies formed during oogenesis in the ovary ?

(1) 4 (2) 3

(3) 1 (4) 2

Q.38 Extrusion of second polar body from egg nucleus occurs-

(1) After entry of sperm before completion of fertilization

(2) After completion of fertilization

(3) Before entry of sperm

(4) Without any relation of sperm entry

Q.39 Polar bodies are-

(1) Haploid (2) Diploid

(3) Triploid (4) Polyploid

Q.40 Secondary oocyte is formed

(1) Before ovum maturation

(2) After mitosis of germinal cells

(3) After fertilization

(4) Before fertilization

Q.41 On fertilization of egg nucleus with sperm nucleus

(1) Second maturation is completed

(2) Embryo is formed

(3) First polar body is formed

(4) First maturation is completed

Q.42 In oogenesis, divisions are mitotic except during the formation of

(1) Ogonia (2) Primary oocytes

(3) First polar body (4) Second polar body

Q.43 Minute cells separating from ova are

(1) Primary oogonia

(2) Polar bodies

(3) Secondary oogonia

(4) Primary spermatogonia

Q.44 In spermatogenesis, a primary spermatocyte produce four similar sperms while in oogenesis a primary oocyte forms

(1) Four similar ova

(2) Three large ova and one polar body

(3) Two large ova and two polar bodies

(4) One large ovum and 3 polar bodies

Q.45 50 secondary oocytes in female and 50 secondary spermatocytes in male give rise to

(1) 50 ova and 100 sperms

(2) 100 ova and 200 sperms

(3) 200 ova and 50 sperms

(4) 100 ova and 100 sperms

Q.46 How many sperms and ova are produced from 25 primary spermatocytes and 25 primary oocytes ?

(1) 100 sperms and 100 ova

(2) 100 sperms and 25 ova

(3) 100 sperms and 30 ova

(4) 50 sperms and 25 ova

Q.47 A freshly laid unfertilized egg of hen contains

(1) One cell (2) A million cells

(3) 1000 cells (4) 100 cells

Q.48 Human eggs are (on the basis of amount of yolk)

(1) Alecithal (2) Telolecithal

(3) Mesolecithal (4) Macrolecithal.

Q.49 Freshly released human egg has

(1) Two Y-chromosome

(2) One X-chromosome

(3) Two X-Chromosomes

(4) One X-chromosome and one Y-chromosome

Q.50 What kind of eggs would be present in Elephant

(1) Microlecithal and isolecithal

(2) Microlecithal and telolecithal

(3) Mesolecithal and homolecithal

(4) Macrolecithal and centrolecithal

Q.51 Megalecithal eggs occur in

(1) Frog (2) Mammals

(3) Birds (4) Cockroach

Q.52 The eggs of some mammals have more yolk.They are
(1) Aquatic mammals (2) Metatherians
(3) Protherians (4) Eutherlans

Q.53 Insect egg is
(1) Homolecithal (2) Telolecithal
(3) Centrolecithal (4) Alecithal

Q.54 Cytoplasm with yolk in frog's egg is found in-
(1) Centre (2) Periphery
(3) Animal pole (4) Vegitative pole

Q.55 In a floating egg of frog, the vegital pole remains-
(1) Upside (2) Right side
(3) Left side (4) Down side

Q.56 The eggs which have yolk-less peripheral ooplasm-
(1) Alecithal (2) Centrolecithal
(3) Telocithal (4) None

Q.57 Term "alecithal" was coined by-
(1) Kent (2) Aristole
(3) Bear (4) Torry

Q.58 The eggs of crocodile & ostrich are-
(1) Telolecithal (2) Homolecithal
(3) Alecithal (4) None

Q.59 Largest egg is of-
(1) Elephant (2) Whale
(3) Shark (4) None

C. FERTILIZATION

Q.60 The fertilization membrane is secreted because-
(1) It checks the entry of more sperms after fertilization
(2) It checks the entry of antigens in ovum
(3) It represents the left out tail of sperm
(4) It represents the plasma membrane of sperm

Q.61 In man the sperm released from the testis take the following route to reach the ureter-
(1) Vasa efferentia, Bidder canal, uriniferous tubules and nephrostome
(2) Vasa efferentia, epididymis, vas deferens and urethra
(3) Vasa efferentia, Bidder's canal nephrostome
(4) Vasa efferentia, collecting tubules and bidder canals

Q.62 Sperms move actively in female genital tract by-
(1) Creeping (2) Gliding
(3) Swimming (4) Jet propulsion

Q.63 The rate of active movement of sperm is-
(1) 1.5 – 3.0 cm/min (2) 1.5 – 3.0 mm/min
(3) 1.5 – 3.0 m/min (4) 1.5 – 3.0 m/hr.

Q.64 The fertilization in mammals including man takes place in-
(1) Vestibule (2) Vagina
(3) Uterus (4) Fallopian tubes

Q.65 What is true about the process of fertilization?
(1) Only acrosome of sperm enters the egg
(2) Two haploid nuclei fuse but the fusion nucleus divides immediately to form two haploid nuclei
(3) Entry of sperm activates the egg to complete meiosis
(4) Only one sperm enters an egg

Q.66 Egg is liberated from ovary in-
(1) Secondary oocyte stage
(2) Primary oocyte stage
(3) Oogonial stage
(4) Mature ovum stage

Q.67 Fertilization is-
(1) Union of diploid spermatozoon with diploid ovum to form diploid zygote
(2) Union of haploid sperm with haploid ovum to form haploid zygote
(3) Union of haploid sperm with haploid ovum to form diploid zygote
(4) Union of diploid sperm with haploid ovum to form triploid zygote

Q.68 First step in activation of ovum during process of fertilization is-
(1) Formation of fertilization membrane
(2) Fertilizin-antifertilizin reaction
(3) Penetration of sperm in ovum
(4) Formation of fertilization cone

Q.69 Cortical granules are associated with-
(1) Oogenesis (2) Spermatogenesis
(3) Cleavage (4) Fertilization

Q.70 Fertilizins are emitted by
(1) Immature eggs (2) Mature eggs
(3) Sperms (4) Polar bodies

Q.71 Which chemical of the egg attracts and holds sperm?
(1) Fertilizin (2) Antifertilizin
(3) Agglutin (4) Antiagglutin

Q.72 After a sperm has penetrated on ovum, entry of other sperm is prevented by
(1) Condensation of yolk
(2) Formation of pigment coat
(3) Development of vitelline membrane
(4) Development of fertilization membrane

Q.73 One gamete has-
(1) Both alleles of a gene
(2) One allele of a gene
(3) All alleles of a gene
(4) None

D. CLEAVAGE

Q.74 If an unfertilized egg is pricked with a microneedle it will-
(1) Die immediately (2) Start dividing
(3) Remain undivided (4) None of the above

Q.75 During cleavage, nucleocytoplasmic ratio is-
(1) Maintained (2) Decreased
(3) Increased (4) Variable

Q.76 In embryo, cleavage brings about-
(1) Increased DNA content
(2) Increased mass of protoplasm
(3) Increased size
(4) Change in shape and size

Q.77 Determinate cleavage is found in-
(1) Coelentrates (2) Annelids
(3) Nematodes (4) All the above

Q.78 Coeblastula is found in-
(1) Labeo (2) Snakes
(3) Star fish (4) Unio

Q.79 The superficial blastula is the characteristic of-
(1) Birds (2) Reptiles
(3) Insects (4) Annelids

Q.80 Cleavage differs from mitosis because-
(1) In cleavage there is no growth phase
(2) In cleavage consumption of O_2 increases
(3) In cleavage nucleus-cytoplasmic ratio increases
(4) All the above

Q.81 During cleavage all divisions are-
(1) Equal (2) Reductional
(3) Mitotic (4) Determinate

Q.82 In some eggs the future organs can be demarcated as to the regions even before the beginning of cleavage. It is-
(1) Regulated development
(2) Mosaic development
(3) Gynogenesis
(4) Indetermined development

Q.83 What is true of cleavage -
(1) Daughter cells or blastomeres grow in size equal to parent cell
(2) Blastomeres separate
(3) Cytoplasm of blastomeres increases after each division
(4) There is no growth of daughter cells

Q.84 A morula can be differentiated from blastula in-
(1) Presence of cavity
(2) Presence of more yolk
(3) Presence of yolk
(4) Absence of cavity

Q.85 A zygote is completely divided into two by a cleavage furrow. The cleavage type is-
(1) Equatorial (2) Meroblastic
(3) Radial (4) Holoblastic

Q.86 Development of fertilized egg starts from
(1) Invagination (2) Regeneration
(3) Cleavage (4) Implantation

Q.87 During cleavage, what is true about cells ?
(1) Nucleocytoplasmic ratio remains unchanged
(2) Size does not increase
(3) There is less consumption of oxygen
(4) The division is like meiosis

Q.88 What is true of cleavage ?
(1) Daughter cells or blastomeres grow in size equal to parent cell
(2) Blastomeres separate
(3) Cytoplasm of blastomeres increases after each division
(4) There is no growth of daughter cells.

Q.89 Meroblastic cleavage takes place in
(1) *Hydra* (2) *Amphioxus*
(3) Frog (4) Chick

Q.90 Meroblastic cleavage is division

(1) Horizontal (2) Partial

(3) Total (4) Spiral

Q.91 Meroblastic segmentation occurs during the development of

(1) Pigeon (2) Human

(3) Frog (4) Dog Fish

Q.92 In centrolecithal eggs, the cleavage is

(1) Equal holoblastic

(2) Unequal holoblastic

(3) Meroblastic discoidal

(4) Meroblastic superficial

Q.93 A zygote is completely divided into two by a cleavage furrow. The cleavage type is-

(1) Equatorial (2) Meroblastic

(3) Radial (4) Holoblastic

Q.94 The morula stage of man is bounded by-

(1) Shell (2) Vitelline membrane

(3) Zona radiata (4) Albumin

Q.95 A morula can be differentiated from blastula in

(1) Presence of cavity

(2) Presence of more yolk

(3) Presence of yolk

(4) Absence of cavity

Q.96 Blastopore is

(1) Opening of neural tube

(2) Opening of gastrocoel

(3) Future anterior end of embryo

(4) Found in blastula

E. GASTRULA AND NEURULA

Q.97 Morphogenetic movement involve-

(1) Movement of organs

(2) Movement of small cell masses

(3) Movement of large cells masses

(4) Differentiation of cells

Q.98 Vertebral column develops from-

(1) Notochord (2) Nerve cord

(3) Mesoderm (4) Endoderm

Q.99 Emboly is-

(1) Migration of micromeres into the blastocoel

(2) Migration of macromeres into the blastocoel

(3) Migration of endoderm, mesoderm and notochord in the blastocoel

(4) None of the above

Q.100 The hypoblast (inner germ layer of gastrula) forms the-

(1) Ectoderm (2) Mesoderm

(3) Endoderm (4) None of the above

Q.101 During gastrulation blastomeres move from the surface to their destination in the embryo. These movements are called-

(1) Migratory movement

(2) Formative movements

(3) Morphogenetic movements

(4) All the above

Q.102 Gastrula end stage is characterised by-

(1) End of blastocoel

(2) Blastopore

(3) Formation of neural tube

(4) End of archenterone

Q.103 Termination of gastrulation is indicated by-

(1) Obliteration of blastocoel

(2) Obliteration of archenteron

(3) Closure of blastopore

(4) Closure of neural tube

Q.104 Archenteron begins forming in

(1) Early gastrula (2) Late gastrula

(3) Early morula (4) Blastula

Q.105 In mammals, the archenteron/primitive gut is lined with-

(1) Ectoderm

(2) Mesoderm

(3) Endoderm

(4) Mesoderm and endoderm

Q.106 The best definition of the process of gastrulation is that it is a process where the

(1) Simple layered blastula becomes two layered

(2) Archenteron is formed

(3) Cells move to occupy their definite position

(4) Zygote gets converted into larva

Q.107 During embryo development, blastocoel of blastula is replaced by a new cavity in gastrula. lt is
(1) Coelenteron (2) Archenteron
(3) Splanchnocoel (4) Haemocoel

Q.108 Gastrulation involves the differentiation of
(1) Ectoderm and endoderm
(2) Ectoderm, endoderm and mesoderm
(3) Ectoderm and mesoderm
(4) Mesoderm and endoderm.

Q.109 During gastrulation is formed -
(1) Notochord (2) Nerve cord
(3) Myotome (4) Archenteron

Q.110 Gastrula end stage is characterised by
(1) End of Blastocoel (2) Blastopore
(3) Formation of neural tube
(4) End of archenteron

Q.111 Termination of gastrulation is indicated by -
(1) Obliteration of blastocoel
(2) Obliteration of archenteron
(3) Closure of blastopore
(4) Closure of neural tube

Q.112 Embryologists can presume future organs of embryo in
(1) Morula (2) Blastula
(3) Early gastrula (4) Post gastrula.

Q.113 Cells become variable in morphology and function in different regions of the embryo. The process is
(1) Differentiation (2) Metamorphosis
(3) Organisation (4) Rearrangement

Q.114 If chorda mesoderm evaginates instead of invagination
(1) Only ectodermal and endodermal structures develop
(2) Only mesodermal and endodermal structures develop
(3) No development occurs
(4) Only ectodermal and mesodermal structures develop

Q.115 If the ectoderm from neural tissue area is removed from the embryo and transplanted in place of presumptive belly ectoderm, embryo will develop
(1) Without a neural tube
(2) With a neural tube
(3) With two ectodermal coats
(4) With two neural tubes

Q.116 Formation of notochord is
(1) Neurulation (2) Notogenesis
(3) Morulation (4) Blastulation

Q.117 Notochord grows from
(1) Neuropore (2) Prechordal plate
(3) Hypochordal rod (4) Chorda-mesoderm

Q.118 Notochord develops from
(1) Primary ectoderm (2) Primary endoderm
(3) Primary mesoderm (4) Both 1 and 2

Q.119 True coelom is lined by
(1) Mesoderm
(2) Mesoderm and ectoderm
(3) Endoderm
(4) Ectoderm

Q.120 Skeleton and muscles originate from
(1) Yolk plug (2) Mesoderm
(3) Endoderm (4) Ectoderm

Q.121 Ontogenetically liver and pancreas are
(1) Ectodermal (2) Mesodermal
(3) Endodermal (4) None

Q.122 The mesoderm gives rise to all the following structures in the fully developed animal except
(1) Muscular system (2) Nervous system
(3) Circulatory system (4) Gonads

Q.123 Vascular and excretory organs are formed from
(1) Endoderm (2) Mesoderm
(3) Ectoderm (4) Mesendoderm

Q.124 Sensory receptors, such as retina, develop from
(1) Ectoderm
(2) Endoderm
(3) Mesoderm
(4) Mesoderm and endoderm

Q.125 In which organ the bulk is formed of endoderm
(1) Intestine (2) Liver
(3) Heart (4) Kidney

Q.126 Choose the correct one
(1) Mesoderm-Skeleton
(2) Mesoderm-Brain
(3) Ectoderm-Liver
(4) Endoderm-Epidermis

F. EMBRYONIC MEMBRANE

Q.127 Foetal membranes produced by trophoblast are-

(1) Chorion and allantois

(2) Chorion and amnion

(3) Amnion and allantois

(4) Allantois and yolk sac

Q.128 Splanchnocoel is-

(1) Haemocoel (2) Pseudocoel

(3) True coelom (4) Pseuocoelom

Q.129 Extra-embryonic membranes of the mammalian embryo are derived from-

(1) Inner cell mass (2) Trophoblast

(3) Formative cells (4) Follicle cells

Q.130 Foetal membrane that provides the first blood corpuscle for circulation in embryo is-

(1) Trophoblast (2) Yolk sac

(3) Amnion (4) Chorion

Q.131 Amnion is helpful to embryo in

(1) Nutrition

(2) Protection from shock

(3) Excretion

(4) Respiration.

Q.132 Amnion is a membrane which develops on the outside of embryo in

(1) Fish (2) Cockroach

(3) Toad (4) Lizard

Q.133 Blastocyst has a selectively permeable and hormone secreting outer layer known as

(1) Mesoderm (2) Amnion

(3) Trophoblast (4) Chorion

Q.134 Allantois is embryonic membrane found in

(1) Mammals (2) Birds

(3) Reptiles

(4) Birds, mammals and reptiles

Q.135 Allantosis of the mammalian embryo helps in

(1) Respiration (2) Excretion

(3) Protection (4) Nutrition

Q.136 Umblical cord contains

(1) Umblicus (2) Placenta

(3) Discus proligerus

(4) Allantoic artery and vein

Q.137 For ensuring effectiveness of reproduction, the mammals possess

(1) Placenta

(2) Yolk sac

(3) Reduced number of eggs

(4) All the above

G. PLACENTA

Q.138 Chorionic gonadotropin is secreted by-

(1) Pituitary (2) Ovary

(3) Placenta (4) Uterus

Q.139 Placenta provides for-

(1) Storage of food

(2) Protection of embryo from shock

(3) Channelisation of nutrients

(4) Conveying nerve impulse

Q.140 Human placenta is-

(1) Haemochorial (2) Syndesmochorial

(3) Yolk sac (4) Haemo-endothelial

Q.141 Placenta is-

(1) Channel for providing essential requirement for growth of embryo

(2) Storage organ

(3) Conductor for nerve impulse

(4) Meant for protecting the embryo from shocks

Q.142 Placenta is the region where-

(1) Foetus is attached to mother by umbilical cord

(2) Foetus is provided with mother's blood

(3) Foetus receives nourishment from mother's blood

(4) Foetus is covered by membranes

Q.143 Zonary placenta occurs in-

(1) Herbivorous mammals

(2) Carnivorous mammals

(3) Both 1 and 2 (4) Birds

Q.144 Role of placenta is to

(1) Provide nutrition to developing embryo

(2) Protect embryo from shock

(3) Act as storage organ

(4) Convey nerve impulses

Q.145 Eutherian placenta is derived from

(1) Allantois (2) Aminon

(3) Chorion and allantois

(4) Yolk sac

Q.146 Parasitic mode of nutrition occurs in

(1) Amphibian embryo (2) Mammalian embryo

(3) Avian embryo (4) Reptilian embryo.

Q.147 The placental barrier between the foetal and maternal blood is minimum in

(1) Goat (2) Pig

(3) Cow (4) Man

Q.148 In simplest type of placenta, Six barriers separate maternal blood from foetal blood. How many barriers are lost in human placenta ?

(1) One (2) Two

(3) Three (4) Four

H. FROG EMBRYOLOGY

Q.149 The process by way of which a larva or miniature adult comes out of the egg membranes is called-

(1) Hatching (2) Emboly

(3) Epiboly (4) Ingression

Q.150 Metamorphosis in frog does not occur in the absence of-

(1) Thyroid (2) Pituitary

(3) Adrenal cortex (4) Adrenal medulla

I. HUMAN EMBRYOLOGY

Q.151 First menstrual cycle is-

(1) Parturition (2) Menopause

(3) Menarche (4) Implantation

Q.152 Menopause occurs in females at the age of-

(1) 55-60 years (2) 50-55 years

(3) 45-50 years (4) 37-42 years

Q.153 Menstrual cycle is generally of-

(1) 21 days (2) 28 days

(3) 30 days (4) 40 days

Q.154 In menstrual cycle ovum is released during-

(1) Beginning (2) Midway

(3) End (4) Any time

Q.155 Menstrual cycle is controlled by-

(1) Estrogen and progesterone of ovary

(2) FSH and LH of pituitary

(3) Both 1 and 2

(4) FSH of pituitary

Q.156 Stages in menstrual cycle are-

(1) Recovery phase and proliferative phase

(2) Proliferative phase and secretory phase

(3) Proliferative, secretory and menstrual

(4) Recovery phase, secretory phase and phase menstrual flow

Q.157 Lutea phase is the other name of-

(1) Follicular phase

(2) Proliferative phase

(3) Menstrual flow phase

(4) Secretory phase

Q.158 Human embryo completes development in-

(1) 180 days (2) 300 days

(3) 250 days (4) 266 days

Q.159 The delivery of child or child birth is called-

(1) Labour (2) Parturition

(3) Implantation (4) Insemination

Q.160 Zona pellucida disintegrates just-

(1) Before fertilization

(2) After fertilization

(3) Midway during cleavage

(4) After completion of cleavage

Q.161 Mesoderm proliferates from-

(1) Trophoblast

(2) Cephalic end of embryonic disc

(3) Caudal end of embryonic disc

(4) Ectoderm of embryonic disc

Q.162 For ensuring effectiveness of reproduction, the mammals posses-

(1) Placenta (2) Yolk sac

(3) Reduced number of eggs

(4) All the above

Q.163 Gestation period in human is-

(1) 10 weeks (2) 28 weeks

(3) 32 weeks (4) 38 weeks

Q.164 Onset of pregnancy-

(1) Stimulates testosterone secretion

(2) Inhibits further ovulation

(3) Leads to degeneration of ovary

(4) Inhibits fusion of egg and sperm nuclei

Q.165 Loss of reproductive capacity in women after age of 45 years is-

(1) Menstruation (2) Ageing

(3) Menopause (4) Menarche

Q.166 On fertilization, the urine of would be mother contains-

(1) LH (2) Progesterone

(3) FSH (4) hCG

Q.167 Which is correct ?

(1) Menstrual cycle is present in all mammals

(2) Menstrual cycle is present in all primates

(3) Estrous cycle occurs in all mammals

(4) Most mammals are ovoviviparous

Q.168 In mammals, the onset of pregnancy causes

(1) Secretion of testosterone

(2) Degeneration of ovary

(3) Inhibits further ovulation

(4) Inhibits fertilization

Q.169 Human embryo is about an inch in length after

(1) Eight weeks (2) Six weeks

(3) Four weeks (4) Two weeks

Q.170 In human beings, the developing embryo resides in

(1) Fallopian tubes (2) Uterus

(3) Ovaries (4) Vagina

Q.171 Pseudopregnancy differs from normal pregnancy in

(1) Development of ovum

(2) Developmental changes in endometrium

(3) Absence of foetus

(4) Absence of corpus luteum

J. GROWTH REPAIR REGENERATION AGEING

Q.172 Growth is–

(1) Increase in size

(2) Increase in weight

(3) Synthesis of new proptoplasm

(4) All of the above

Q.173 Growth occurs when–

(1) Anabolism is higher than catabolism

(2) Catabolism is higher than anabolism

(3) Protoplasmic synthesis is more than apoplasmatic synthesis

(4) Apoplasmatic synthesis is more than protoplasmic synthesis

Q.174 Degrowth takes place when–

(1) Anabolism is higher than catobolism

(2) Catabolism is higher than anabolism

(3) Protoplasmic synthesis is more than apoplasmatic synthesis

(4) Apoplasmatic synthesis is more than protoplasmic synthesis

Q.175 Auxetic growth is characterised by–

(1) Increase in cell number

(2) Growth without increase in cell number

(3) Both increase in cell number and cell growth

(4) Expansion in transverse direction

Q.176 Accretionary growth is due to–

(1) Reserve cells (2) Meristematic cells

(3) Embryonic cells (4) Differentiated cells

Q.177 In human beings, which part shows the minimum increase in weight from birth to adulthood–

(1) Brain (2) Fat

(3) Muscles (4) Skeleton

Q.178 Adult females tend to have less weight than adult males due to lesser development of–

(1) Muscles

(2) Skeleton

(3) Both muscles and skeleton

(4) Fat

Q.179 As compared to whole body, the head of new born human baby is–

(1) One–third (2) One–half

(3) One–fifth (4) One–fourth

Q.180 Approximate age of sexual maturity in human being is–

(1) 10–14 years (2) 8–11 years

(3) 10–13 years (4) 11–16 years

Q.181 Growth at the end of childhood and during puberty is controlled by–
(1) Thyroxine
(2) Thymosin
(3) Somatorophic hormone
(4) Thyroxin and somatotrophic hormones

Q.182 Human body regularly loses cells in the region of–
(1) Skin surface (2) Lining layer of gut
(3) Red blood cells (4) All of above

Q.183 Repetitive regeneration is found in–
(1) Tadpole (2) Molluscs
(3) Hydra (4) Human beings

Q.184 Reparative regeneration occurs in–
(1) Invertebrates
(2) Vertebrates
(3) Both invertebrates and vertebrates
(4) A few vertebrates

Q.185 Restorative regeneration is common in–
(1) Vertebrates
(2) Mostly invertebrates
(3) In some verebrate groups
(4) In some invertebrate groups

Q.186 Salamander and Axolotl larve regenerate–
(1) Limbs, eye structures and intestine
(2) Jaws and external gills
(3) Both '1' and '2'
(4) Trunk

Q.187 What is true about regeneration–
(1) beak in birds (2) Tails in lizards
(3) Fish fins (4) All the above

Q.188 Autotomy is recorded in–
(1) Legs in crabs (2) Tail of lizards
(3) Viscera in holothurian
(4) All of the above

Q.189 Morphallaxis is–
(1) Reconstruction of the whole body
(2) Growth of lost limb
(3) Healing of injury
(4) Regeneration with the help of blastema

Q.190 Factors controlling regeneration seem to be–
(1) Neural (2) Hormonal
(3) Both neural and hormonal
(4) Genetic

Q.191 Gerontology is the branch of science that deals with–
(1) A sexual reproduction
(2) Ageing
(3) Embryo development
(4) Asexual reproduction

Q.192 During ageing, collagen present in intercellular spaces become–
(1) Destroyed
(2) Impermeable and rigid
(3) More elastic
(4) All of the above

Q.193 In an ageing person, there is a–
(1) Increase in mucopolysaccharide
(2) Gradual alteration in components of connective tissue
(3) Increasing collagen rigidity of connectvie tissue
(4) Both '2'and '3

Q.194 According to immunity theory, ageing is due to–
(1) Accumulation of errors
(2) Reduced functioning of endocrine glands
(3) Degeneration of thymus
(4) Accumulation of waste products

Q.195 With the advancenment of age, hair of males start thinning due to–
(1) Falling of hair
(2) Low ATP formation
(3) Reduced rate of protein synthesis
(4) None of the above

Q.196 Regeneration of Hydra is–
(1) Morphollaxis by interstitial cells
(2) Epimorphosis by interstitial cells
(3) Epimorphosis by archaeocytes
(4) Epimorphosis by glandular cells

Q.197 The correct sequence of growth curve for bacteria is–
(1) Lag, log, decline and stationary
(2) Lag, log, decline and stationary
(3) Stationary, lag , log decline
(4) Decline, lag and log phase

K. GENERAL QUESTION

Q.198 Formation of whole body from a fragment is–

(1) Morphallaxis (2) Epimorphosis

(3) Epigenesis (4) Auxetic growth

Q.199 Gestation period is duration of

(1) Between egg growth and ovulation

(2) Of fertilization

(3) Between fertilization and parturition

(4) Between preparation of sex cells and fertilisation

Q.200 Gestation period in humans is

(1) 10 weaks (2) 25 weaks

(3) 7 months (4) 9 months

Q.201 Gestation period of elephant is

(1) 22 months (2) 15 months

(3) 11 months (4) 10 months

Q.202 Gestation period of Rat is

(1) 5 weaks (2) 4 weaks

(3) 3 weaks (4) 2 weaks

Q.203 Gestation period of Rabbit is

(1) 18 - 20 days (2) 28 - 32 days

(3) 48-50 days (4) 60-70 days

ANSWER KEY

EXERCISE – 1

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	1	2	2	1	1	2	2	4	4	3	1	1	3	3	4	2	2	4
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	2	1	3	1	4	3	1	3	2	4	2	2	3	3	1	2	1	1	4
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	2	4	1	2	1	1	2	1	3	3	3	4	4	2	1	1	3	1
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	3	2	4	4	1	3	2	4	2	1	4	2	2	3	1	4	3	3	4
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	2	4	4	4	3	2	4	4	2	1	4	4	3	4	2	2	1	3	3
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	3	1	1	3	3	2	2	4	1	1	3	1	2	4	2	4	3	1	2
Que.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	3	2	2	1	2	1	2	3	2	2	2	4	4	4	2	4	1	3	3	1
Que.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	1	3	3	1	3	2	2	3	1	1	3	3	2	2	3	3	4	4	2	4
Que.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	3	1	4	2	3	4	2	3	2	2	3	4	1	2	2	1	3	3	4	4
Que.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
Ans.	4	4	3	3	4	1	4	4	1	3	2	2	4	3	3	1	2	1	3	4
Que.	201	202	203																	
Ans.	1	3	2																	

EXERCISE - 2

Q.1 Cleavage takes place in–
(1) Ovum (2) Zygote
(3) Neuron (4) All

Q.2 Egg in which yolk is found in the centre. The peripheral part is yolk-less–
(1) Homolecithal (2) Microlecithal
(3) Centrolecithal (4) Telolecithal

Q.3 The type of cleavage in a egg is determined by–
(1) Number of egg membranes
(2) Amount & distribution of yolk
(3) Size & position of nucleus
(4) Size & shape of sperm

Q.4 The sperms gain the capacity of fertilization on contact with vaginal secretion is called as–
(1) Cortical reaction (2) Capactitation
(3) Acrosomal reaction (4) None

Q.5 In an egg of frog is divided in a way that one part has animal hemisphere and an other part is deficient in that then-
(1) Only animal hemisphere region forms embryo
(2) Both the sites form embryo
(3) Embryo is not formed from any region
(4) Animal hemisphere deficient region forms the embryo

Q.6 Sequential and regular conversion of zygote into an animal is known as-
(1) Transformation (2) Genetic characters
(3) Embryonic induction (4) Stimulation

Q.7 Body cavity is found between –
(1) Ectoderm & endoderm
(2) Ectoderm & mesonephros
(3) Ectoderm & body wall
(4) Body wall & mesoderm

Q.8 Polar bodies are formed in –
(1) Oogenesis (2) Spermatogenesis
(3) Gametogenesis (4) Spermiogenesis

Q.9 The release of the egg from the ovary is called as –
(1) Oogenesis (2) Ovulation
(3) Oviposition (4) Ovo-viviparity

Q.10 Law of organiser was given by –
(1) Spemann (2) Leeuwenhoek
(3) Von- Baer (4) Wolff

Q.11 Double axial gradient theory was given by–
(1) Child (2) Roux
(3) Driesch (4) Horstadius

Q.12 Connective tissues originate form–
(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) Meso-endoderm

Q.13 The correct sequence of various stages in embryonic development –
(1) Fertilization – Cleavage –Morula – Blastula – Gastrula
(2) Cleavage – Fertilization – Gastrula – Blastula
(3) Blastula – Cleavage – Gastrula – Fertilization
(4) Gastrula– Fertilization – Cleavage – Blastula

Q.14 Eggs which have large amount of yolk–
(1) Microlecithal (2) Macrolecithal
(3) Oligolecithal (4) Mesolecithal

Q.15 The group which originate from mesoderm –
(1) Thyroid, Pancrease, Kidney
(2) Heart, Spleen, Gonad
(3) Pineal body, Stomodium, Proctodaeom
(4) Nervous system, Epidermis, Internal ear

Q.16 Chromosomes in primary sex cell –
(1) Haploid (2) Diploid
(3) Similar to sperm (4) Similar to ovum

Q.17 In which animal parthenogenesis is common–
(1) Rats (2) Hens
(3) Aphids (4) Monkeys

Q.18 Meroblastic cleavage takes place in–
(1) Spiral cleavage (2) Equal cleavage
(3) Complete cleavage (4) Partial cleavage

Q.19 In which blastula is called as blastocyst –
(1) Frog (2) Fish
(3) Bird (4) Eutherian

Q.20 5th cleavage results in the formation of–
(1) 16– cells (2) 48– cells
(3) 64– cells (4) 32–cells

Q.21 Convergence & divergence of embryonic cells is called as –

(1) Differentiation (2) Induction

(3) Morphogensis (4) Blastulation

Q.22 Which of the following is haploid–

(1) Primary oocyte

(2) Oogonia

(3) Secondary oocyte

(4) Primary spermatocyte

Q.23 In sperm , the acrosome is found –

(1) On the top part (2) In the mid piece

(3) Behind the nucleus (4) On the tail part

Q.24 Enzyme secreted by the acrosome of sperm–

(1) Hyaluronidase (2) Pepsin

(3) Carboxylase (4) Dehydroginase

Q.25 Begining of embryonic development in the egg is indicated by–

(1) Cleavage (2) Differentiation

(3) Polarity (4) organogenesis

Q.26 Liver and pancreas develops from–

(1) Ectoderm (2) Mesoderm

(3) Ecto-mesoderm (4) Endoderm

Q.27 Brain originates from–

(1) Mesoderm (2) Ectoderm

(3) Ecto-mesoderm (4) Endoderm

Q.28 Following is an example of recapitulation theory

(1) Extra-embryonic membrane in reptiles

(2) Tadpole larva of frog

(3) Placenta in mammals

(4) Gill cleft in human foetus

Q.29 What is present in the vegetal pole of the frog's egg –

(1) Pigment (2) Gray crescent

(3) Yolk (4) Germinal cup

Q.30 The name of the small cell separates from the ovum during maturation is –

(1) Primordial germinal cell

(2) Polocyte

(3) Secondary germinal cell

(4) Primary spermatocyte

Q.31 The upper coloured part of the frog egg is associated with –

(1) Nutrition (2) Camouflage

(3) Respiration (4) To provide colour

Q.32 Blastopore is found in –

(1) Blastula & opening of archenteron

(2) Blastula & opening of blastocoel

(3) Gastrula & opening of archenteron

(4) Gastrula & opening of blastocoel

Q.33 How many secondary spermatocyte will form 400 spems –

(1) 100 (2) 400

(3) 40 (4) 200

Q.34 100 primary oocyte will form how many egg –

(1) 300 (2) 400

(3) 200 (4) 100

Q.35 Oogenesis involves –

(1) Multiplication phase (2) Growth phase

(3) Maturation phase (4) All

Q.36 The mid-piece of the sperm contains –

(1) Nucleus (2) Proteins

(3) Centriole (4) Mitochondria

Q.37 Frog's eggs is –

(1) Isolecithal (2) Mesolecithal

(3) Megalecithal (4) Centrolecithal

Q.38 If an unfertilized egg of frog is pricked by a minute needle–

(1) It will remain live but undivided

(2) It will change into youngone soon

(3) It will begin to divide

(4) It will die

Q.39 External fertilization occurs in–

(1) Lizard (2) Bird

(3) Rat (4) Frog

Q.40 Development of embryo from unfertilized egg is called as–

(1) Parthenogenesis (2) Apogamy

(3) Pseudogamy (4) Parthenocarpy

Q.41 Yolk plug in gastrula is future –

(1) Anterior (2) Posterior end

(3) Dorsal side (4) Ventral side

Q.42 The organ which form gametes in animals is –

(1) Ovary (2) Testes

(3) Gonad (4) Oviduct

Q.43 Which form microlecithal eggs –

(1) Insects (2) Fishes

(3) Birds (4) Mammals

Q.44 Entry of sperm into the ovum results in–

(1) Formation of Ist polocyte

(2) Formation of 2nd polocyte

(3) Ist meiosis

(4) Formation of pronuclei

Q.45 The egg of placental mammals are–

(1) Microlecithal (2) Alecithal

(3) Mesolecithal (4) Homolecithal

Q.46 The part of the sperm which has mitochondria–

(1) Head (2) Middle-piece

(3) Neck (4) Tail

Q.47 The ovum released from human ovary contains–

(1) One X- chromosome

(2) One Y- chromosome

(3) Two X- chromosome

(4) XY- chromosome

Q.48 The number of chromosome in the spermatid of man –

(1) 48 (2) 23

(3) 24 (4) 46

Q.49 Head of the sperm contains–

(1) Nucleus (2) Golgi body

(3) Centriole (4) Mitochondria

Q.50 Sperm locomotes by –

(1) Head (2) Acrosome

(3) MId-piece (4) Tail

Q.51 The cleavage which cleaves the egg partially-

(1) Holoblastic (2) Meroblastic

(3) 1 & 2 Both (4) Spiral

Q.52 Unfertilized egg of honey bee develops into–

(1) Sterile male (2) Sterile female

(3) Fertile male (4) Fertile female

Q.53 The cells forming ectoderm spread & stretch to cover the embryo except a pore called blstopore. This movement in gastrulation is called as–

(1) Emboly (2) Involution

(3) Invagination (4) Epiboly

Q.54 Intestine in both invertebrates & vertebrates develops from –

(1) Ectoderm (2) Pharyngeal pouch

(3) Endoderm (4) Mesoderm

Q.55 Which of the following egg is found in cockroach–

(1) Alecithal (2) Microlecithal

(3) Centrolecithal (4) Oligolecithal

Q.56 Grey crescent structure is found in–

(1) Eye of cockroach (2) Eye of frog

(3) Brain of rabbit (4) Fertillized egg of frog

Q.57 Vegetal pole of egg has –

(1) Yolk (2) Pigment

(3) Grey Crescent (4) Germinal Vesicle

Q.58 Spermatogenesis involves–

(1) Mitosis (2) Meiosis

(3) Transformation (4) 1 & 2 both

Q.59 Hormone which control spermatogenesis is–

(1) FSH (2) LH

(3) LTH (4) Vasopressin

Q.60 Acrosome of sperm helps in-

(1) Locomotion (2) Ovum penetration

(3) To provide energy (4) None

Q.61 During fertilization, the point of entry of sperm is–

(1) Rotation centre of embryo

(2) Axis of cleavage

(3) Grey crescent

(4) Dorsal lip of blastopore

Q.62 Sperm in frog's egg enters from–

(1) Animal pole (2) Vegetal pole

(3) Grey crescent (4) From any where

Q.63 Apomixis is–

(1) Vegetative reproduction

(2) Asexual reproduction

(3) Sexual reproduction which is without meiosis & gametogenesis

(4) None

Q.64 In which of following, fertilization of ovum takes place in Rabbit and Man–

(1) Ovary (2) Vagina

(3) Fallopian tube (4) Uterus

Q.65 Eggs of egg laying mammals are –

(1) Macrolecithal (2) Alecithal

(3) Mesolecithal (4) Telolecithal

Q.66 Jelly of frog egg is laid –

(1) During ovulation

(2) After fertilization in water

(3) In oviduct

(4) In ovary

Q.67 Noncleidoic eggs are found in –

(1) Fish (2) Bird

(3) Reptile (4) Mammals (Platypus)

Q.68 Hyaluronic acid is present in –

(1) Human sperm

(2) Ovary

(3) Ovum of the female

(4) A type of protein of blood

Q.69 The human sperm releases a substance to dissolve egg membrane, called–

(1) Hyaluronidase (2) Hyaluronic acid

(3) Fertilizin (4) Antifertilizin

Q.70 Polar bodies are found during –

(1) Oogenesis (2) Spermatogenesis

(3) Spermeogenesis (4) None of these

Q.71 Insect's eggs are -

(1) Microlecithal and centrolecithal

(2) Megalecithal and isolecithal

(3) Megalecithal and centrolecithal

(4) Megalecithal and telocithal

Q.72 The site of fertilization in mammals is-

(1) Ovary (2) Abdominal

(3) Uterus (4) Fallopian tube

Q.73 Natural parthenogenesis is found in-

(1) Housefly (2) Honey bee

(3) Drosophila (4) All of these

Q.74 Spermatogenesis is induced by-

(1) FSH (2) ACTH

(3) ICSH (4) ATH

Q.75 Cleavage found in mesolecithal egg is-

(1) Holoblastic and equal

(2) Holoblastic and unequal

(3) Meroblastic

(4) Discoidal

Q.76 Egg of frog is-

(1) Alecithal (2) Macrolacithal

(3) Microlecithal (4) Mesolecithal

Q.77 Which is formed in gastrulation ?

(1) Archenteron (2) Heart

(3) Brain (4) None of these

Q.78 How many sperms are produced from first spermatocyte-

(1) 4 (2) 2

(3) 1 (4) 8

Q.79 Which chemical attracts sperms towards egg-

(1) Fertilizin (2) Antifertilizin

(3) Agglutinin (4) Thromobin

Q.80 Grey crescent is the area-

(1) At the point of entry of sperm into ovum

(2) Just opposite to the site of entry of sperm into ovum

(3) At the animal pole

(4) At the vegetal pole

Q.81 If mammalian ovum fails to get fertilized, which one of the following is unlikely-

(1) Corpus luteum will disintegrate

(2) Progesteron secretion rapidly declines

(3) Estrogen secretion further decreases

(4) Primary follicle starts developing

Q.82 Withdrawal of which of the following hormones is the immediate cause of menstruation?

(1) Progesterone

(2) Estrogen

(3) FSH

(4) FSH-RH

Q.83 Sertoli cells are regulated by the pituitary hormone known as-

(1) LH (2) FSH

(3) GH (4) Prolactin

Q.84 Which part of ovary in mammals acts as an endocrine gland after ovulation?

(1) Stroma (2) Germinal epithelium

(3) Vitelline membrane (4) Graffian follicle

Q.85 Compared to a bull a bullock is docile because of-

(1) Higher levels of cortisone

(2) Lower levels of blood testosterone

(3) Lower level of adrenaline/noradrenalin in its blood

(4) Higher level of thyroxin

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	2	2	1	1	4	1	2	1	1	3	1	2	2	2	3	4	4	4
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	3	1	1	1	4	2	4	3	2	2	3	4	4	4	4	2	3	4	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	3	4	2	2	2	1	2	1	4	2	3	4	3	3	4	1	4	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	1	3	3	1	2	1	3	1	1	3	4	2	1	2	4	1	1	1	2
Ques.	81	82	83	84	85															
Ans.	4	1	2	4	2															

EXERCISE-3 PREVIOUS YEAR'S QUESTIONS

Q.1 Human placenta is : **[AIIMS 99]**
(1) Haemochorial (2) Syndesmochorial
(3) Yolk sac (4) Haemo-endothelial

Q.2 Human eggs are **[MPPMT 2000]**
(1) Alecithal (2) Microlecithal
(3) Mesolecithal (4) Macrolecithal

Q.3 Middle piece of mammalian sperm possesses : **[CBSE 1991]**
(1) Mitochondria and centriole
(2) Mitochondria only
(3) Centriole only
(4) Nucleus and mitochondria

Q.4 Human egg has : **[MPPMT 2000]**
(1) One Y-chromosome
(2) One X-chromosome
(3) Two Y-chromosome
(4) One X-chromosome and one Y-chromosome

Q.5 Fertilizins are emitted by : **[J.I. PMER 2000]**
(1) Immature eggs (2) Mature eggs
(3) Sperms (4) Polar bodies

Q.6 Meroblastic cleavage takes place in : **[MPPMT 1991]**
(1) Hydra (2) Amphioxus
(3) Frog (4) Chick

Q.7 During cleavage, what is true about embryo ? **[CBSE 1991, CPMT 99]**
(1) Nucleocytoplasmic ratio remains unchanged
(2) Size does not increase
(3) There is less consumption of oxygen
(4) The division is like meiosis

Q.8 Meroblastic cleavage is division **[CBSE 1992, MPPMT-97]**
(1) Horizontal (2) Partial/Parietal
(3) Total (4) Spiral

Q.9 Eye lens is formed from : **[CBSE 1992]**
(1) Ectoderm
(2) Mesoderm
(3) Endoderm
(4) Ectoderm and mesoderm

Q.10 Extrusion of second polar body from egg nucleus occurs **[CBSE 2000]**
(1) After entry of sperm before completion of fertilization
(2) After completion of fertilization
(3) Before entry of sperm
(4) Without any relation of sperm entry

Q.11 Termination of gastrulation is indicated by : **[CBSE 1993]**
(1) Obliteration of blastocoel
(2) Obliteration of archenteron
(3) Closure of blastopore
(4) Closure of neural tube

Q.12 In telolecithal egg the yolk is found : **[CBSE 1993]**
(1) All over the egg (2) On one side
(3) Both the sides (4) Centre

Q.13 Acrosome reaction in sperm is triggered by **[CBSE 1993]**
(1) Capaciation (2) Release of lysin
(3) Influx of Na^+ (4) Release of fertilizin

Q.14 Amounnt of yolk and its distribution are changed in the egg. Which one is affected? **[CBSE 1993]**
(1) Pattern of cleavage
(2) Formation of zygote
(3) Number of blastomeres
(4) Fertilisation

Q.15 Fertilization is : **[KARNATAKA 1994]**
(1) Union of diploid spermatozoon with diploid ovum to form diploid zygote
(2) ovum of haploid sperm with haploid ovum to form haploid zygote
(3) Union of haploid sperm with haploid ovum to form diploid zygote
(4) Union of diploid sperm with haploid ovum to form triploid zygote

Q.16 At the end of first meiotic division, male germ cell differentiates into : **[CBSE 1994, MPPMT 96]**
(1) Secondary spermatocyte
(2) Primary spermatocyte
(3) Spermatogonium
(4) Spermatid

Q.17 Extra-embryonic membranes of the mammalian embryo are derived from : **[CBSE 1994]**

(1) Inner cell mass (2) Trophoblast

(3) Formative cells (4) Follicle cells

Q.18 What is true about cleavage in fertilized egg of humans? **[CBSE 1994]**

(1) Meroblastic

(2) Starts when egg reaches uterus

(3) Starts in fallopian tubes

(4) It is identical to normal mitosis

Q.19 Vascular tissue is derived from : **[KARNATAKA 1994]**

(1) Epithelium

(2) Ectoderm

(3) All germinal layers

(4) Mesoderm

Q.20 In a mamanalian sperm, spiraly arranged mitochondria around an axial filament occurs in **[BHU 1994, 2000]**

(1) Middle piece

(2) Head

(3) End piece of tail

(4) Principal piece of tail

Q.21 A mature sperm has **[AFMC 1994]**

(1) A pair of flagella

(2) A nucleus, an acrosome, and a centriole

(3) A nucleus, an acrosome, a pair of centrioles

(4) A nucleus, an acrosome, a pair of centroiles and a tail.

Q.22 Ovulation occurs under the influence of : **[AIIMS 96]**

(1) LH (2) FSH

(3) Estrogen (4) Progesterone

Q.23 Part of sperm involved in penetrating egg membrane is **[MP PMT 99, 2000]**

(1) Tail (2) Acrosome

(3) Allosome (4) Autosome

Q.24 Type of cleavage in an egg is determined by : **[CBSE 1995, RPMT 99]**

(1) Amount and distribution of yolk

(2) Number of egg membranes

(3) Size and location of nucleus

(4) Shape and size of sperm

Q.25 Which one develops from endodermis? **[BHU 1995]**

(1) Nervous system urinary bladder and eye

(2) Liver, connective tissue and heart

(3) Thymus, spiral cord and brain

(4) Liver, pancreas and thymus/thyroid

Q.26 Reptile and bird eggs are: **[AIIMS 1996]**

(1) Macrolecithal (2) Oligoleithal

(3) Mesolecithal (4) Alecithal

Q.27 Fertilization is fusion of : **[AIMS 1996]**

(1) Diploid spermatozoan with diploid ovum to form diploid zygote

(2) Haploid spermatozoan with diploid ovum to from diploid zygote

(3) Diploid spermatozoan with haploid ovum to form diploid zygote

(4) Haploid spermatozoan with haploid ovum to form diploid zygote

Q.28 Spermatozoa are nourished during their development by **[KARNATAKA 1997]**

(1) Setroli cells

(2) Interstitial cells

(3) Connective tissue cells

(4) None of the above

Q.29 Correct sequence in development is : **[CPMT 1998]**

(1) Fertilization $\rightarrow$ Zygote $\rightarrow$ Cleavage $\rightarrow$ Morula $\rightarrow$ Blastula $\rightarrow$ Gastrula

(2) Fertilization $\rightarrow$ Zygote $\rightarrow$ Blastula $\rightarrow$ Morula $\rightarrow$ Cleavage $\rightarrow$ Gastrula

(3) Fertilization $\rightarrow$ Cleavage $\rightarrow$ Morula $\rightarrow$ Zygote $\rightarrow$ Blastula $\rightarrow$ Gastrula

(4) Cleavage $\rightarrow$ Zygote $\rightarrow$ Fertilization $\rightarrow$ Morula $\rightarrow$ Blastula $\rightarrow$ Gastrula

Q.30 Eye develops from : **[CBSE 1998]**

(1) Ectoderm (2) Mesoderm

(3) Endoderm (4) Both 2 and 3

Q.31 Middle piece of mammalian sperm contains : **[AIIMS 1998, CBSE 99]**

(1) Nucleus (2) Vacuoles

(3) Mitochondria (4) Centriole

Q.32 Egg with peripheral cytoplasm around the yolk is : **[AIIMS 1998]**

(1) Isolecithal (2) Microlecithal

(3) Telocithal (4) Centolecithal

Q.33 Immediately after ovulation, the mammalian egg is covered by a membrane called : **[AIIMS 1998]**

(1) Chorion (2) Zona pellucida

(3) Corona raidata (4) 2 & 3

Q.34 Cleavage in the fertilized egg of humans : **[AFMC 1999]**

(1) Starts in uterus

(2) is meroblastic

(3) starts when egg is in fallopian tube

(4) is discoidal

Q.35 Polar body is produced during the formation of: **[Pb PMT 1999]**

(1) Sperm (2) Secondary oocyte

(3) Oogonium (4) Spermatocytes

Q.36 The head of mature mammalian sperm is made of : **[AIIMS 1999]**

(1) An acrosome

(2) Elongated nucleus covered by acrosome

(3) Two centrioles and an axial filement

(4) **N**ucleus, acrosome, cytoplasm and mitochondrial sheath

Q.37 Ovulation or release of ovum occurs on the day of menstrual cycle : **[Manipal 2000]**

(1) 8 – 10 (2) 12 – 14

(3) 4 – 14

(4) Last two day of menstrual cycle

Q.38 Division of human egg is : **[CBSE 2000]**

(1) Equal holoblastic

(2) Unequal holoblastic

(3) Superficial meroblastic

(4) Discodial meroblastic

Q.39 First successful animal clone was : **[CBSE 2000]**

(1) Dolly goat (2) Dolly sheep

(3) Molly goat (4) Molly sheep

Q.40 Sperms produce an enzymatic substance for dissolving egg coverings. It is called : **[KARNATAKA 2001]**

(1) Hylauronic acid (2) Hyaluronidase

(3) Androgamone (4) Diastase

Q.41 Oocyte is liberated from ovary under the influence of LH, after completing : **[AIIMS 2001]**

(1) Metosis and before liberating polar bodies

(2) Meiosis I and before liberating second polar bodies

(3) Meiosis

(4) Meiosis II after release of first polar body

Q.42 Noncleiodic eggs occurs in : **[BHU 2001]**

(1) Birds (2) Fish

(3) Reptiles (4) Platypus

Q.43 In which one Meroblastic cleavage is found **[RPMT 2000]**

(1) Dog (2) Owl

(3) Monkey (4) Rhinoceros

Q.44 In which of the following mosaic cleavage occurs : **[RPMT 2000]**

(1) Camel (2) Whale

(3) Dog fish

(4) Echinococcus granulosus

Q.45 Microlecithal eggs are gound in : **[RPMT 2001]**

(1) Reptilia + Aves

(2) Amphibia + Aves + Reptilia

(3) Reptilia + Aves + Chiroptera

(4) Eutheria

Q.46 Which cell div. is found during cleavage ? **[RPMT 2001]**

(1) Amitosis (2) Mitosis

(3) Closed mitosis (4) Meiosis

Q.47 10 oogonia yield 10 primary oocytes, then how many ova are produced on completion of oogenesis: **[RPMT 2001]**

(1) 5 (2) 10

(3) 20 (4) 40

Q.48 At the time of fertilization sperm head enters in the egg from **[RPMT 2001]**

(1) Any where (2) Animal pole

(3) Vegetal pole (4) Lateral side of egg

Q.49 Which have macrolecithal eggs? **[RPMT 2001]**
(1) Aves, Reptilia
(2) Aves, Reptilia, Amphibia
(3) Aves, Reptilia, Chiroptera
(4) Aves, Eutheria

Q.50 Which part of sperm provides energy it to fertilize the egg : **[RPMT 2001]**
(1) Sperm head (2) Acrosome
(3) Sperm tail (4) Middle piece

Q.51 In which stage of development the embryonic cells form the germinal layers by the movement : **[RPMT 2001]**
(1) Morula (2) Blastula
(3) Gastrula (4) Nerula

Q.52 Cleidoic egg is an adaptation for : **[RPMT 2001]**
(1) Aquatic life (2) Marine life
(3) Terrestrial life (4) Aerial life

Q.53 In mammals egg are microlecithal and isolecithal because these are : **[RPMT 2001]**
(1) Oviparou (2) Viviparous
(3) Ovoviviparous (4) None of them

Q.54 Eggs of birds are : **[RPMT 2001]**
(1) Microlecithal (2) Centrolecithal
(3) Megalecithal (4) Alecithal

Q.55 In which of the following animal cleavage divisions are restricted to a small part of cytoplasm & nucleus in animal pole of egg? **[RPMT 2002]**
(1) Cockroach (2) Frog
(3) Chick (4) Rabbit

Q.56 Which of the following is not the correct for gastrulation **[RPMT 2002]**
(1) Archenteron is formed
(2) All germinal layers are formed
(3) Morphogenetic movements
(4) Some blastomeres & blastocoel degenerate

Q.57 At which stage of spermatogenesis sperm aquire their whole structural maturity and they contain a haploid nucleus & other organs **[RPMT 2002]**
(1) Spermiogenesis (2) Growth phase
(3) Multiplication phase
(4) Maturation phase

Q.58 Insects eggs are : **[RPMT 2002]**
(1) Microlecithal & centrolecithal
(2) Megalecithal & isolecithal
(3) Megalecithal & centrolecithal
(4) Megalecithal & telolecithal

Q.59 In rabbit at the time of fertilization zygote is formed in : **[RPMT 2002]**
(1) Coelom (2) Fallopian tube
(3) Uterus (4) Vagina

Q.60 Sperm enters from which part of egg: **[RPMT 2002]**
(1) Any where in unfertilized egg from vegetal pole
(2) From animal pole in unfertilized egg
(3) In unfertilized egg from vegetal pole
(4) None

Q.61 Completion of gastrulation is indicated by **[RPMT 2003]**
(1) Obliteration of archenterone
(2) Obliteration of blastocoel
(3) Closing of blastopore
(4) Closing of neural tube

Q.62 In mammals, egg is fertilised in : **[RPMT 2003]**
(1) Ovary (2) Fallopian tube
(3) Uterus (4) Vagina

Q.63 In mesolecithal eggs, the cleavage is : **[RPMT 2004]**
(1) Equal, holoblastic (2) Unequal holoblastic
(3) Meroblastic (4) Discoidal

Q.64 Cortical granules are absent in : **[RPMT 2004]**
(1) Fish (2) Frog
(3) Man (4) Rat

Q.65 The egg of frog is : **[RPMT 2004]**
(1) Microlecithal (2) Mesolecithal
(3) Telolecithal (4) Alecithal

Q.66 What is formed at the time of gastrulation? **[RPMT 2004]**
(1) Gills (2) Heart
(3) Myotome (4) Archenteron

Q.67 Which part of the spermatid forms acrosomes of sperm ? **[RPMT 2004]**
(1) Mitochondria (2) Golgibody
(3) Nucleus (4) Lysosome

Q.68 How many sperms are formed by one primary spermatocyte ? **[RPMT 2005]**
(1) 4 (2) 3
(3) 2 (4) 1

Q.69 The chemical in ovun which attracts sperms : **[RPMT 2005]**
(1) Fertilizin (2) Antifertilizin
(3) Agglutinin (4) Thrombin

Q.70 Which of the following organ is differentiated first during development ? **[RPMT 2005]**
(1) Heart (2) Skin
(3) Brain (4) Neural tube

Q.71 Blastopore is the pore of : **[CBSE 2000]**
(1) Archenteron (2) Blastocoel
(3) Coelon (4) A.C.

Q.72 What is true for cleavage: **[CBSE 2002]**
(1) Size of embryo increases
(2) Size of cells decrease
(3) Size of cells increase
(4) Size of embryo decreases

Q.73 During embryonic development, the establishment of polarity along anterior/ posterior, dorsal/ ventral or medial/ lateral axis is called : **[CBSE 2003]**
(1) Organizer phenomenon
(2) Axis formation
(3) Anamorphosis
(4) Pattern formation

Q.74 Grey cresent is the area: **[CBSE 2005]**
(1) At the point of entry of sperm in to ovum
(2) Just opposite to the site of entry of sperm in to ovum
(3) At the animal pole
(4) At the vegetal pole

Q.75 Development of animal embryo from egg without fertilization is called : **[BIHAR 2004]**
(1) Parthenogenesis (2) Parthenocarpy
(3) Apospory (4) Apomixis

Q.76 During embryonic development, endoskeleton and muscle develop from which germinal layer **[BIHAR 2006]**
(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) Blastopore

Q.77 In the development of a frog, the gastrulation process involves : **[UP CPMT 2001, RPMT 08]**
(1) Epiboly (2) Emboly
(3) Invagination (4) All of these

Q.78 Polar bodies are produced during the formation of : **[UP CPMT 2001]**
(1) Sperm (2) Oogonium
(3) Spermatocytes (4) Secondary oocyte

Q.79 The part where fertilization of ovum occurs in placental mammals is : **[UP CPMT 2001]**
(1) Ovary (2) Uterus
(3) Vagina (4) Fallopian tube

Q.80 In a vertebrate which germ layer forms the skeletal muscles **[UP CPMT 2004]**
(1) Ectoderm (2) Endodem
(3) Mesoderm (4) Both 1 and 2

Q.81 Grey crescent in fertilized frog's egg is the area: **[UP CPMT 2006]**
(1) At the point of the entry of sperm into ovum
(2) at the vegetal pole
(3) at the animal pole (4) none of these

Q.82 During embryonic development the establishment of polarity along anterio/posterior, dorsal/ ventral or medial/lateral axis is called : **[UP CPMT 2005]**
(1) anamorphosis
(2) organizer phenomenon
(3) pattern formation
(4) axis formation

Q.83 Liver and pancreas of frog and rabbit are derived from : **[UP CPMT 2006]**
(1) Ectoderm (2) Mesentery
(3) Endoderm (4) Both 1 and 3

Q.84 Which layer develops first during embryonic development : **[UP CPMT 2006]**
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) Both 1 and 3

Q.85 The egg of frog is : **[UTTARANCHAL 2004]**
(1) Telolecithal (2) Microlecithal
(3) Alecithal (4) Centrolecithal

Q.86 Which of the following undergoes spermiogenesis **[UTTARANCHAL 2004]**

(1) Spermatids
(2) Spermatogonia
(3) Primary spermatocytes
(4) Secondary spermatocytes

Q.87 Antifertilizin is present on : **[UTTARANCHAL 2004]**

(1) Egg (2) Tail
(3) Ovum (4) Spermatozoa

Q.88 Various changes in mammalian sperm which prepare it to fetilise the ovum are called : **[UTTARANCHAL 2004]**

(1) Capacitation (2) Regeneration
(3) Growth (4) None of these

Q.89 In gastrulation, which is (are) formed : **[Jharkhand 2005]**

(1) Endoderm
(2) Mesoderm
(3) Ectoderm, endoderm
(4) Ectoderm, mesoderm, endoderm

Q.90 During oogenis, the small structure separated from egg is : **[Jharkhand 2006]**

(1) Polar bodies
(2) Secondary endosperm
(3) Herring bodies
(4) Hela cells

Q.91 Foetal sex is determined by examining cells from amniotic fluid looking for **[Jharkhand 2004]**

(1) Chiasmata (2) Autosomes
(3) Sex-chromosomes (4) Nucleus

Q.92 Which of the following is not correct for gastrulation **[Jharkhand 2003]**

(1) Archenteron is formed
(2) All germinal layers are formed
(3) Morphogenetic movements
(4) Blastomeres and gastrocoel degenerate

Q.93 In human foetus, the heart begins to beat at developmental age of : **[Jharkhand 2002]**

(1) 4^{th} weak (2) 3^{rd} week
(3) 6^{th} week (4) 8^{th} week

Q.94 Acrosome of spermatozoa is formed from : **[MP PMT 2004]**

(1) Lysosomes (2) Golgi bodies
(3) Ribosome (4) Mitochondria

Q.95 Frog's egg is : **[MP PMT 2006]**

(1) Alecithal (2) Centrolecithal
(3) Isolecithal (4) Telolecithal

Q.96 The whole nervous system including neuron in frog and other vertebrates is derived from : **[MP PMT 2006]**

(1) Ectoderm (2) Endoderm
(3) Mesoderm (4) All of these

Q.97 The cavity, which formed during gastrulation is named as : **[MP PMT 2007]**

(1) Blastocoel (2) Archenteron
(3) Coelom (4) Pseudocoel

Q.98 In a sperm, the mitochondria occurs : **[MP PMT 2001]**

(1) In tail (2) In acrosome
(3) In middle piece (4) In head

Q.99 Identical twins will be produced when : **[MP PMT 2001]**

(1) One spermatozoan fertilizes two ova
(2) One ovum is fertilized by two spermatozoa
(3) Two eggs are fertilized
(4) One fertilized egg divides into two blastomers and they becomes separae

Q.100 Which set of enzymes is found in the acrosome of mammalian spermatozoa **[MP PMT 2001]**

(1) Hyaluronidase, Corona penetrating Enzyme (CPE)
(2) Hyaluronidase, CPE, Zona lysine
(3) Hyaluronidase, CPE, Peptidase
(4) Hyaluronidase only

Q.101 Fixing up of the blastocyst in the wall of the uterus is known as : **[MP PMT 2002]**

(1) Fertilization (2) Implantation
(3) Impreganation (4) Placentation

Q.102 The type of placenta found in human beings is of type **[MP PMT 2002]**

(1) Diffuse (2) Zonary
(3) Cotyledonary (4) Discoidal

Q.103 The number of foetal membranes in man is : **[MP PMT 2002]**

(1) 1 (2) 3
(3) 4 (4) 0

Q.104 Placenta in human beings in formed by : **[MP PMT 2002]**

(1) Amnion (2) Chorion
(3) Allantois
(4) Allantois, chorion and uterine wall

Q.105 The phenomenon of nuclear fusion of sperm and egg is known as : **[MP PMT 2002]**

(1) Karyogamy (2) Parthenogenesis
(3) Vitellogenesis (4) Oogenesis

Q.106 Cleidoic eggs are characteristic of : **[MP PMT 2002]**

(1) Mammals
(2) Reptiles, Birds & Insects
(3) Insects only (4) Fishes

Q.107 Arrchenteron cavity is found in : **[MP PMT 2002]**

(1) In Blastula (2) In Gastrula
(3) In Morula (4) In planula

Q.108 Microlecithal eggs with very small amount of food reserve are found in : **[MP PMT 2002]**

(1) Frog (2) Insects
(3) Man (4) Fish

Q.109 Mammalian placenta originates from : **[MP PMT 2007]**

(1) Allantois and chorion
(2) Yolksac
(3) Allantois (4) Amnion

Q.110 The eggs of reptiles and birds contain a large amount of yolk. We refer to such eggs as : **[CPMT 2009]**

(1) Alecithal (2) Oligolecithal
(3) Mesolecithal (4) Telolecithal

Q.111 Human egg is : **[Karnataka CET 2008]**

(1) Alecithal (2) Centrolecithal
(3) Telolecithal (4) Megalecithal

Q.112 Eggs having yolk in centre and cytoplasm in a peripheral region are called : **[Pb. PMT 2007]**

(1) Isolecithal (2) Telolecithal
(3) Microlecithal (4) Centrolecithal

Q.113 The eggs of silkmoth are : **[BHU 2008; Uttarakhand PMT 2008]**

(1) Telolecithal (2) Mesolecithal
(3) Homolecithal (4) Centrolecithal

Q.114 Fertilizin a chemical substance produced by : **[Manipal 2005; CMC, Vellore 2008]**

(1) Acrosome (2) Polar bodies
(3) Mature eggs
(4) Middle piece of sperm

Q.115 The fusion of male and female pronuclei is known as : **[JCECE 2008; JKCMEE 2009]**

(1) Eumixis (2) Endomixis
(3) Fertilization (4) Amphimixis

Q.116 The cell division that takes place in a zygote is known as : **[JKCMEE 2007]**

(1) Mitosis (2) Meiosis
(3) Cleavage (4) Differentiation

Q.117 What is true for cleavage? **[CBSE 2002; RPMT 2007]**

(1) Size of cell increases
(2) Size of embryo increases
(3) Size of cell decreases
(4) Size of embryo decreases

Q.118 In insects, cleavage is : **[RPMT 2002; AFMC 2006; JCECE 2007]**

(1) Equal holoblastic
(2) Meroblastic disoidal
(3) Unequal holoblastic
(4) Meroblastic superficial

Q.119 Differentiation of organs and tissues in a developing organism is associated with : **[CBSE 2007]**

(1) Lethal mutations
(2) Deletion of genes
(3) Developmental mutations
(4) Differential expression of genes

Q.120 The brain is evolved from embryonic : **[MH-CET 2003; Orissa JEE 2010]**

(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) Archenteron

Q.121 Which of the following is correct grouping?

1. Ectoderm–Retina,epidermis,nevous system
2. Mesoderm–Ovary, urinary bladder, kidney
3. Mesoderm–Kiney, connective tissue, testis
4. Endoderm–Thyroid, pineal gland, thymus

Answer codes : **[BHU 2007]**

(1) 1 and 2 are correct
(2) 2 and 4 are correct
(3) 1 and 3 are correct
(4) 1, 2 and 3 are correct

Q.122 Where is jelly deposited as a covering on the egg of frog? **[VMMC-Safdarjung 2008]**

(1) Ovary
(2) Oviduct
(3) Water after fertilization
(4) Water during fertilization

Q.123 Grey crescent is the area : **[CBSE 2005; JIPMER 2007]**

(1) At the animal pole (2) At the vegetal pole
(3) At the point of the entry of sperm into ovum
(4) Just opposite to the site of entry of sperm into ovum

Q.124 Blastula of frog has : **[Uttarakhand PMT 2008]**

(1) Blastocoel (2) Blastopore
(3) Gastrula (4) Neurula

Q.125 Main processes involved in gastrulation in frog are : **[BHU 2007]**

(1) Epiboly, involution, cleavage
(2) Involution, epiboly, invagination
(3) Involution, invagination, epiboly
(4) Cleavage, Invagination, involution

Q.126 In which stage, blastopore is found? **[Karnataka CET 2010]**

(1) Morula (2) Blastula
(3) Neurula (4) Gastrula

Q.127 A blastopore is found in : **[AFMC 2007]**

(1) Blastula and is the opening of blastocoel
(2) Gastrula and is the opening of blastocoel
(3) Blastula and is the opening of archenteron
(4) Gastrula and is the opening of archenteron

Q.128 Yolk plug forms during : **[BHU 2007]**

(1) Neurulation
(2) Gastrulation
(3) Blastula formation
(4) Morula formation

Q.129 During embryonic development, the establishment of polarity along anterior / posterior, dorsal / ventral or medial/lateral axis is called : **[CBSE 2003; CPMT 2005; RPMT 2007]**

(1) Axis formation
(2) Anamorphosis
(3) Pattern formation
(4) Organizer phenomena

Q.130 The extraembryonic membranes of mammalian embryo are derived from : **[BHU 2004; Uttarakhand PMT 2008]**

(1) Triphoblast (2) Follicle cells
(3) Formative cells (4) Inner cell mass

Q.131 Find out the wrong statement : **[Kerala PMT 2007]**

(1) In mammals allantois is not excretory in function
(2) Amnion is the outer layer containing amniotic fluid that acts as shock absorber to the soft embryo
(3) Yolk sac is a foetal membrane that helps in the nourishment of the embryo in general
(4) Chorio-allantoic membrane develops villi and contribute much to the development of placenta
(5) Amnion and chorion develop as upward projecting folds of somatopleure called amniotic folds

Q.132 Which extraembryonic membrane in humans prevents desiccation of the embryo inside the uterus? **[CBSE 2008]**

(1) Amnion (2) Chorion
(3) Yolk sac (4) Allantois

Q.133 The extrastructure that provides nutrition to the embryo is : **[BHU 2005, 08]**

(1) Chorion (2) Amnion
(3) Placenta (4) Umbilicus

Q.134 In human being, placenta is formed by :
[Manipal 2006; AMU 2007]
(1) Chorion (2) Amnion
(3) Allantois (4) All of these

Q.135 In rabbit, placenta is formed by :
[EAMCET 2007]
(1) Chorio-allantoic membrane and endometrium
(2) Chorio-allantoic membrane and yolk sac
(3) Amnion, chorion and yolk sac
(4) Allantois and endometrium

Q.136 Which of the following has discoidal placenta?
[BCECE 2007]
(1) Pig (2) Deer
(3) Rabbit (4) Sheep

Q.137 On the basis of nature of maternal and foetal tissue, types of placenta are :
1. Haemo-endothelial placenta
2. Haemo-chorial placenta
3. Cotyledonary placenta
4. Deciduate placenta

Answer code : **[BHU 2007]**
(1) 1 and 2 are correct
(2) 2 and 4 are correct
(3) 1 and 3 are correct
(4) 1, 2 and 3 are correct

Q.138 Woman who counsumed the durg thalidomide for relief from vomiting during early months of pregnancy gave birth to children with :
[AIIMS 2004, 07]
(1) Harelip
(2) No spleem
(3) Extra fingers and toes
(4) Underdeveloped limbs

Q.139 The organs which have dual origin from embryonic layers :
1. Hypophysis 2. Adrenal gland
3. Sense organs 4. Pancreas

Answer codes : **[BHU 2008]**
(1) 2 and 4 are correct
(2) 1 and 3 are correct
(3) 2 and 3 are correct
(4) 1, 2 and 3 are correct

Q.140 Notochord, skeletal system and dermis of the skin are the derivatives of :
[Karnataka CET 2008]
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) All the there layers

Q.141 A gradual decrease in the size of the tail during metamorphosis in the life cycle of frog is a good example for : **[Karnataka CET 2008]**
(1) Cell necrosis
(2) Cell senescene
(3) Pinocytic activity
(4) Programmed cell death

Q.142 A change in the amount of yolk and its distribution in the egg will affect :
[CBSE 2009]
(1) Fertilization
(2) Pattern of cleavage
(3) Formation of zygote
(4) Number of blastomeres produced

Q.143 The chemical substance released by activated spermatozoa that acts on the ground substance of the follicle cells is known as :
[Kerala PMT 2009]
(1) Relaxin (2) Teratogen
(3) Progesterone (4) Hyaluronidase
(5) gonadotropin

Q.144 Identify the correctly matched pair/pairs of the germ layers and their derivatives :
A. Ectoderm – Epidermis
B. Endoderm–Dermis
C. Mesoderm – Muscles
D. Mesoderm –Norochord
E. Endoderm – Enamel of teeth
[Kernataka CET 2009]
(1) A and D only (2) A and B only
(3) A, C and D (4) A, B, C and E only

Q.145 The internal cavity commonly formed by cell division prior to gastrulation is the :
[DUMET 2010]
(1) Coelom (2) Enteron
(3) Blastopore (4) Blastocoel

Q.146 in mesolecithal egg the cleavage is : **[MPPMT 2010]**

(1) Meroblastic (2) Equal holoblastic

(3) Unequal holoblastic

(4) None of these

Q.147 The cavity formed during gastrulation is : **[MPPMT 2010]**

(1) Archenteron (2) Gastrocoel

(3) Primitive gut (4) All of these

Q.148 Which one of the following is the most widely accepted method of contraception in India at present? **[CET 2009]**

(1) Cervical caps (2) Tubectomy

(3) Diaphragms

(4) IUDs (intra uterine devices)

Q.149 Medical Termination of Pregnency (MTP) is considered safe up to how many weeks of pregnancy **[KARNATAKA 1996]**

(1) Eight weeks (2) Twelve weeks

(3) Eigtheen weeks (4) Six weeks

Q.150 The Test-tube Baby Programme employs which one of the following techniques ? **[AIPMT PRE 2012]**

(1) Intra uterine insemination (IUI)

(2) Gamete intra fallopian transfer (GIFT)

(3) Zygote intra fallopian transfer (ZIFT)

(4) Intra cytoplasmic sperm injection (ICSI)

ANSWER-KEY

EXERCISE – 3

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	**1**	**1**	**1**	**2**	**1**	4	2	2	1	1	1	2	2	1	3	1	2	3	4	1
Ques.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	4	1	2	1	4	1	4	1	1	1	3	4	4	3	2	2	2	2	2	2
Ques.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	2	2	2	4	4	3	2	2	1	4	3	3	2	3	3	4	1	3	2	2
Ques.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	2	2	2	4	2	4	2	1	1	3	1	2	1	2	1	3	4	4	4	3
Ques.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	4	2	3	3	1	1	4	1	4	1	3	4	1	2	4	1	2	3	4	2
Ques.	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
Ans.	2	4	3	4	1	2	2	3	1	4	1	4	4	3	4	3	3	4	4	1
Ques.	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
Ans.	3	4	4	1	3	4	4	2	4	1	2	1	3	1	1	3	1	4	3	2
Ques.	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**										
Ans.	4	2	4	3	4	3	4	4	2	3										

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** Up to morula stage, the cells divide without any increase in size.

R : Zona pellucida remains intact till cleavage is complete.

Q.2 **A :** A sperm sticks to an egg for fertilization.

R : Interaction of surface receptor's, fertilizen on the egg and antifertilization on the sperm head, makes them, adhere together.

Q.3 **A :** Zona pellucida disappears when blastocyst reaches the uterus.

R : Role of zona pellucida is to check the implantation of the blastocyst at an improper site.

Q.4 **A:** All members of bee society are diploid except the drones.

R : Drones are produced parthenogenetically.

Q.5 **A :** Testes originates in the abdomen but later descend in to the scrotum under the influence of testesterone.

R : The interstial cells of the testes secreates male sex harmone the testosterone.

Q.6 **A :** A woman passes out HCGH in the urine during pregnancy.

R : Excess harmones are excreted by the kidneys presence of HCGH in urine is the basis for pregnancy test.

Q.7 **A :** Cervix contains the largest and the most powerful spheneter muscles in the body.

R : Cervix opens into the vagina by external O.S.

Q.8 **A :** The "Chorda-mesoderm" is regarded as the 'organiser' of amphibians embryo.

R : The "Corda mesoderm" later gives rise to the notochord & the mesoderm.

Q.9 **A :** The fate of germ layers is same in all triploblastic animals.

R : There is a close relationship Among all triploblastic animals due to their evolution from common source.

Q.10 **A :** Foetal blood & maternal blood are in direct contact.

R : The placenta works as a link between them.

Q.11 **A :** Twins may arise from a single egg or from two eggs..

R : One egg gives rise to identical twins by separtion of blastomeres, and two eggs produce nonidentical twins.

Q.12 **A :** In a graffian follicles, the primary oocyte and the follicle cells may be regarded sibling cells.

R : Both arise from the same parent cell, the oogonium by mitotic division.

Q.13 **A :** A tadpole whose thyroid gland has been removed does not metamorphore into adult.

R : Calcitonin and thyroxine are produced from thyroid gland ; these hormones stimulate protein synthesis for the development and growth of tadpole larva.

Q.14 **A :** Emboly involves the invagination and involution.

R : Emboly is exhibited by the formation, elongation.

Q.15 **A :** Amniotic fluid serves as a protective cushion.

R : It breaks the mechanical shocks and lessens the effect of changes of temperature.

Q.16 **A :** Sperm of man not fertilized egg of rat.

R : Fertilizine and antifertilizine reaction not takes place between egg & sperm.

Q.17 **A :** Sperms of human being perform chemotaxis movement.

R : Egg of human being secrete antifertilizine.

Q.18 **A :** Asexual reproduction is also called blastogenesis.

R : In asexual reproduction, there is no formation & fusion of gametes.

Q.19 **A :** The middle part of sperm term as energy chamber.

R : Mitochondria of middle part provide the energy for activation of sperm.

Q.20 **A :** There is generally monospermy in most animals.

R : Vitelline membrane of ovum checks polyspermy.

ANSWER KEY

EXERCISE – 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	1	1	1	2	1	2	2	1	4	1	1	1	1	1	1	4	2	1	3

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A Question I am unable to solve in first attempt	COLUMN : B Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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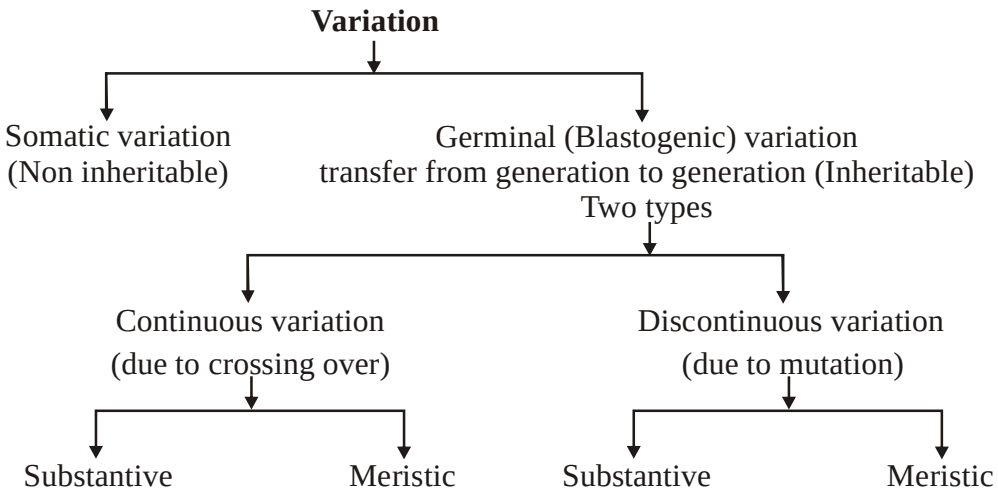
GENETICS

Genetics term was given by **W.Bateson**. (1905) (Father of Modern Genetics).
Genetics = Branch of biology which deals with the study of heredity and variation
Heredity – Transmission of genetic characters from generation to generation.
Variation – Individuals of same species have some difference, these are called variation.



INHERITANCE : HEREDITY AND VARIATIONS

HEREDITY : It is the transmission of genetic characters from parents to the offsprings. It deals with the phenomenon of ''like begets like'' e.g., human babies are like human beings in overall characteristics.

VARIATIONS : Variations are common in sexually reproducing organisms. Variations are of following two types :

1. **Somatogenic :** These are acquired variations and are non-inheritable in nature. The ability of an organism to alter its phenotype in response to environment is called **phenotypic plasticity**.

A. Blastogenic Variations : These are germinal variations and are hereditary in nature. They are again of two types:

(a) Continuous variations : These are the fluctuating variations and can not give rise to new species. These are further of two types

i. **Substantive :** Variation in size, shape and colour of organism.
ii. **Meristic :** Variation in number of parts e.g. number of grains in an ear of wheat.

(b) Discontinuous Variations : Also known as **mutations, sports** or **saltations.** These variation are responsible for formation of new species and organism thus formed is called **mutant**.
Types of discontinuous variations :

i. **Substantive variations :** These influence shape, colour, size etc., e.g., hairless cat, short legged ancon sheep.
ii. **Meristic variation :** These affect number of parts e.g. polydactyly in humans.

Variations are significance in evolution as they make the organism better suited to modifying environmental conditions, produce new trait in organism and provide raw material for evolution.

History :

- **Muller :** Proposed the term "**Cytogenetics**" (Cytology + Genetics)
  Father of Actinobiology.
  Actinobiology - Study the effect of radiation of living organisms.
- **Morgan :** Father of Experimental genetics. He experiment on Drosophila melanogaster & proposed various concepts
  Gene theory : According to gene theory; genes are linearly located on chromosome.
  Linkage term, Theory of sex linkage, Crossing over term, Criss - cross inheritance.

EARLY SPECULATIONS (PREMENDELIAN)

(1) Vapour Theory (2) Preformation Theory (3) Encasement Theory
(4) Theory of Epigenesis (5) Pangenesis Theory (6) Weismann Theory of Germ plasm
(7) Mendelism

(1) Vapour Theory :

- Proposed by a Greek philosopher **Pythagoras** in 500 B.C.
- Each organ of an animal body emitted some kind of vapour and that a new individual was formed by combination of the vapour from different organs.

(2) Preformation Theory (1632 – 1723) :

- Dutch scientist **'Swammerdam'** propounded the preformation theory. This theory holds that the sex cells (sperm and ova) had the **miniature copy of adults** and the development of embryo was actually only the enlargement of parts that were already present in the sperm or egg.
- This minature form of the animal present in the gamete was called **'Homunculus'**.
- This theory was supported by **Hartsoeker**.
- Those who considered homunculus to be present in sperms were called **Spermist**.
- Those who considered homunculus to be present in ova (eggs) were called **Ovist**.
- **Antony Van Leeuwenhoek** was the **first** to observe human sperms.

(3) Encasement Theory :

- **'Charles Bonnet'** and his supporters presumed that every female contains within her body minature prototypes of all the creatures which will every descend from her, one generation within the other **some what like a series of chinese bones.** (a box inside a box and so on).

(4) Theory of Epigenesis :

- **Wolff** proposed that germ cells contain definite but undifferentiated substances which, after fertilization becomes organized into various complex body organs (Differentiated) which form the **adult**.
  This idea was referred to as **epigensis**.

(5) Pangenesis Theory :

- **Charles Darwin** propounded pangenesis theory.
- According to this theory every cell, tissue and organ of animal body produces many minute particles known as **pangenes** or **gemmules**.
- These gemmules are discharged in the blood stream and are deposited in the reproductive organs. These reproductive cells contain these pangenes and a child develops as a result of blending of the pangenes from two parents.
- Thus the individual would represent the **mixture** of both of the parents.

(6) Theory of Germplasm :

- **'August Weismann' (1889)** suggested the theory of continuity of germplasm.
- They referred to the reproductive cells as germplasm and to rest of the body as somatoplasm.

- The **germplasm** forms the bridge of life and passes from one generation to the next.
- Soma is **'Mortal'** because it eventually dies and disintegrates, the germ is **"immortal"**, because it continues forever.

(7) Mendelism :

- Experiments performed by Mendel on genetics and description of mechanisms of hereditery processes and formulation of principles are known as Mendelism.
- **Gregor Johann Mendel (1822 – 1884)** : Mendel was born on july 22, 1822 at Heinzendorf in Austria a Silesia village. Mendel worked in Augustinian Monastery as monk at Brunn city, **Austria.**
- In 1856-57, he started his historical experiments of heredity on pea (pisum sativum) plant. His experimental work continued on pea plant till 1865 (19th century).
- The results of his experiments were published in the science journal, **"Nature For schender varien"** in 1866.
- This journal was in Germen language. Title was **"verschue uber Pflangen Hybridan"**.
- This journal was published by **'Natural History society of Bruno'.**
- A paper of Mendel by the name of ''Experiment in plant Hybridization'' published in this journal. Mendel was unable to get any popularity. No one understood of him. He died in 1884 without getting any credit of his work due to kidney disease (Bright disease).
- After 16 years of Mendel's death in 1900, Mendel's postulates were rediscovered. Rediscovery by three scientists independently.
- **Carl Correns** : Germany (Experiment on Maize).
- **Hugo deVries** (Holland) (Experiment on Evening Primerose).
  He republished the Mendel's results in 1901 in **Flora** magazine.
- **Erich von Tschermak Seysenegg** - (Austria) (Experiment on different flowering plants).
  The credit of rediscovery of Mendelism goes to three scientists.
  Correns given two laws of Mendelism
  Law of heredity / Inheritance / Mendel

✸ **Mendel Results Remain Hidden due to :**

- At that time Darwin's book ''Origin of Species'' published. Scientists were busy in discussion with this book.
- Medel's ideas were ahead of that time.
- Mendel used higher statistical calculation in his experiments so the results were complicated to understand.
- Mendel also performed his experiments on Hawkeweed (hieracium) and beans (Lablab) plant on suggestion of Karl Nageli but mendel did not get succeed in Heriacium, Parthenogenesis is present in it.

✸ **Reasons for Mendel's success :**

- Mendel studied the inheretance of one or two characters at a time unlike his predecessors who had considered many characters at a time (Kolreuter-Tobacco plant, John Goss & Knight-Pea plant).
- Selection of Material (Pea plant - Pisum sativum)
- Selection of garden pea plant is suitable for studies. Which have following advantage.
- Pea plant is annual plant with short life cycle of 2-3 months so large number of offsprings can be analysed within a short period of time.
- It has many contrasting traits.
- Natural self pollination is present in pea plant so purity of character is maintained in it.
- Cross pollination can be performed in it artificially so hybridization can be made possible.
- Pea plant easy to cultivate.
- Pea seeds are large. In addition to pea, Mendel worked on rajama.

- Mendel quantitatively analyse the inheritance of qualitative characters.
- He maintained the statistical records of all the experiments.

✸ **Mendel's work** : Mendel studied 7 characters or 7 pairs of contrasting traits.

Actual data obtained by Mendel in F_2 progenies in garden pea				
S.No.	**Character (Chromosomal position)**	**Dominant**	**Recessive**	**Ratio**
1	Length of plant (4)	787 (tall)	277 (dwarf)	2.84:1
2	Colour of flower (1)	705 (violet)	224 (white)	3.15:1
3	Pod or flower position (4)	651 (axial)	207 (terminal)	3.14:1
4	Shape of pod (4)	882 (inflated)	299 (constricted)	2.94:1
5	Colour of pod (5)	428 (green)	152 (yellow)	2.82:1
6	Shape of seed (7)	5,474 (round)	1850 (wrinkled)	2.96:1
7	Colour of cotyledon (1)	6,022 (yellow)	2,001 (green)	3.01:1
Average of all traits studied				2.98:(=3:1)

✸ **Technique of Mendel**

He developed a technique **Emasculation and Bagging** for hybridization in plants.

Flowers of pea plant are bisexual. In this method one considered as male and another as female.

The plant used as female, stamens of this plant are removed at juvenile stage, this is called Emasculation.

Emasculation is done to prevent self pollination.

Emasculated flowers covered by bags, this is called bagging.

Bagging is only used to prevent undersirable cross pollination.

Mature pollen grains are collected from male plants and spread over emasculated flower.

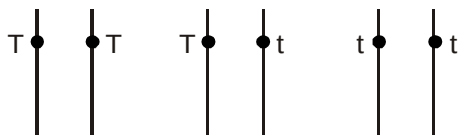
Seeds are formed in the female flower after pollination.

The plants that are obtained from these seeds are called First Filial generation or F_1 generation according to mendel.

Mendel was great plant breader (true breader)

SOME DEFINED TERMS

1. **Factors :** Unit of heredity which is responsible for inheritance and appearance of characters. These factors were referred as genes by **Johannsen** (1909). Mendel used term "**element**" for factor.
2. **Morgan** first use symbol to represent the factor. Dominant factor are represented by capital letter while recessive factor by small letter
3. **Allele :** Alternative forms of a gene which are located on same position [locus] on the homologous chromosome is called Allele. Term allele was coined by **Bateson.**

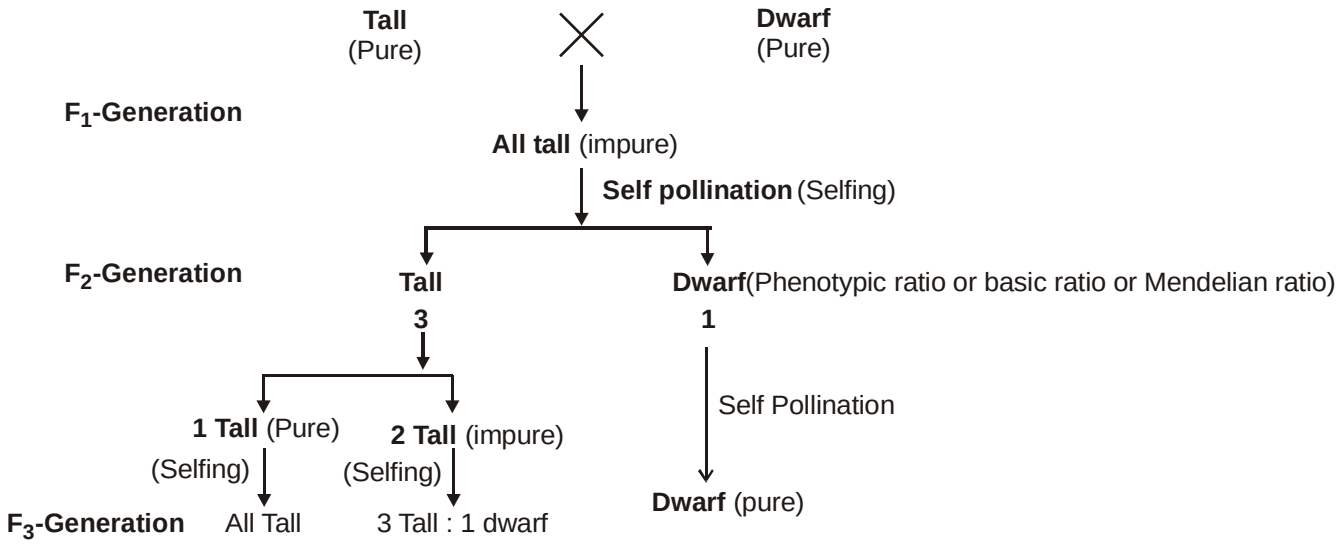


4. **Homozygous** : A zygote is formed by fusion of two gametes having identicle factors is called homozygote and organism developed from this zygote is called homozygous. Ex. TT, RR, tt
5. **Heterozygous :** A zygote is formed by fusion of two different types of gamete carrying different factors is called Heterozygous (Tt) (Rr) and individual developed from such zygote is called hetrozygous. The term homozygous and heterozygous are coined by **Bateson.**

6. **Hemizygous :** If individual contains only one gene of a pair then individual said to be hemizygous. Male individual is always hemizygous for sex linked gene.
7. **Phenotype :** It is the external and morphological appearance of an organism for a particular character.
8. **Genotype :** The genetic constitution or genetic make-up of an organism for a particular character. Genotype & phenotype terms were coined by **Johannsen.**
9. **Phenocopy :** If different genotypes are placed in different environmental conditions if they produce same phenotype. These individual are said to be Phenocopy of each other.

MONOHYBRID CROSS

When we consider the inheritance of one character at a time by a cross is called monohybrid cross. First of all, Mendel selected tall and dwarf plants



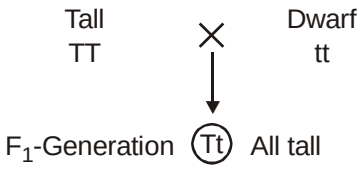
Conclusions (results) of Monohybrid Cross

- **Ist Conclusion :**

  According to Mendel each genetic character is controlled by a pair of unit factor. It is known as conclusion of paired factor or unit factor.

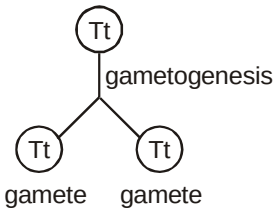
- **IInd Conclusion :**

  This conclusion is based on F_1 - generation. When two different unit factors are present in single individual, then only one unit factor is able to express itself and known as dominant unit factor. Another unit factor fails to express is the recessive factor. In the presence of dominant unit factor recessive unit factor can not express and it is known as conclusion of dominance.



- **IIIrd Conclusion :**

  During gamete formation; the unit factors of a pair segregate randomly and transfer inside different gamete. Each gamete receives only one factor of a pair; so gametes are pure for a particular trait. It is known as conclusion of purity of gametes or segregation.



DIHYBRID CROSS

A cross in which study of inheritance of two pairs of contrasting traits or two characters.

Mendel wanted to observe the effect of one character on another character.

Mendel selected traits for dihybrid cross for his experiment as follows :

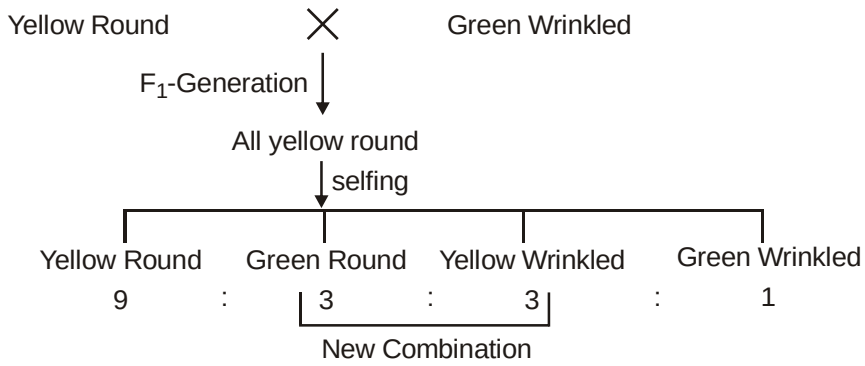
Colour of cotyledons → Yellow (Y) & Green (y)

Seed form → Round (R) and Wrinkled (r)

Yellow and round characters are dominant and green and wrinkled are recesive characters. Mendel crossed yellow and round seeded plants with green and wrinkled seeded plants. All the plants in F_1-generation had yellow and round seeds.

All the plants in F_1-generation had yellow and round seeds.

When F_1 plants were self pollinated to produce four kinds of plants in F_2 generation such as yellow round, yellow-wrinkled, green round and green wrinkled, there were in the ratio of 9 : 3 : 3 : 1. This ratio is known as Dihybrid ratio.



Expression of yellow round (9) and green wrinkled (1) traits shows as their parental combination. Green round and yellow wrinkled type of plants are produced by the results of new combination (Recombinant).

- **Conclusion :**

The F_2 generation plant produce two new phenotypes, so inheritance of seed coat colour is independent from the inheritance of shape of seed. Otherwise It can not possible to obtain yellow wrinkled and green round type of seeds.

This observation leads to the Mendel's conclusion that different type of characters present in plants assorted independently during inheritace.

This is known as **Conclusion of Independent Assortment**. It is based on F_2 - generation of dihybrid cross. The nonhomologous chromosome show random distribution during anaphasei-I of meiosis.

- **Explaination :**

A pure yellow and round seeded plant crossed with green and wrinkled seeded plant which are having genotype YYRR and yyrr to produced F_1 generation having YyRr genotype.

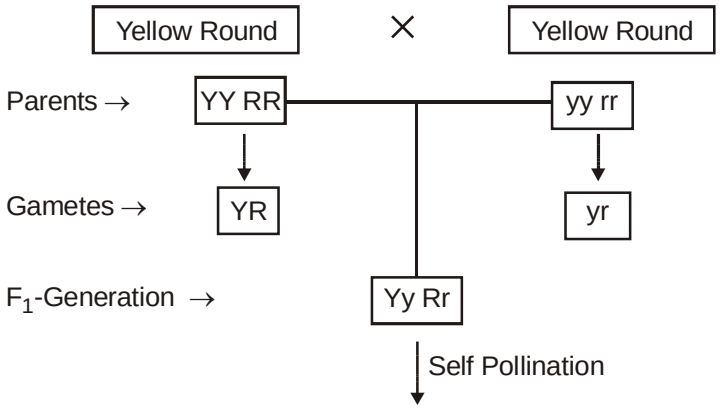
Both the characters recombine independently from each other during gamete formation in F_1 generation. Factor (R) of pair factor (r) is having equal change to (Y) factor or (y) factor of gametes during recombination to form two type of gametes (YR) and (yr).

Similarly (r) factor also having equal change with (Y) factor or (y) factor of gametes to form a two type gamets (Yr) and (yr).

Thus, total four types of gametes - (YR), (yr), (yR), (yr) are formed.

Therefore during the gametes formation in F_1 generation new combination or recombination appear in F_2.

✸ **Demonstration by checker board method**



F_2 - Generation ➡

	YR	**Yr**	**yR**	**yr**
YR	YYRR	YYRr	YyRR	YyRr
Yr	YYRr	YYrr	YyRr	Yyrr
yR	YyRR	YyRr	yyRR	yyRr
yr	YyRr	Yyrr	yyRr	yyrr

Yellow Round = 9 / 16 Green Round = 3 / 16

Yellow Wrinkled = 3 / 16 Green Wrinkled = 1 / 16

Phenotypic Ratio = 9 : 3 : 3 : 1

Phenotype		**Genotype**		
Homozygous yellow & Homozygous Round	—	YY RR	=	1
Homozygous yellow & Heterozygous Round	—	YY Rr	=	2
Heterozygous yellow & Homozygous Round	—	Yy RR	=	2
Heterozygous yellow & Heterozygous Round	—	Yy Rr	=	4
Homozygous yellow & Homozygous wrinkled	—	YY rr	=	1
Heterozygous yellow & Homozygous wrinkled	—	Yy rr	=	2
Homozygous green & Homozygous Round	—	yy RR	=	1
Homozygous green & Heterozygous Round	—	yy Rr	=	2
Homozygous green & Homozygous wrinkled	—	yy rr	=	1
F_2 Genotypic Ratio = 1:2:2:4:1:2:1:2:1	—			

Number of traits hybrid (n)	**Experiment**	**Types of gametes (2^n)**	**Number of Zygotes / offsprings (gametes)^2**	**Number of Phenotype (2^n)**	**Number of genotype (3^n)**	**Phenotypic Ratio**	**Genotypic Ratio**
1	Monohybrid cross (Aa × Aa)	$2^n = 2^1 = 2$	$2^2 = 4$	$2^n = 2^1 = 2$	$3^1 = 3$	3 : 1	1 : 2 : 1
2	Dihybrid cross (AaBb × AaBb)	$2^2 = 4$	$4^2 = 16$	$2^2 = 4$	$3^2 = 9$	$(3 : 1)^2$ = 9 : 3 : 3 : 1	$(1 : 2 : 1)^2$ = 2 : 4 : 2 : 1 : 2 : 1 : 1 : 2 : 1
3	Trihybrid cross AaBbCc × AaBbCc	$2^3 = 8$	$8^2 = 64$	$2^3 = 8$	$3^3 = 27$	$(3 : 1)^n$	$(1 : 2 : 1)^3$

- **Back Cross :**

  A back cross is a cross in which F_1 individuals are crossed with any of their parents.

  When F_1 individual is crossed with dominant parent then it is termed **out cross.** The generation obtained from this cross, all possess dominant character.

- **Test Cross :** When F_1 progency is crossed with recessive parent then it is called test cross. The total generations obtained from this cross, 50% having dominant character and 50% having recessive character. [Monoybrid test cross]. Test cross helps to find out the genotype of dominant individual. Whether it is homozyous or heterozyous for that character

- **Monhybrid Test Cross :** The progeny obtained, from the monohybrid test cross are in equal proportion, means 50% is dominant phenotypes and 50% is recessive phenotypes. It can be represented in symbolic forms as follows.

F_1 progeny(hybrid) T t × F recessive parent t t

	t
T	Tt
t	tt

Monohybrid test cross ratio = 1 : 1

Dilhybrid Test Cross : The progency is obtained from dihybrid test cross are four types and each of them is 25%

F_1 - dihybrid [T t R r] × recessive parent [t t r r]

	RT	Tr	Tr	Tr
tr	TtRr	Ttrr	ttRr	Ttrr

Phenotype or Genotype ratio of Dihybrid test cross = 1:1:1:1

- **Conclusion :** In test cross phenotypes and genotypes ratio are same.
- **Trihybrid test** cross (phenotype, genotype) ratio = 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1
- **Reciprocal Cross :**

  When two parents are used in two experiments in such a way that in one experiment ''A'' is used as the female parent and ''B'' is used as the male parent, in the other experiment ''A'' will be used as the male parent and ''B'' as the female parent. Such type of a set of two experiments is called Reciprocal cross. Characters which are controlled by karyogene are not affected by Reciprocal cross. In case of cytoplasmic inheritance result become change by Reciprocal cross.

(a) TT (Female) × tt (Male) → All Tall

(b) TT (Male) × tt (Female) → All Tall

CYTOPLASMIC INHERITANCE (Correns)

Inheritance of characters which are contorlled by cytogene or cytoplasm is called cytoplosmic inheritance. Genes which are present in cytoplasm called **'Cytogene'** or **'Plasmagene'** or **extra nuclear gene.** Total cytogene present in cytoplasm is called '**Plasmon**'.

A gene which is located in the nucleus is called '**karyogene**'.

- Inheritance of cytogene in higher plants only through the female.
- The male gamete of higher plant is called male nucleus. It has very minute [equivelent to nil] cytoplasm.So male gamete only inherited karyogene.
- Thus, inheritance of cytogene only through female cytoplasm. (also called maternal inheritance)
- If there is a reciprocal cross in this condition, then result will be effected.

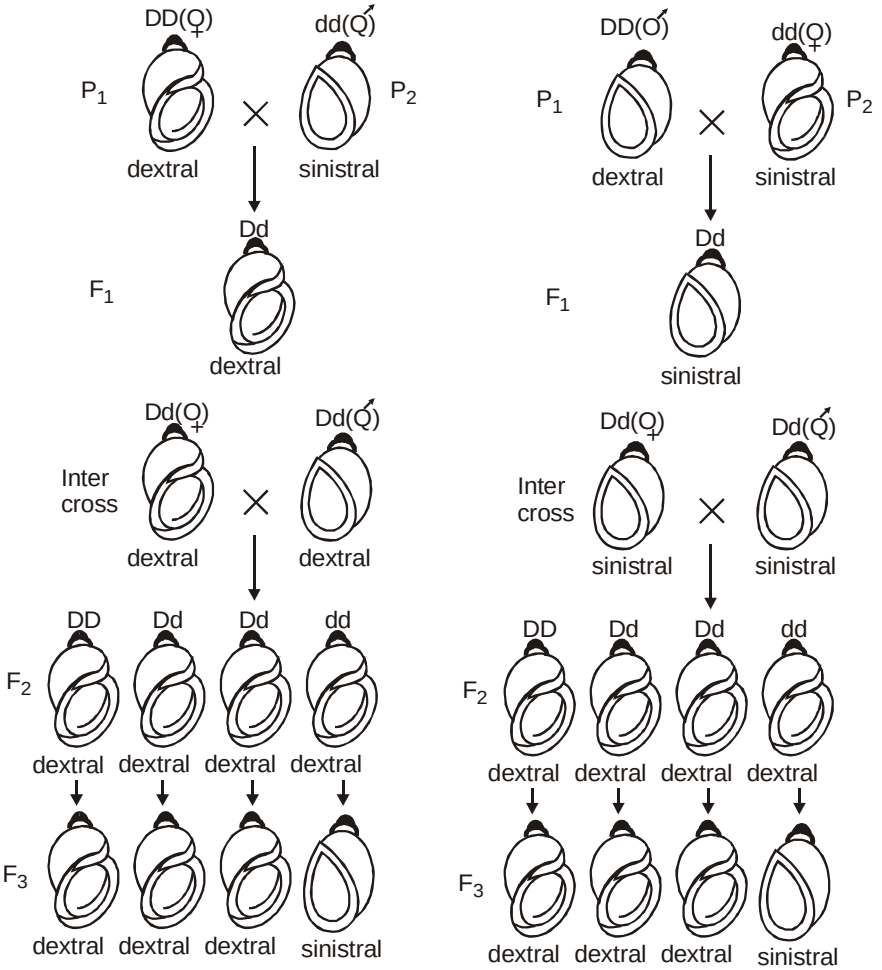
✸ **Cytoplasmic inheretance of three types :**

- Maternal effect depending indirectly on nuclear genes and involving no known cytoplasmic cytoplasmic hereditary unit called as **predetermination.** maternal effect is determine before fertilization.
- Cytoplasmic inheritance involving dispensable and infective heredetary particle in cytoplasm which may or may not depend on nuclear genes called as **Dauermodification.**
- Cytoplasmic inheritance involving essential organelles like, Chloroplast and mitochondria called as **organellar genetics.**

Example of predetermination :

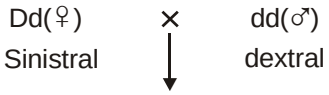
Shell coiling in snail (Limnaea peregra)

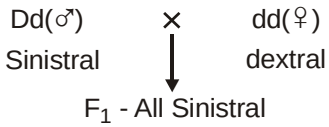
In Shell coiling of snail can be dextral (Coiling to the right) or sinistral (coiling to the left). This direction of coiling is genetically the dextral coiling depending upon maternal dominant allele D and sinistral coiling depending upon maternal recessive allele (d).



Above reciprocal cross indicates that phenotype of offspring is decided by genotype of female parent not the phenotype of female parent. If female parent contains only one dominant gene 'D' then phenotype of all offspring will be dextral.

Example :



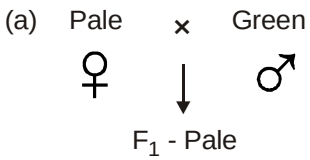


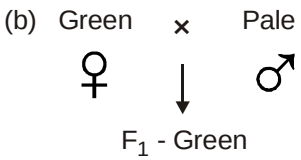
- **Example of Dauermodification -**
- **Sigma particle in Drosophila** these particle are virus like particles which are present in Drosophila and related to CO_2 sensitivity. Inheritance of sigma particle takes place through the egg cytoplasm.
- **Kaapa particle in Paramecium** kappa particles are found in certain ''Killer strains'' of Paramecium and are responsible for production of substance paramecin which is toxic to strain not prossessing Kappa. (Sensitive Strain)

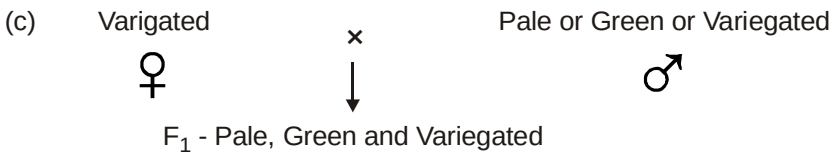
  The minimum number of kappa particlesis 400 to secrete paramecin. Kappa particles are symbiotic bacteria named **"Caedobacter taeniospiralis"**
- **Example of Organellar Genetics :** (True examles of cytoplasmic inheritance)
- **Plastid inheritance in Mirabilis jalapa –** cytoplasmic inheritance first discovered by **Correns** in Mirabilis jalapa.

  In Mirabilis jalapa plastid inheritance i.e. branch colour is example of cytoplasmic inheritance.

Branch colour







- **Male strelity in maize plant –** Gene of male sterelity present in mitochondria. If a normal male plant crossed with a female plant which has genes of male sterelity then all the generation become male sterile because a particular gene was present in female which inherited by female.
- **Albinism in plant :** Gene of albinism is found in chloroplast. Gene of albinism is leathal in plant.
- **Inheritance of Bacterial plasmid.** In bacteria plasmid inheritance is due to conjugation.
- **Petite form in yeast** = (mitochondrial gene) petite is mutant form of yeast. This mutant form is slow growing on culture medium.
- **Iojap inheritance in Maize** Iojap is characterized by contrasting strip of green and white colour of leaves.
- **Poky Neurospora** - (Mitochondrial gene) poky is mutant form of Neurospora. It is slow growing on culture medium.
- **Exceptions of conclusions of Mendel :**
- **Exception of Dominance :** There are two exceptions of law of dominance.

  (A) Incomplete dominance; (B) Co-dominance,

A. Incomplete Dominance : According to Mendel's law of dominance. Dominant character must be present in F_1 generation. But in some organisms, F_1 generation is **different** from the both parents.

Both factors such as dominant and recessive are present in incomplete dominance but dominant factors are unable to express their character completely, resulting different type of generation is formed which is different from the both parents.

Incomplete dominance was first discovered by **Correns** in Mirabilis jalapa. This plant is also called as **'4 O' clock plant** 'or' **Gul-e-Bans'**.

- Three different types of plant are found in Mirabilis on the basis of flower colour, such as red, white and pink. When plants with red flowers is crossed with white flower plants, pink flower obtained in F_1 generation the reason of this is that the genes of red colour incompletely dominant over the genes of white colour.

When F_1 generation of pink flower is self pollinated then the phenotypic ratio of F_2 generation is red, pink, white = 1 : 2 : 1 in placed of normal monohybrid cross - 3 : 1

The ratio of phenotype and gentype of F_2 generation in incomplete dominance is always same.

Red × White

R R ↓ r r

F_1 geheration R r (Pink) →

↓ Self pollination

F_2 – Generation

	R	r
R	RR	Rr
r	Rr	rr

RR = Red - 1

Rr = Pink - 2

rr = White - 1

- **Antirrhinum majus -** Incomplete dominance is also seen in this plant. This plant is also known as **'Snapdragon'** or **'Dog flower'**. Incomplete dominance is found in this plant which is the same as Mirabilis flower colour.
- **Andalusian Fowls -** Incomplete dominance is present for their feather colour. When a black colour fowl is crossed with a white colour fowl, the colour of F_1 generation is blue.

✸ **CO-DOMINANCE :** In this phenomenon, both the gene expressed for a particular character in F_1 hybrid progeny.

Examples : Co-dominance is seen in animals for coat colour.

When a black parent is crossed with white parent, a roan colour F_1 progeny is produced.

When we obtain F_2 generation from the F_1 generation, the ratio of black; black white (Roan);white of animals is 1 : 2 : 1.

Note : F_2 generation is obtained in animals by sib-mating cross.

BLACK × WHITE

R_1R_1 ↓ R_2R_2

F_1 generation R_1R_2 (Roan)

↓ Sib-mating cross

	R_1	R_2
R_1	R_1R_1	R_1R_2
R_2	R_1R_2	R_2R_2

R_1R_1 = Black 1 R_1R_2 = Roan - 2 R_2R_2 = White - 1

It is obvious by above analysis that the ratio of phenotype as well as genotype is 1 : 2 : 1 in co-dominance.

Sp. Note : In incomplete dominance, characters are blended phenotypically, while in co-dominace, both the ganes of a pair exhibit both the characters and effect of both the character is independent from each other.

Other Example of Co-dominance :

- AB blood group ibheritance (I^AI^B)
- Carrier of Sickle cell anaemia (Hb^ Hb^S)

✸ **Conclusion of Segregation :** There is no exception of law of segregation. The segeragation is essential during the meiotic division in all sexually reproducing organisms. (Nondisiunction may be exception of the law).

✸ **Exception of conclusion of independent assortment**

The law of independent assortment is most criticised. Linkage is the exception of this law.

LINKAGE :

Collective inheritance of character is called linkage first time seen by **Bateson and Punnett** in ***Lathyrus odratus*** and gave **coupling and repulsion phenomenon.** But they did not explain the phenomenon of linkage. Sex linkage was first discovered by **Morgan** in Drosophila & coined the term linkage. He proposed the theory of linkage.

In 1906, **Bateson and Punnet** crossed two varieties of Lathyrus odoratus (sweet pea) and observed that the results do not agree with the mendel's law of independent assortment. They formulated the hypothesis of **coupling and repulsion** to explain the unexpected F_2 results of dihybrid cross between a homozygous sweet pea having dominant alleles for blue flowers (BB) and long grains (LL) with another homozygous double recessive plant with red flowers and round pollen grains (bbll).

Test Cross Ratio of F_1 7 : 1 : 1 : 1 indicated that there was a tendency of the dominant alleles to remain together. Similar was the case with recessive alleles.

Parents	Blue flower & long pollen	×	Red flower & round pollen
	BBLL		bbll
Gametes	BL	×	bl
		↓	
F_1		BbLl	
		Blue flower & Long pollen	
Test cross		BbLl × bbll	

Test cross Progeny

7/16 :	1/16 :	1/16 :	7/16
Blue flower & long pollen (BbLl)	Blue flower & round pollen (Bbll)	Red flower & long pollen (bbLl)	Red flower & round pollen (bbll)

It was called **gametic coupling** by bateson and Punnet. The tendency of two dominant genes to remain together in the process of inheritance was called as **coupling.**

In another cross they took a sweet pea plant with blue flowers and round pollens (BBll) and other plant with red flowers and long pollens (bbLL) and obtained the **ratio of 1 : 7 : 7 : 1** by test crossing F_1 generation.

Parents	Blue flower & round pollen	×	Red flower & long pollen	
	BBll	↓	bbLL	
Gametes	Bl		bL	
F_1	BbLl			
	Blue flower & long pollen			
Test cross	BbLl	×	bbll	
	Blue flower & long pollen	↓	Red flower & round pollen	

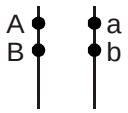
1/16	7/16	7/16	1/16
Blue flower & long pollen (BbLl)	Blue flower & round pollen (Bbll)	Red flower long pollen (bbLl)	Red flower & round pollen (bbll)

When two dominant or recessive genes comes from different parents, they tend to remain separate hence, this ratio is called repulsion ratio. **T.H. Morgan** in 1910 showed that coupling and repulsion are two aspects of the same phenomenon called linkage. He suggested that the two genes present on the same chromosome, are in **coupling phase** and when present on two different homologous chromosomes are in **repulsion phase**. Linkage therefore, may be defined as ''**The tendency of two genes of the same chromosome to remain together in the process of inheritance"**.

According to Morgan, the degree or the strength of linkage depends upon the distance between the linked genes in the chromosome.

Linkage and independent assortment can be represented in dihybrid plant

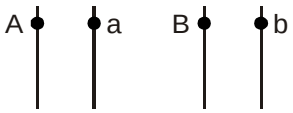
In case of linkage in dihybrid (AaBb)



It produces two types of gamete

AB : ab

In case of independent assortment in dihybrid (AaBb)



It produces four types of gamete

AB : ab : aB : Ab

✵ **Theory of linkage :**

Linkage genes are linearly located on same chromosome. They get separated if exchange (crossing over), takes place between them.

Strength of linkage α 1 / distance between the genes. It means, if the distance between two genes is increased then strength of linkage is reduced and it proves that greater is the distance between genes, the greater the probability of their crossing over.

Crossing over obviously disturbs or degenerates linkage. Linked genes can be separated by crossing over.

Factors effecting crossing over (C.O.) & Linkage

- Distance ↑ = C.O. ↑ Linkage ↓
- Temperature ↑ = C.O. ↑ Linkage ↓
- X-Ray ↑ = C.O. ↑ Linkage ↓
- Age ↑ = C.O. ↓ Linkage ↑
- Sex- Male C.O. ↓ (Crossing over totally absent in male Drosophila) Linkage ♂ > ♀

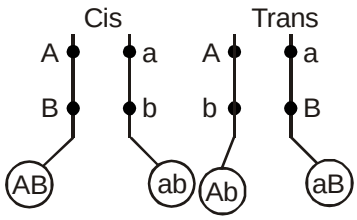
✸ **Arrangement of linked Genes on Chromosomes :**

The arrangement of linked genes in any dihybrid plant is two types.

A. Cis - Arrangement : When, two dominant genes located on one chromosome and both recessive genes located on another chromosome. Such type of arrangement is termed as cis-arrangement. Cis-arrangement is an original arrangement.

Two type of gomets can be produced in this arrangement → (AB) and (ab)

B. Trans arrangement : When a chromosome bears one dominant and one recessive gene, and another chromosome also possess one dominant and one recessive gene, such type of arrangement is called trans-arrangement. Trans arrangement is not an original form. It is due to crossing over. Two types of gamete also formed in trans-arrangement but it is different from cis-arrangement (Ab) and (aB).



✸ **Types of Linkage :**

There are two types of linkage

A. COMPLETE LINKAGE : Linkage in which genes always show parental combination. It never forms new combination.

Crossing over is absent in it. Such genes are located very close on the chromosomes. Such type of linkage very rare in nature e.g., male Drosophila, female silk moth.

B. INCOMPLETE LINKAGE : When new combinations also appear along with parental combination in offsprings, this type of linkage is called incomplete linkage, the new combinations form due to crossing over. The percentage of new combination is equal to the percentage of crossing over. (<50%)

Example : In maize incomplete linkage was observed by **Hutchinson.** w.r.t seed coat colour and seed shape.

The results show that parental combination of alleles (CS/CS and cs/cs) appear in about 96% cases. The other two are new combinations (Cs/cs and cS/cs) apear in about 4% cases. Thus in about 4% cases crossing over has occured between linked genes.

Parents	Coloured & full	×		Colourless & shrunken
	CS / CS			cs / cs
Gametes	CS	×		cs
		↓		
F_1		CS / cs		
		Coloured & full		
Test cross		Cs/cs	×	cs / cs
Gametes	cs			
Result :	CS	CS/cs	–	Coloured & full 48.2%
	cs	Cs/cs	–	Coloured & shrunken 1.8%
	cS	cS/cs	–	Colourless & full 1.8%
	cs	cs/cs	–	Colourless & shruken 48.2%

Incomplete Linkage

Another example was demonstrated by Morgan, while working with Drosphila. (i) Crossing of yellow bodied (Y) and white eyed (W) female with brown bodied (Y^+) red eyed (W^+) male produced F_1 to be brown bodied red eyed. In F_2 generation, obtained by selfing of F_1 hybrids, the ratio deviated significantly from expected. He found 98.7% to be parental and 1.3% as recombinants. (ii) In a second cross between white eyed and miniature winged female (wwmm) wild red eyed normal winged male ($W^+W^+M^+M^+$) all hybrids were found to be wild type. Test cross progency of this hybrid was found to be 62.8% parental and 37.2% recombinant.

Linkag group : All the genes which which are loacated on one pair of homologous chromosome form one linkage group. Genes which are located on homologous chromosomes are allelic so we consider one linkage group.

Linkage group – haploid no. of homologous chromosomes.

	2n	**n**	**Pair**	**Linkage group**
Human	46	23	23	23
Mouse	42	21	21	21
Frog	26	13	13	13
Maize	20	10	10	10
Pea	14	7	7	7
Drosophila	8	4	4	4
Neurospora	7	7	7	7
Bacteria / B.G.A.	–	–	–	1

Application of Linkage :

Distance can be identified by the incomplete linakage. It's unit is centi Morgan (cM).

$$\text{Strength of linkage} \propto \frac{1}{\text{Distance b/w linked gene}} \propto \frac{1}{\text{Crossing Over}}$$

Genetic map / Linkage map / chromosome map – In genetic map different linked genes are linearly arranged or chromosome according to percentage of crossing over ($\propto$ Distance) between them.

With the help of genetic map we can find out the position of a particular gene on chromosome. Genetic map is helpful in the study of genome.

- **Sex Linkage**

When the genes of vegetative / somatic characters are present on sex-chromosome is termed as sex linked gene and such phenomenon is known as sex-linkage. Two - types of sex linkage :

- **X-linkage :** Genes of sometic characters are found on x-chromosome. the inheritance of x-linked character may be through the males and females.

  e.g., Haemophilia, Colour blindness

- **Y-linkage :** The genes of somatic characters are located on Y-chromosome. The inheritance of such type of character only through the males, such type of character is called Holandric character these characters only found in male.

  e.g. Gene which forms TDF

  Hypertrichosis (excessive hair on ear pinna.)

Gene which is located on differential region of Y - chromosome is known as Holandric gene.

Example of X- linkage :

- **Eye colour in Drosophila :** Eye colour in Drosophila is controlled by a X-linked gene. If a red eyed colour gene is represented as '+' and white eyed colour represented as 'w', then on basis of this different type of genotypes are found in Drosophila.
  Gene for red eye domainant (+) and white colour of eye is recessive (w)
  Homozygous red eyed female = X^+X^+
  Heterozygous red eyed female = X^+X^w
  Homozygous white eyed female = X^wX^w
  Hemizygous red eyed male = $X^+ Y$
  Hemizygous white eyed male = X^wY
  It is clear by above different types of genotype that female either homozygous or heterozygous for eye colour. But, for the male eye colour, it is always hemizygous.
- **Haemophilia :** Haemophilia is also called "**bleeder's disease"** and first discovered by **John Otto** (1803). The gene of haemophilia is recessive and x-linked lethal gene.
  On the basis of x-linked, following types of genotype are found.
  X^hX = Carrier female
  X^hX^h = Affected female
  X^hY = Affected male
  But X^hX^h type of female dies during embryo stage because in homozygous condition, this gene is lethal and causes death.
- Haemophilia - A $\rightarrow$ due to lack of factor - VIII (Antihaemophilic globulin AHG)
- Haemophilia B or Christmas disease - due to lack of factor - IX (plasma thromboplastin component)
  Haemophila -C - due to lack of factor XI (plasma thromboplastin anticedent)
  Colour Blindness : The inheritance of colour blindness is like as haemophilia, but it is not a lethal disease so it is found in both male and female (discoverd by **Horner**)
  Three types of colour blindness are :
- **Protanopia** : It is for **red** colour.
- **Deuteranopia :** It is for **green** colour
- **Tritanopia : Blue** colour blindness. Colour blindness is cheked by **Ishihara - chart**.
- **Other examples of X - linkage**
  - Diabetes insipidus (recessive).
  - Duchenne muscular dystrophy (recessive)
  - Fragile x syndrome (recessive).
  - Pesudoricketes (Dominant)
  - Defective enamel of teeth (Dominant)

Types of Inheritance of sex linked characters :

- **Criss Cross inheritance (Morgan) :** In criss-cross inheritance male or famale parent transfer a X-linked character to grandson or grand daughter through the offspring of opposite sex.
- **Diagenic :** Inheritance in which characters are inherited from father to the daughter and from daughter to grandson.
  Father $\rightarrow$ Daughter $\rightarrow$ Grand Son
- **Diandric :** Inheritance in which characters are inherited from mother to the son and from son to grand daughter. Mother $\rightarrow$ Son $\rightarrow$ Grand Daughter
- **Non criss-cross inheritance :** In this inheritance male or female parent transfer sex linked character to grand son or grand daughter through the offspring of same sex.

- **Hologenic :** Mother → Daughter → Grand-daughter (female to female)
- **Holandric :** Father → Son → Grand-son (male to male)

✸ **Sex-Limited Character :** These characters are expressed in one sex and unexpressed in another sex. But their genes are present on autosome of both the sexes and their expression is depend on sex hormone.
Example : Secondary sexual characters → these genes located on the autosomes and these genes are present in both male and female, but effect of these are depend upon presence or absence of sex-hormones. For example - genes of beard & moustache express their effects only in the presence of male hormone - testosterone.

✸ **Sex Influenced Characters :** Genes of these characters are also present on autosomes but they are influenced differently in male and female. In heterozygous condition their effect is different in both the sexes. Example : Baldness : Gene of baldness is dominant (B).

Genotype	Male (♂)	Female (♀)
BB	Baldness present	Baldness present
bb	Baldness absent	Baldness absent
Bb	Baldness present	Baldness absent

Gene Bb shows partiality in male and female, Baldness is found in male, but baldness is absent in female with this genotype.

MULTIPLE ALLELE

More than 2 alternative forms of a gene is called multiple allele.
Multiple allele is formed due to mutation.
Multiple allel located on same locus of homologous chromosome.
A diploid individual contains two allele and gamete contains one allele for a character.
Ex. Blood group - 3 alleles
Coat colour in rabit - 4 allels

If n is the number of allele of a gene then number of different possible genotype = $\frac{n(n+1)}{2}$

Example of multiple allele :

✸ **ABO blood group –** ABO blood groups are determined by allele I^{λ}. allele I^B, allele I^0
I^A = dominant
I^B = dominant
I^O = recessive
Possible phenotypes - A, B, AB, O

Blood Group	Genotype	Antigen or agglutinuogen	Antibody or agglutinin
A	I^AI^A, I^AI^O	A	b
B	I^BI^B, I^BI^O	B	a
AB	$I^\wedge I^B$	A & B	None
O	I^OI^O	none	a & b

Possible genotype number = $\frac{3(3+1)}{2}$ = 6 genotype

- **Coat Colour in rabbit :** Four allels for colour in rabbit

Wild type = Full coloured = agouti = C^+

Himalayan [white with black tip on extremities (like nose, tail and feet)] = c^h

Chinchilla [mixed coloured and white hairs] = c^{ch}

albino = olourless = c^a

These allels show order of dominance $C^+ > c^{ch} > c^h > c^a$

Possible genotypes –

Coloured = C^+C^+, C^+c^{ch}, C^+c^h C^+c^a

Chinchilla = $c^{ch}c^{ch}$, $c^{ch}c^h$, $c^{ch}c^a$

Himalayan = c^hc^h, c^hc^a

Albino = c^ac^a

Possible genotype = $\frac{4(4+1)}{2}$ = 10 genotypes

Eye colour in Drosophila and self incompatibility genes in plants are also the example of multiple allelism.

LETHAL GENE

Gene which causes death of individual in early stage when it comes in homozygous condition called lethal gene. Lethal gane may be dominant or recessive both.

Many of these genes which do not cause definite lethelity are called semilethals.

In semilethal gene death occurs in late stage.

- Lethal gene was discovered by **L.Cuenot** in coat colour of mice, Yellow body colour (Y) was dominant over brown colour (y).

Gene of yellow body colour is lethal.

So homozygous yellow mice are never obtained in population. It dies in embryonal stage.

When yellow mice were crossed among themselves segregation for yellow and brown body colour is obtained in2 : 1 ratio.

Yy × Yy

	Y	y
Y	YY (Death)	Yy
y	Yy	yy

YY - death in embryonal stage so modified ratio = 2 : 1

In plant lethal gene was first discovered by **E.Baur** in Snapdragon (Antirrhinum majus)

Snapdragon → Golden leaves (G)

Snapdragon → Green leaves (g)

Golden (Gg) × Golden (Gg)

	G	g
G	GG (Death)	Gg
g	Gg	gg

Modified Ratio : 2 : 1

Homozygous golden leaves are never obtained.

Sickle cell anaemia in human. In human, gene of sickle cell anaemia Hb^S is the example of sub lethal gene. When two carrier individual of sickle cell anaemia are crossed then offsprings are obtianed.

$Hb^SHb^A \times Hb^SHb^A$

	Hb^S	Hb^A
Hb^S	Hb^SHb^S (Death)	Hb^SHb^A
Hb^A	Hb^SHb^A	Hb^AHb^A

Modified ratio 2 : 1

PLEIOTROPIC GENE

Gene which controls more than one character is called pleiotropic gene.

This gene shows multiple phenotypic effect.

For example :

In Pea plant : Single gene influences → Seed coal colour, Red spot on leaf, Flower colour

In Drosophila recessive gene of vestigial wings also influence the some another characters

- Structure of reproductive organs
- Longevity (Length of Body)
- Bristles on wings.
- Reduction in egg production.

Example of pleiotropic gene in human.

- **Sickle cell anaemia-** Gene Hb^s provide a classical example of pleiotrophy. It not only causes haemolytic anaemia but also results increased resistance to one type of malaria that caused by the parasite *Plasmodium falciparum*.

The sickle cell Hb^S allele also has pleiotropic effect on the development of many tissue and organs such as bone, lungs, kidney, spleen, heart.

G **Cystic fibrosis -** Hereditary metabolic disorder that is controlled by a single autosomal recessive gene. The gene specifies an enzyme that produces a unique glycoprotein.

This glycopotien results in the production of mucous.

More mucous interfere with normal functioning of several exocrine glands including those in the skin, lungs liver and pancreas.

POLYGENIC INHERITANCE :

Inheritance of characters in which one character is controlled by many genes and intensity of character depends upon the number of dominant allele or gene.

Polygenic inheritance first described by **Nilsson - Ehle** in kernal colour of wheat.

Nilsson - Ehle said explain kernal colour of wheat is regulated by two pairs of gene.

RRBB × rrbb

Red White

↓

F_1- gen. RrBb (intermediate)

↓

	Full red	light red	Intermediate red	very light	white
Number of dominant allele	4	3	2	1	0

1 Red : 14 intermediate : 1 white

Example - Colour of the skin in Human.

The inheritance of colour of skin in human studied by **Devenport.**

When Negro (AA BB) phenotype crossed with white (aa bb) phenotype, intermediate phenotype produced in F_1 generation. Phenotypes of F_2 generation as follows.

Negro × White

AA BB ↓ aa bb

F_1 - generation → Aa Bb (Intermediate)

↓

F_2

	A B	**A b**	**a B**	**a b**
A B	AA BB Negro	AA Bb Dark	AbBB Dark	AaBb Intermediate
A b	AA Bb Dark	AA bb Intermediate	AaBb Intermediate	Aabb Light
a B	AaBB Dark	AaBb Intermediate	aa BB Intermediate	aa Bb Light
a b	AaBb Intermediate	Aabb Light	aaBb Light	aabb White

Thus, **Phenotypic ratio** of F_2 generation of quantitative inheritance as (2 pair)

Negro	:	Dark	:	Intermediate	:	Light	:	White
1	:	4	:	6	:	4	:	1

If human skin colour and kernal colour in wheat is regulated by **3 pairs** of alleles so phenotypic ration of F_2 generation

Ratio	1	:	6	:	15	:	20	:	15	:	6	:	1

Negro Intermediate or Mullato White

GENE INTERACTION

Gene interaction is two types (i) allelic interaction : allelic interaction takes place between allele of same gene which are present at same locus.

e.g. Incomplete dominance

Co-dominance

- **Non allelic gene interaction :** When interaction takes place between non allele is called non allelic gene interaction. It changes or modifies other non allelic gene.

✸ **Examples of nonallelic interaction :**

- **Epistasis :** When, a gene prevents the expression of another non-allelic gene, then it is known as epistatic gene and this phenomenon is known as Epistasis.

  Gene which inhibit the expression of another non-alleleic gene is called epistatic gene and expression of gene which is suppressed by epistatic gene is called hypostatic gene.

  Example : Hair Colour in Dog :

  B = Dominant allele for black colour of hairs

  b = Recessive allele for brown colour of hairs.

  I = Epistatic gene (White).

  If the genotype bbii for brown colour and BBII for white colour. Following types of generation will be obtained by following crosses.

bbII × BBII

↓

F_1 generation BbIi White colour

↓ F_2 generation

	BI	Bi	bI	bi
BI	BBII White	BBIi White	BbII White	BbIi white
Bi	BBIi White	BBii Black	BbIi White	Bbii Black
bI	BbII White	BbIi White	bbII White	bbIi white
bi	BbIi White	Bbii Black	bbIi White	bbii Brown

It is obviously clear by above analysis, the phenotypic ratio of F_2-generation in epistasis is 12 : 3 : 1.

✸ **Complementary Gene :** Two pair of non allelic genes are essential in dominant form to produce a particuar character.

Such genes that act together to produce an effect that neither can produce, its effect separately are called complementary genes.

Both types of gene must be present in dominant form.

C – P purple coloured

C – pp colour less

cc – p colour less

cc – pp colour less

Row material $\xrightarrow{\text{Gene C}}$ Chromogen $\xrightarrow{\text{Gene P}}$ Anthocyanin (purple)

CC PP × cc pp

(coloured) (Colourless)

↓

F_1 - Generation → CcPp (Coloured)

↓

	C P	C p	c P	c p
C P	CC PP Coloured	CC, Pp Coloured	Cc, PP Coloured	Cc, Pp Coloured
C p	CC Pp Coloured	CC pp Colourless	Cc, Pp Coloured	Cc, pp Colourless
c P	Cc PP Coloured	Cc Pp Coloured	cc PP Colourless	cc Pp Colourless
c p	Cc Pp Coloured	Cc pp Colourless	cc Pp Colourless	cc pp Colourless

Thus phenogypic ratio of complementary genes = Colourled : Colourless [9 : 7]

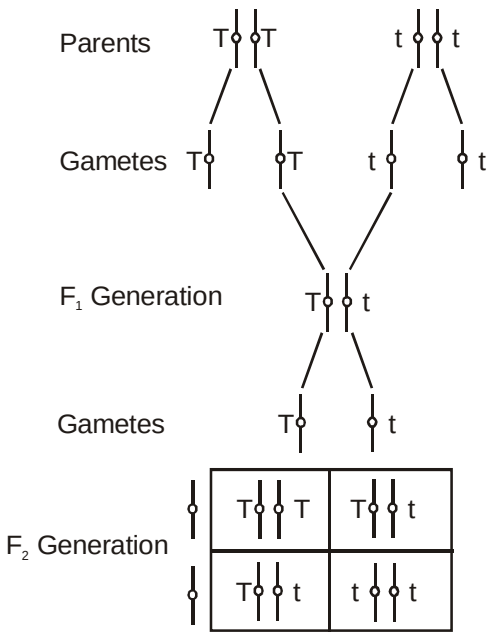
Examples of some autosomal characters in human

Character	Dominant	Recessive
Eye colour	Brown / Black	Blue
Eye size	Large	Smal
Hair	Curly hair	Straight
Cheek	Dimple	Normal
Hand	Right Handed	Left Handed
Rolling of tongue	Roller	Non-Roller
Rh Factor	Rh^+	Rh^-
PTC taster	Taster	Non Taster
Skin pigmentation	Normal	Albino

CHROMOSOMAL THEORY OF INHERITANCE

This theory was proposed by **Walter Sutton** and **Theodor Boveri** (1902). Following are the main points of the theory :

- Male and Female gemetes play an **equal** role in contributing hereditary components of future generation.
- Gemetes serve as the **bridge** between two successive generations.
- Only the nucleus of sperm combines with ovum. Thus, the hereditary information is contained in the **nucleus**.
- Chromatin in the nucleus is associated with the cell division in the form of chromosomes.
- Any type of deletion or addition in the chromosomes can cause structural and functional changes in living beings.
- A sort of **parallelism** is observed between Mendelian



factors and chromosomes.

- A number of genes or Mendelian factors are found on chromosome.
- Determination of sex in most of the animals and plants is affected by specific chromosomes. These chromosomes are called sex chromosomes.

✸ **Parallelism Between Gene and Chromosomes**

- Chromosomes are also **transferred** from one generation to the next as in the case of genes (Mendelian factors).
- The number of chromosomes is **fixed** in each living species. These are found as homologous pairs in diploid cells. One chromosome from father and the other contributed by the mother constitute a homologous pair.
- Before cell division, each chromosome as a whole and the alleles of genes get **replicated** and are separated during mitotic division.
- Meiosis takes place during **Gamete formation.** Homologous chromosomes form synapses during prophase-I stage which in later course get separated and transferred to daughter cells. Each gamete or a haploid cell has only one allele of each gene present in the chromosome.
- A characteristic diploid number is again established by the **union** of the two heploid gametes.
- Both chromosomes and the alleles (Mendelian factors) behave in **according to Mendel's law** of **segregation**.

  Homologus chromosomes of a pure tall plant. allele (T) is found for tallness in each chromosome. Likewise. in a pure dwrf plant (tt) allel (t) is present in each chromosome.

  These homologous chromosome. Likewise. in a pure dwarf plant (tt) allele (t) is present in each chromosome. These homologous chromosomes get separated during meiotic division. Hence, each gamete possess only one chromosoms each pair. Accordingly all the gamets of tall plants possess a chromosome with an allele of tallness (T), while the gametes of dwarf plants possess a chromosome with an allele for dwarfness (t). Their cross to produce F_1 generation will yield tall hybrid plants with homologous chromosomal pair containing Tt allele with homologous chromosomal pair containing Tt allelic pair. In this generation two kinds of gamete will be formed during gametogenesis. 50% with the allele (T) for tallness and 50% with the allele for dwrfness (t). **Random combination** of these gametes will produce offsprings in F_2 generation in the ratio of 25% pure tall (TT). 50% hybrid tall (Tt) and 25% dwarf (tt).

SEX DETERMINATION

SEX DETERMINATION

Establishment of sex through differential development in an individual at an early stage of life, is called sex determination. Various methods operate in sex determination like enviromental, non-allosomic genetic determination, allosomic sex determination and haplodiploidy

- **Sex Determination on the basis of fertilization.**
- **Three types :**
- **Progamic :** Sex is determined before fertilization. eg. – Drone in honey bee
- **Syngamic –** Sex is determined during fertilization. eg. – most of plants & animals
- **Epigamic –** Sex is determined after fertilization. eg. – Female in honey bee.

Environmental Determination of Sex. It is non genetic determination of sex which is based purely on environmental conditions. The organisms are potentially hermaphrodite and capable of expressing any of the sexes.

- In marine worm **Bonellia**, larva develops into female if it settles down alone in an isolated place. Any larva coming in contact with the already grown female, it changes into male, and lives as a parasite in the uterus of female.
- **Crepidula** (marine mollusca) where larva develops into male in the company of female and develops into female if left alone.
- In **Crocodiles** low temperature induces femaleness and high temperature maleness.
- In **turtles** temperature **below 28ºC** induces maleness, above **33ºC** femaleness while between **28 - 33ºC** equal number of male and female animals are formed.
- In marine fish **Medusa** sex changes according to environmental condition, becoming male in cold water and female in warm water.

- **Allosomic determination of sex**

Chromosomes are of two types :

i. Autosomes or somatic chromosomes. These regulate somatic characters.

ii. Allosomes or Hetersomes or Sex chromosomes

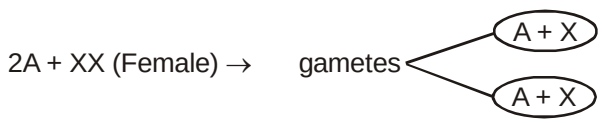
These chromosomes are associated with sex determination. Term "Allosome" & "Heterosome" were given by **Montgomery**.

Sex chromosomes first discovered by "**Mc Clung**" in grass hopper

X - Chromosome discovered by "**Henking**" and called 'x-body'.

Wilson & **Stevens** proposed **chromosomal theory for sex determination**.

- **XX - XY type or Lygaeus type :** This type of sex determination first observed by **Wilson** & **Stevens** in **Lygaeus** insect. Two types.
- **XX female and XY male :** In this type of sex determination female is Homogametic produces one type of gamete



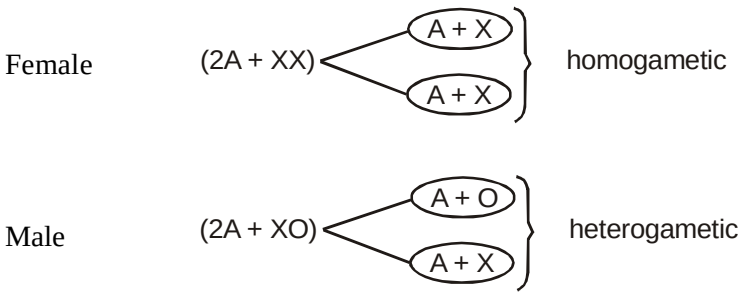
- Male is heterogametic (male produces two types of gamete)

In male X-chromosome containing gametes is called **"Gynosperm**" and Y-chromosome containing gamete is called "**Androsperm**". e.g. Man and dioecious plants like Cocinea, Melandrium

- **XY female and XX male or ZW female and ZZ male** : In this type of sex determination female is hetergametic produces two types of gamete and male individual is homogametic produces one type of gamete.

  It is found in some insects like **butter flies, moths** and **vertebrates** like **birds**, **fishes** and **reptilies.** In plant kingdom this type of sex determination is found in **Fragaria elatior.**

- **XX female and XO male** : or **"Protenor type"** : In this type of sex determination deficiency of one chromosome in male. In this type, female is homogametic and male is heterogametic.



Example :

Grass hopper

Squash bug Anasa

Cockroach

Ascaris and in plants like - Dioscorea sinuta & Vallisneria spiralis.

GENIC BALANCE THEORY

C.B. Bridges proposed genic balance theory for sex determination in Drosophila.

- According to Bridges in Drosophila Y-chromosome is heterchromatic so it have no role in sex determination.

In Drosophila sex determination takes place by sex index ratio.

$$\text{Sex index ratio} = \frac{\text{No.of x chromosomes}}{\text{No. of set of Autosomes}} = \frac{X}{A} \text{ (0.5 is male and 1 is female)}$$

In Drosophila gene of femaleness (Sxl = Sex lethal gene) is located on x-chromosome and gene of maleness is located on autosome.

Gene of male fertility is located on y-chromosome and in Drosophila, y-chromosome plays addition role in spermatogenesis and development of male reproductive organ, so y-chromosome is essential for the production of fertile male.

Sex index ratio $\frac{X}{A} = 1 \rightarrow$ female (2A + XX), (3A + XXX)

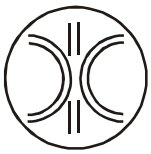
$\frac{X}{A} = 0.5 \rightarrow$ male $\begin{cases} \text{(2A + XY) = Fertile male} \\ \text{(2A + XO) = Sterile male} \end{cases}$

$\frac{X}{A}$ = 1.5 → Super female or meta female (sterile) (2A + XXX)

$\frac{X}{A}$ = less than 0.5 → Super male or meta male (Sterile) (3A + XY)

$\frac{X}{A}$ = In between 0.5 and 1 → Intersex (Sterile) (3A + XX)

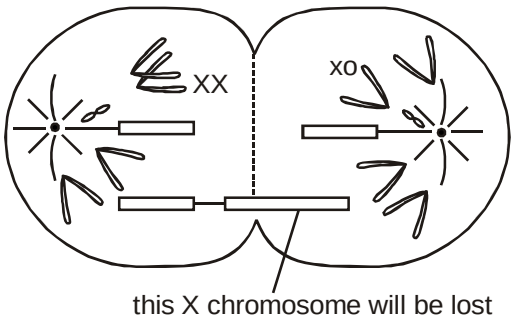
$\frac{X}{A} = \frac{1}{2}$ = 0.5 (Male)



Chromosmal diagram of Drosophila

- **Gynandromorph -**

Body of some Drosophila has some cells with male (X0) and some cells with female genotype (XX). Body of such type of Drosophila has half lateral part of male and half lateral part of female and it is called bilateral gynandromorph. It is formed due to **loss of one x-chromosome at metaphase** plate during first zygotic division. Formation of gynandromorph is the best evidence that y-chromosome does not play any role in sex determination.



HAPLOID - DIPLOID MECHANISM

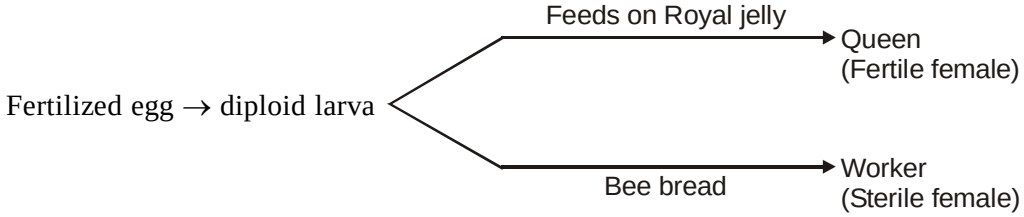
In insects of order Hymenoptera which includes ants. honey bees, wasps etc.

Sex determination takes place by sets of chromosomes.

Diploid (two sets) → Female

Haploid (One set) → Male

In honey bee, male individual (Drone) develops from unfertilized eggs (Haploid.) Male is always parthenote. Queen and worker bees develop from diploid eggs i.e. fertilized egg.



SEX DETERMINATION BY HORMONE

Dizygotic twins are common in cattle like cow, sheep, goat etc. Some times the placenta of the two dizgytic twins fuse forming blood vascular connections between two developing foetus. If twins are dizygotic, one foetus may be male and the other female.

- **Male hormone produced before female** hormone by male twins which suppress the differentiation of female (♀) sex organ. Such a sterile female with underdeveloped overties ovducts, Uterous etc. is called **free martin.**

  In free martin conditions, female is sterile & male is normal.

  Y spots : Males are identified by **Y spots (Zech 1970). Number of Y spots are equal to number of Y chromosomes.**

CYTOLOGICAL BASIS OF SEX DETERMINATION

Barr body technique or **Lyon's hypothesis** -

Interphasic nucleus of human female contains two X-chromosomes. Out of two, one X - Chromosome becomes heterochromatin and other X - Chromosome is euchromatin. By staining X - heterochromatin, it appears as a dens body which is called Barr body. (Facultative hetrochromatin)

No. of Barr body = (No. of X chromosomes - 1)

So a Normal female (2A + XX) $\rightarrow$ One Barr body

Normal male (2A + XY) $\rightarrow$ Barr body absent

Turner syndrome (Sterile female) (2A + XO) $\rightarrow$ No. Barr body

Klinefelter syndrome (Sterile male) (2A + XXY) $\rightarrow$ One Barr Body

Drum stick which occurs in blood of female of mammals, is also a type of barr body. Drum stick is absent in neutrophils of Male.

SEX DETERMINATION IN HUMAN

There occur a special gene on differential region of Y-chromosome of human. called Sry - gene (Sex determine region on y-chromosome). This gene forms a proteinaceous factor called TDF (testes determining factor). TDF responsible for the development of male reproductive organs. So presence and absence of Y-chromosome determines sex.

- **Sex determination in plant :**

  H.E. Warmke discovered sex determination in Melandrium plant. In Melandrim Y- chromosome is long as compare to X - chromosome. In plant sex chromosomes are found only in unisexual plant.

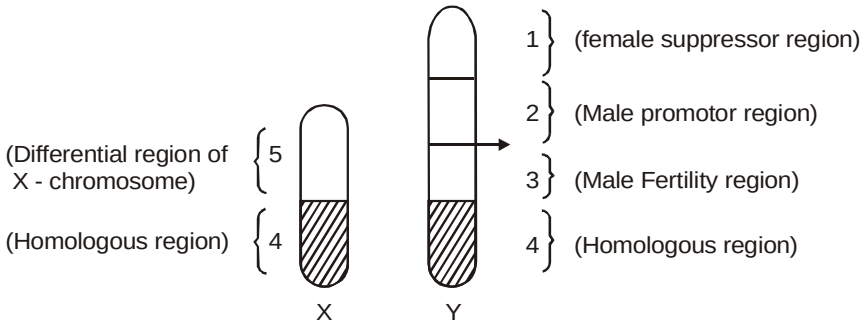
  Prof. R.P. Roy gave the importance of Y-chromosome in plant.

  He discovered sex determination in **Coccinea Indica** (Family - cucurbitaceae)

  Y - Chromosome contains four regions and X - chromosome contains two regions. Different functions of these regions.

- I^{st} region - (Female suppressor region) : This region suppress the development of female reproductive structures.
- II^{nd} region (Male promotor region) : This region initiates or start the development of Anther
- III^{rd} region (Male fertility region) : This region induces the further development of Anther.
- IV^{th} region (Homologous region) : This region helps in the disjunction & Pairing of X and Y chromosome during meiosis.

- V^{th} region (Differential region of X-chromosome) : This region induces the development of female gonads So when one or more than one Y - chromosome is present then plant is male and in female plant Y-chromosome is absent.



✸ **Special Case :**

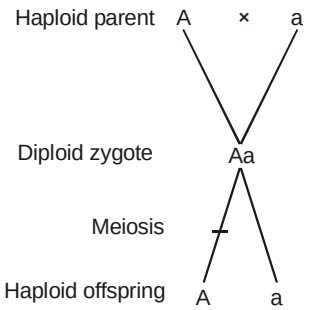
If I^{st} region of Y chromosome is removed then plant becomes **bisexual**

If II^{nd} region of Y chromosome is removed then plant becomes **female** due to absence of II^{nd} region, I^{st} region of Y chromosome does not suppress the V^{th} region of X - chromosome.

If III^{rd} region of Y chromosome is removed then plant becomes **sterile male** due to absence of III^{rd} region so further development of anther does not take place.

PHENOTYPIC EXPRESSION IN HAPLOID ORGANISMS

Diploid organisms such as pea and *Drosophila*, have two allels for each gene. With the result, the recessive allele is not expressed in the phenotype in presence of the dominant one. However, this is not so in the case of haploid organisms. Contrary to diploid organisms, the genetics of haploid organisms exhibit the following features.

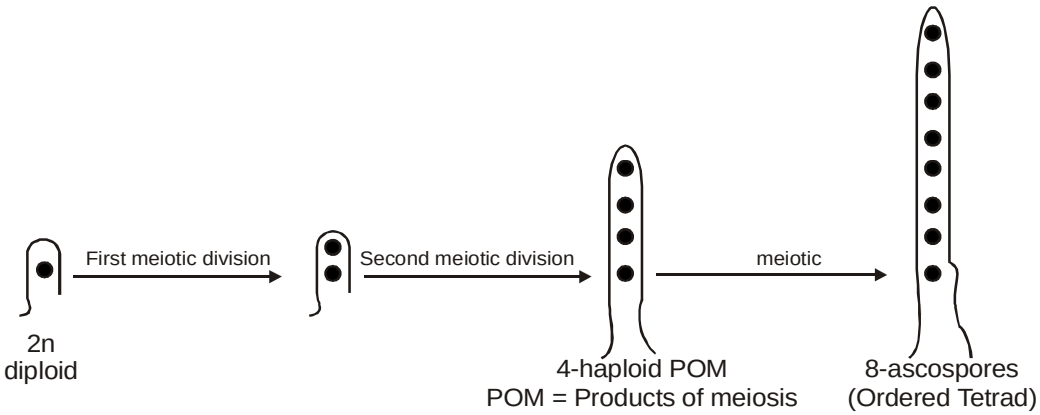


- Haploid organisms contain only one allele of a gene, so there is no complication of dominance. All the genes, whether dominant or recessive, express itself in the offsprings.
- In absence of dominance, any new mutation is immediately expressed, in hapoid organism
- Study inheritance of mutated gene, linkage, crossing over and biochemical consequence of a mutation can easily be studied in haploid.

LINKAGE AND RECOMBINATION IN NEUROSPORA (Drosophila of plant kindgom)

Detection of linkage and recombination of genes in haploid organisms as in fungi, bacteria etc. is comparatively simple. Fungus **Neurospora** is one of the favourite material with geneticists, because :

- The life cycle is of a short duration.
- The life cycle of **Neurospora** is the product of a single meosis
- The meiotic products are **linearly arranged** in ascus as 8 ascospores as ordered tetrads (i.e., the eight ascospores are arranged in the same order in which chromatids were on the meiotic metaphase plate. This is called **linear** or **ordered tetrad**. Each of the four products of meiosis can be culutred separately to study their phenotypes and genotypes. This is called **tetrad analysis**.



- **First Division Segregation Between Centromere and Gene - a.**

  A cross between two strain of Neurospora, one normal (a^+) and other mutant (a) strain produces 8-ascospores, out of which four are normal (a^+) and other four mutants (a). The linear arrangement of ascospores in ascus is $4a^+ : 4a$. It indicates the absence of crossing over between locus-a and centromere. This described as first division segration (4 : 4).

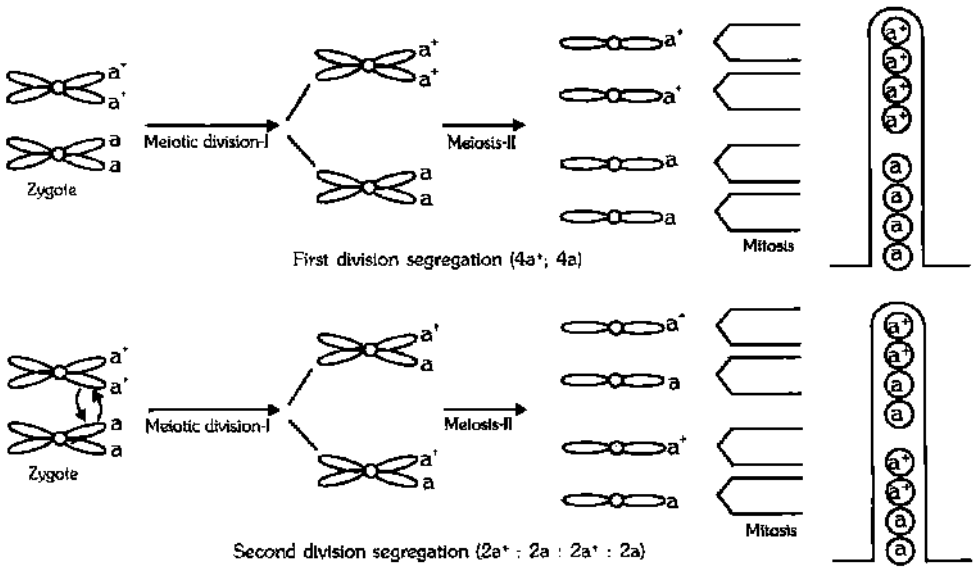
- **Second Division Segregation Between Centromere and Gene-a**

  In a similar cross if crossing over takes place leading to paired arrangement of ascospores with a prticular gene, it is described as **second division segregation.** The arrangement of ascopores in the sequence (2 : 2 : 2 : 2) is as follows :

  $a^+ : a^+ : a : a : a : a : a^+ : a^+$ (2 : 4 : 2)

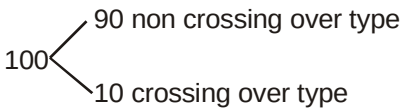
  $a : a : a^+ : a^+ : a^+ : a^+ : a : a$ (2 : 4 : 2)

  $a^+ : a^+ : a : a : a^+ : a^+ : a : a$ (2 : 2 : 2 : 2)



- **Single Gene Mapping in Neurspotra**

  In Neurospora centromere behaves as a gene for mapping gene pair. In such a case distance of gene from the centromere is calculated by calculating the percentage of cross over between centromere and gene. Que. If 10% asci show crossing over what will be distance between gene and centromere. If total 100 asci are precsent in a Neurospora



1 asci is derivative of 8 spores

100 asci are derivative of (100 × 8 = 800 spore)

10 asci are derivative of 80 spores

(Out of 80 only 40 will be the recombinant type)

$$\% \text{ C.O.} = \frac{\text{recombinant spore}}{\text{Total spore}} \times 100$$

$$= \frac{40}{800} \times 100 = 5\% \qquad \textbf{Ans. 5 cM}$$

MUTATION

- Sudden Heritable change in genetic material of an organism is called as Mutation.
- Mutation are discontinuous source of variation.
- Frequency of mutation at present is 1 × 10-6 (1 cell in : 1 million-cell). But it will increase in future due to pollution and destruction of ozone layer.
- Mutation word was given by Hugo De Vries.
- De Vries studied mutations in the plant Oenothera lamarckiana (evening primrose). It is a hybrid plant.
- De Vries gave (proposed) mutation theory of evolution.
- This theory was given in support of Darwinism because Darwin was unable to explain the source of variations. Darwin called variation as sport.
- According to De Vries there are two types of variations in evolutions.

✸ **Continuous variations :**

- The variations are develop in every generation of an organism.
- These variations are developed by crossing over/meiosis/sexual reproduction.
- Only minor variation are developed by crossing over.

✸ **Discontinuous variations :**

- These variations are developed by mutations.
- Suddenly in any generation
- Both minor and major type of variations are developed by mutations mostly major type.

✸ **Seth Right :**

- Mutation was first observed by him.
- He observed some short legged sheep (Ancon) variety in a population of long legged sheep.
- It was an example of dominant germinal of mutation.
- Those mutation are only heritable which occur in germinal cell of an organism. While somatic mutations are non heritable.
- Somatic mutations are also heritable in vegetative propagated plants.

✸ **Morgan :**

- Credit of discovery of mutation is given to him. He observed some white eyed male Drosophila in a population of red eyed Drosophila.
- In Drosophila eye colour is a sex linked character. Gene of eye colour is located on X chromosome. Gene of Red eye is dominant over the gene of white eye. So in Drosophila genotypes for eye colour are of following types.

Male	Female
X^WY - Red	X^W Y - White
50 - 50% Red & White $X^W X^W$ = Red	$X^W X^W$ = Red $X^W X^W$ = White

- **Muller :**
- Discoverer of Induced Mutations.
- He induced mutations in Drosophila by the help of X-rays.
- **Mac Farlane Burnitt, Neil Jerne :**
- Induced mutations in B-lymphocytes of blood to obtain new antibodies.
- **Beadle and Tatum :**
- Induced mutations in Neurospora to study nutritional mutation by the help of U.V. rays. or X-rays.

$$\underset{\text{(Prototroph)}}{\text{Wild Neurospora}} \xrightarrow{\text{U.V. ryas}} \underset{\text{(Auxotroph)}}{\text{Mutant Neurospora}}$$

- Normal-Neurospora can be grown in minimal medium (which lacks some nutrients), because it can make all nutrients for it. This is known as prototroph.
- Mutant Neurospora doesn't has capability to grow in minimal medium because due to mutation it loses those genes which prepare some special nutrients for it. Eg. Vita. -B or Thiamine.
- When Vit-B or Thiamine was given to mutant Neurospora then the growth of Neurospora was normal. This form is known as Auxotroph.
- **M.S. Swaminathan :**
- He induced mutations in wheat by the help of -rays to obtain good varieties for eg. Sharbati Sonora
- Swaminathan established garden in IARI-New Delhi (Pusa Institute).
- Largest Institute in the field of Agriculture in Aisa.
- **Main Points :**
- Mostly mutations are harmful.
- Sometimes they are lethal which leads to death of organisms.
- But sometimes they are benefical which are used to obtain good varieties of plants and animals. It is called as **Mutation Breeding**.
- Mostly mutations are recessive and being recessive they never eliminate from a population it is called as hardy-weinberg law.
  Which is applicable to large population and random mating.
- Dominant lethal mutation always eliminate from a population either it is large or small.

FORWARD AND BACKWARD MUTATION

- $\text{Wild gene} \underset{\text{Backward}}{\overset{\text{Forward}}{\rightleftharpoons}} \text{Mutant gene}$

- **Mutator gene and Mutable gene :**
- Gene which induce mutation in another gene is called mutator gene and in which mutation is induced is called as mutable gene.

✸ **Neutral Mutation\Suppression :**

- Mutation in one gene is neutralized by mutation in another gene called as neutral mutation. So it means mutation without effect and in neutralization two mutations are required.

✸ **Complementation :**

- Occur in Heterokaryon or dikaryon cells in which two genetically different nuclei are present in a cell. Mutation effect in one nucleus is neutralized by the another nucleus of heterokaryon. This condition occur in Neurospora during somatogamy.

✸ **Hot Spot :**

- Place on DNA or gene where frequency of mutation is high.
- In Prokaryotes frequency of mutation is high than eukaryotes due to naked DNA.

✸ **Muton (unit of mutation) :**

- Smallest part of DNA which undergoes mutation.
- It is one nucleotide.

✸ **Types of mutation :**

(A) Chromosomal Mutation

(B) Gene Mutation

A. CHROMOSOMAL MUTATIONS

- Change in number or structure of chromosome.

  Types of chromosomal mutation :

  (a) Heteroploidy/Genomatic mutation → change in chromosome number

  (b) Chromosomal aberration → change in structure of chromosome.

(a) Heteroploidy/Genomatic mutation :

- Change in number of sets or chromosomes in sets. Two types-

  (i) Euploidy → Change in number of sets.

  (ii) Aneuploidy → Change in number of chromosome in set.

(i) Euploidy :

- Change in number of sets/loss or addition of sets of chromosomes.
- In a normal diploid cell two sets of chromosome are present
- Loss of one set (2n - n = n) monoploidy
- Add^{n}. of set called as polyploidy

Add^{n}. of one set	called as Triploidy	2n + n = 3n
Add^{n}. of two sets	called as Tetraploidy	2n + 2n = 4n
Add^{n}. of three setscalled as	Pentaploidy	2n + 3n = 5n
Add^{n}. of four sets	called as Hexaploidy	2n + 4n = 6n
Add^{n}. of five fsets	called as Heptaploidy	2n + 5n = 7n

- Octaploid plants rarely survive.
- Polyploid plants with even number of sets are always fertile, reproduce sexually and form seeds.
- Polyploid plants with odd number of sets are always sterile don't reproduce by sexual reproduction, They don't produce seeds but they may produce seedless fruits by parthenocarpy.

  eg. Banana and seedless grapes.

  Polyploidy is of two types :

(1) Autopolyploidy :

- It is repetition of same set of chromosomes. Eg. AAA.

- **Cyanodon and Rose** → Autotriploid plants
- These are sterile plants.
- Reproduce by vegetative propagation.

(2) Allopolyploidy :

- More than one type of sets are present in these plants eg. AA BB.
- These plants are obtained by intergeneric cross.

  e.g., Raphanobrassica is obtained by cross between Raddish and cabbage and first time obtained by Rusian Scientist Karpechenko.

Raphanus Sativus X **Brassiaca oleracea**
2n = 18
↓
Raphanobrassica Sterile Plant
2n = 18
Colchicine ↓
Raphanobrassica Fertile
4n = 36

Triticale : Triticum durum X Rye (Secale Cereale)
4n = 28 2n = 14
↓
Triticale Sterile Plant
3n = 21
Colchicine ↓
Triticale Fertile
6n = 42

Triticale : Triticum aestivum X Rye (Secale Cereale)
6n = 42 2n = 14
↓
Triticale Sterile Plant
4n = 28
Colchicine ↓
Triticale Fertile
8n = 56

(ii) Aneuploidy :

Loss or addition of chromosomes in sets of chromosomes. Types of Aneuploidy:

(1) Hypoaneuploidy (loss)

- 2n - 1 = monosomy:- (loss of one chromosome in one set)
- 2n - 1 - 1 = double monosomy (loss of one chromosome from each set, but these are non homologus.)
- 2n - 2 = Nullisomy (loss of two homologus chromosome)

(2) Hyperaneuploidy (add.)

- 2n + 1 = Trisomy: addition of one chromosome in one set.
- 2n + 1 + 1 = Double Trisomy: addition of one chromosome in each set.
- 2n + 2 = Tetrasomy: addition of two chromosomein one set.
- Cause of aneuploidy is chromosomal non disjunction means chromosomes fail to separate during meiosis.
- Chances of aneuploidy are more in higher age female due to less activity of oocyte, so chances of syndrome increase in children who are born from higher age female.

(b) Chromosomal Aberrations :

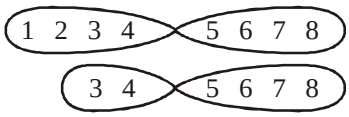
Change in structure of chromosome.

(i) Deletion :

Loss of a part or segment of chromosome which leads to loss of some gene is called as deletion.

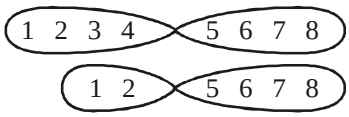
It is of 2 types:-

(1) Terminal deletion- Loss of chromosomal segment from one or both ends. e.g., The cry-du-chat syndrome is an example of terminal deletion in 5th chromosome.



e.g., The cry-du-chat syndrome is an example of terminal deletion in 5^{th} chromosome.

(2) Intercalary deletion- Loss of chromosomal part between the ends.

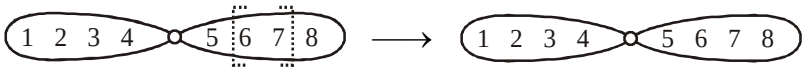


(ii) Inversion :

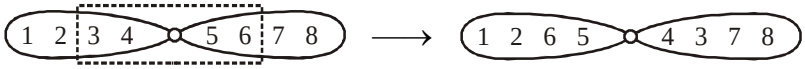
Breakage of chromosomal segment but reunion on same chromosome in reverse orders. It leads to change in distance between genes on chromosome or sequence of genes on chromosome so crossing over is affected.

It is of 2 types :

(a) Paracentric - If inversion occur only in one arm and inverted segment does not include centromere.



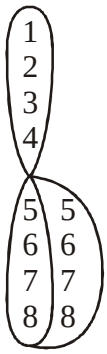
(b) Pericentric - In this type of inversion inverted segment include centromere.



(iii) Duplication :

Occurrence of a chromosomal segment twice on a chromosome. If in this segment any recessive gene is present, then it given it's expression due to homozygous condition. If in this segment any recessive but lethal gene is present, it lead to death of organism.

Example: In drosophila "Bar eye character" is observed due to duplication in X-chromosome. Bar eye is a character where eyes are narrower as compared to normal eye shape.

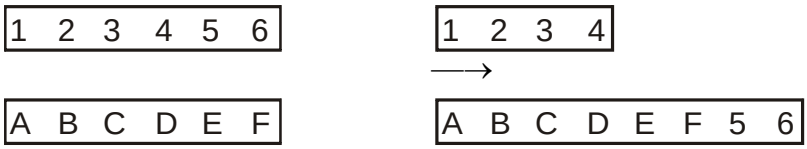


(iv) Translocation :

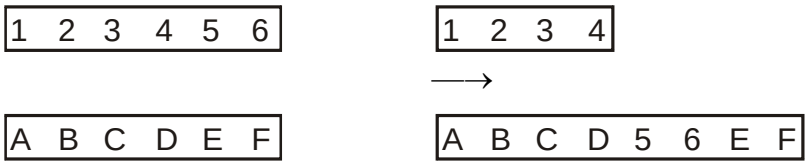
In this, a part of the chromosome is broken and may be joined with non homologous chromosome. This is also known as Illegitimate crossing over (illegeal crossing over)

Three types of translocation-

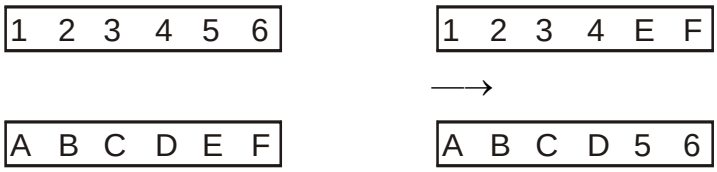
(a) Simple Translocation : When a chromosomal segment breaks and attached to the terminal end of a non-homologous chromosome.



(b) Interstitial or shift translocation : If a segment of chromosome breaks and gets inserted in interstitial position of a non homologous chromosome.



(c) Reciprocal Translocation : Exchange of segments between two non-homologous chromosome.



e.g., Chronic myloid leukemia [C M L] is a type of blood cancer. This disease is a result of reciprocal transiocation between 22 and 9 chromosome.

Note: If exchange of segments takes place in between homologous chromosomes then it is called crossing over.

B. GENE MUTATION OR POINT MUTATION

Two types : -

(1) Substitution **(2) Frame shift mutation.**

(1) Substitution :

Replacement of one nitrogenous base by another nitrogenous base is called as substitution.

- It causes change in one codon in genetic code which leads to change in one amino acid in structure of protein. *e.g.,* Sickle cell anaemia

Main Point :

- Change may not occur because for one animo acid more than one type of codons are present.

Substitution is of two types :

(a) Transition (b) Transversion.

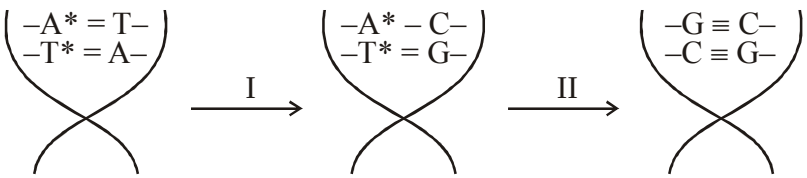
(a) Transiton :

Replacement of one purine by another purine or replacement of pyrimidine by another pyrimidine.

Methods of Transition :-

1. **By Tautomerisation :** By this method transition is induced by HNO_2. HNO_2 changes normal structure of nitrogenous base and changed nitrogenous base is called as **Tautomer**.

- In structure of adenine and guanine, amino group is present, HNO_2 changes it into imino group.

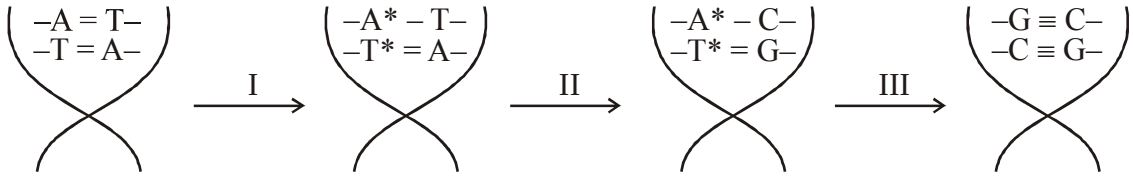


Forbidden

- In the structure of cytosine and thymine, keto group is present. Which is change into enol group by HNO_2.
- In first DNA replication, Tautomer of adenine pairs with a normal cytosine and Tautomer of thymine pairs with normal guanine.

- It is unusual pairing which is called as forbidden pairing so a wrong type of DNA is formed in cell.
- In second DNA replication normal cytosine pairs with normal guanine and normal guanine pairs with normal cytosine.
- It is usual pairing so transition completes in two DNA replication (Tautomers always perform forbidden pairing).

2. **By Ionisation :** By this method transition is induced by ionizing radiation like X-ray. These radiations convert nitrogenous bases in their ions and ions perform forbidden pairing. So by this method transition is completed in two DNA replications.
3. **By Base Analogues :** Transition is induced by chemicals which are same as nitrogenous base in function. They are called base analogues or duplicates of nitrogenous base.
   e.g., Aminopurine is base analogue to Adenine (purine) 5-Bromo uracil is base analogue to thymine (pyrimidine), 5-Iolo uracil is base analogue to guanine, 5-Chloro uracil is base analogue to cytosine.



Forbidden pairing

- In I DNA replication base analogues get establish in normal structure of DNA
- IN II DNA replication they perform forbidden pairing
- In III DNA replication transition is completed.

(b) Transversion :

- Replacement of purine by pyrimidine or pyrimidine by purine is called transversion.
- EMS ⇒ Ethyl methane sulphonate
- MMS ⇒ Methyl methane sulphonate
- These chemicals causes depurination means they remove one purine from structure of DNA. So a gap is formed.
- If this gap is filled by another purine then it is called as transition.
- But if this gap is filled by pyrimidine then it is called as transversion.
- So EMS and MMS may cause both transition and transversion.

(2) Frame shift mutation/Gibberish mutation :

(1) Arredine (2) proflavin

These chemicals causes loss or addition of one or two nitrogenous bases in structure of DNA so complete reading of genetic code is changed. It leads to change in all animo acids in structure of protein so a new protein is formed which is completely different from previous protein.

ATG ACG GAC AGA AAC……

ATG CGG ACA GAA AC……..

- So frame shift mutations are more harmful as compared to substitution.
- Thallesemia (lethal genetic disorder)

Mutagens :

- Mutagens are those substance which cause mutations : -

1. **Radiation :** - They are two types
   (i) Ionising:- [redacted], X-ray
   (ii) Non ionizing:- U.V. rays

- U.V. rays has less penetration power and skin of higher organisms absorb radiations. So they don't cause any effect in higher animals, but U.V. rays and radiations are effective mutagens in microbes and due to more effect leads to death of microbes. So U.V. rays are used to sterilize operation theatre.

- Radiations mainly cause chromosomal aberrations which cause major change in organisms. So chromosomal mutations are more important in evolution.
- U.V. rays and HNO_2 cause deamination of nitrogenous base means they remove amino group from nitrogenous base by deamination of,

  Adenine $\longrightarrow$ Hypoxanthine
  Guanine $\longrightarrow$ Xanthine
  Cytosine $\longrightarrow$ Uracil

  U.V. rays do not cause deamination in thymine. By U.V. rays two adjacent thymine bind together and form **thymine-dimer**.

2. Chemical mutagens :

eg. Mustard gas (first identified Chemical Mutagens)
Carbon tetra sulphide, Nitrous acid (HNO2)
Organic peroxide, Ethyl urethane, Pesticides etc.
DDT (Dichloro Diphenyl Trichloro Ethane)
LSD (Lysergic acid diethylamide)

- Chemical mutagens are more harmful than radiations because body is not protected against chemicals.
- Source of chemical mutagens are food, air and water.
- Effect of radiation is localized, while chemical mutagens spread in complete body through blood circulation and when they reaching gonads they cause germinal mutation.
- Chemicals also cause chromosomal mutations.

Antibiotics :

1. Neomycin 2. Kenamycin 3. Streptomycin

These antibiotics combine with small subunit of prokaryotic ribosome and Cause misreading of genetic code or induce error in translation.

Main Point :

- Same effect of puromycin antibiotic in eukaryotes.

Special Point

Mis-sense mutation : When a nucleotide change in genetic code cause the change of one amino acid of a polypeptide chain it is called mis-sense mutation.

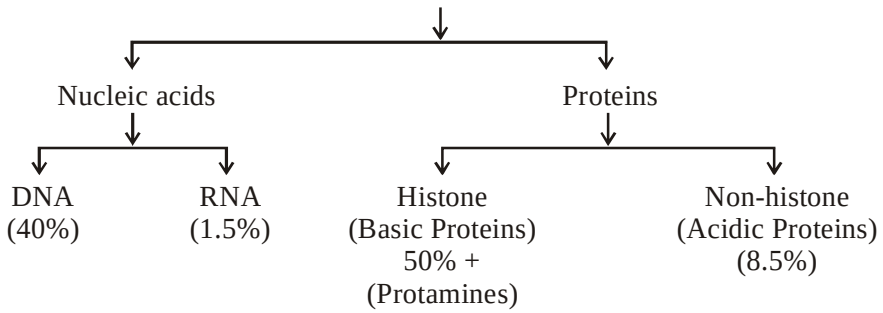
Non-sense mutation : When a nucleotide change in one codon causes termination of polypepetide synthesis by producing non-sence codon.

Same sense codon - A change in one nucleotide in a codon does not change amino acid in polypeptide chain, because both codons code same amino acid.

NUCLEIC ACIDS -

CHEMICAL COMPOSITION :

Chemical analysis of chromosomes reveals the following substances

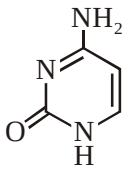


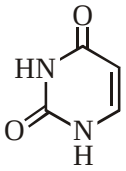
- Meischer discovered nucleic acids in nucleus of pus cell and called it "nuclein". The name nucleic acid proposed by "Altaman".
- Nucleic acids are polymer of nucleotides.

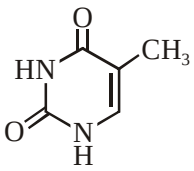
  = Nitrogen base + pentose + phosphate

  On the basis of structure nitrogen bases are broadly of two types :

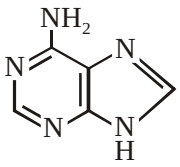
1. **Pyrimidines :** Consist of one pyrimidine ring. Skeleton of ring composed of two nitrogen and four Carbon atoms e.g. Cytosine, Thymine and Uracil.

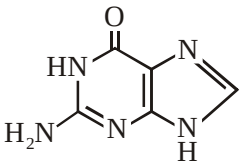

Cytosine


Uracil

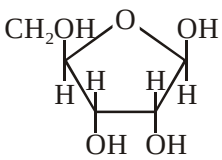

Thymine

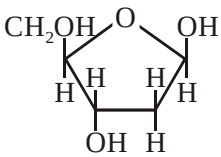
2. **Purines :** Consist of two rings i.e. one pyrimidine ring (2N + 4C) and one imidazole ring (2N + 3C) e.g. Adenine and Guanine.

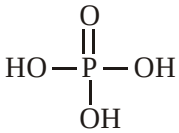

Adenine


Guanine

Pentose Sugar :

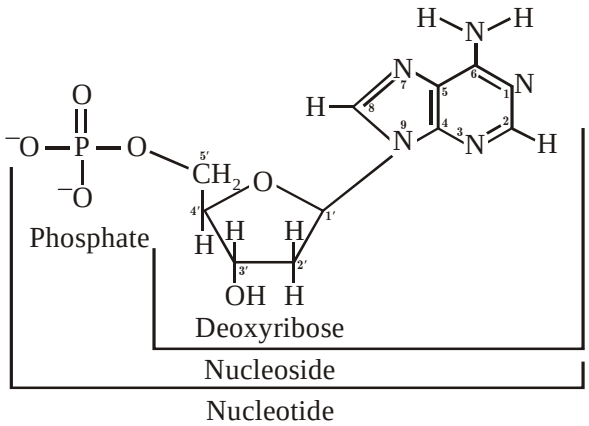

Ribose


Deoxy Ribose


Phosphoric acid

Nitrogen base forms bond with first carbon of pentose sugar to form a nucleoside. Nitrogen of first place (N_1) forms bond with sugar in case of Pyrimidines while in purines nitrogen of ninth place (N_9) forms bond with sugar.

Phosphate forms ester bond (covalent bond) with fifth carbon of sugar to form a complete nucleotide.



Types of Nucleosides and Nucleotides

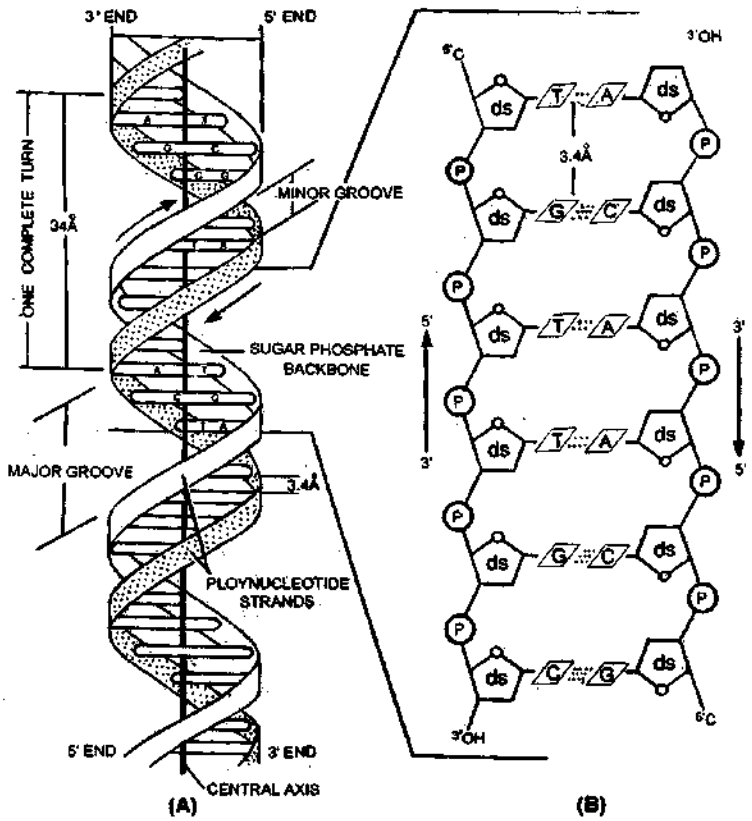
1. Adenine + Ribose = Adenosine

   Adenosine + Phosphate = Adenylic acid

2. Adenine + Deoxyribose = Deoxy adenosine
   Deoxy adenosine + P = Deoxy adenylic acid
3. Guanine + Ribose = Guanosine
   Guanosine + P = Guanylic acid
4. Guanine + Deoxyribose = Deoxy guanosine
   Deoxy guanosine + P = Deoxy guanylic acid
5. Cytosine + Ribose = Cytidine
   Cytidine + P = Cytidylic acid
6. Cytosine + Deoxyribose = Deoxycytidine
   Deoxycytidine + P = Deoxycytidylic acid
7. Uracil + Ribose = Uridine
   Uridine + P = Uridylic acid
8. Thymine + Deoxyribose = Deoxy thymidine
   Deoxythymidine + P = Deoxythymidylic acid

DNA

- Discovered by - **Meischer**
- DNA term given by - **Zacharis**
- In DNA pentose sugar is deoxyribose sugar and four types of nitrogen bases A, T, G, C.
- Wilkins and Franklin studied DNA molecule with the help of X-Ray crystallography.
- With the help of this study, **Watson** and **Crick** (1953) proposed a double helix molel for DNA. For this model Watson, Crick and **Wilkins** were awarded by noble prize in 1962.
- According to this model, DNA is composed of two polynucleotide chains.
- Both polynucleotide chains are complementary and antiparallel to each other.



- In both strand of DNA direction of phosphodiester bond is opposite. i.e. If direction of phosphodiester bond in one strand is 5'-3' then it is 3'-5' in another strand.
- Both strand of DNA held together by Hydrogen bonds. These hydrogen bond are present between Nitrogen bases of both strand.
- Adenine binds to Thymine by two hydrogen bonds and cytosine binds to Guanine by three hydrogen bonds.
- Chargaff's equivalency rule - In a double stranded DNA amount of purine nucleotides is equal to amount of pyrimidine nucleotides.

  Purine = Pyrimidine

  $[A] + [G] = [T] + [C]$

- Base ratio = $\frac{[A]+[G]}{[T]+[C]}$ = constant for a given species.
- In a DNA, A + T > G + C $\Rightarrow$ A - T type DNA. Base ratio of A - T type of DNA is more than one. eg. Eucaryotic DNA
- In a DNA G + C > A + T $\Rightarrow$ G - C type DNA. Base ratio of G -C type of DNA is less than one. eg. Procaryotic DNA
- Melting point of DNA depends on G - C contents.

  More G - C contents then more Melting point.
- Tm = Temperature of melting.

  Tm = of prokaryotic DNA > Tm of Eucaryotic DNA
- DNA absorbs U.V. rays means 2600Å wavelength.
- Out of two strand of DNA only one strand participates in transcription, it is called **Antisense strand/ Non coding strand / Template strand**.
- Other strand of DNA which does not participate in transcription is called **sense strand/Coding strand**.
- Denaturation and renaturation of DNA - If a normal DNA molecule is placed at high temperature (80 - 90°C) then both strand of DNA will separate to each other due to breaking of hydrogen bonds. It is called **DNA-denaturation**.

  When denatured DNA molecule is placed at normal temperature then both strand of DNA attached and recoiled to each other. It is called **Renaturation of DNA**.
- Hyperchromicity - When a double stranded DNA is denatured by heating then denatured DNA molecule absorbs more amount of light, this phenomenon is called **hyperchromicity**.
- Hypochromicity - When denatured DNA molecule cool slowly then it becomes double stranded and it absorb less amount of light. This phenomenon is called **hypochromicity**.

Configuration of DNA Molecule :

- Two strands of DNA are helically coiled like a revolving ladder. Back bone of this ladder (Reiling) is composed of phosphates and sugars while steps (bars) composed of pairs of nitrogen bases.
- Distance between two successive steps is 3.4Å. In one complete turn of DNA molecule there are such 10 steps (10 pairs of nitrogen bases.) So the length of one complete turn is 34Å. This is called **helix length**.
- Diameter of DNA molecule i.e. distance between phosphates of two strands is 20Å.
- Distance between sugar of two strands is 11.1 Å.
- Length of hydrogen bonds between nitrogen bases is 2.8-3.0 Å. Angle between nitrogen base and C_1 Carbon of pentose is 51°.
- Molecular weight of DNA is 106 to 109 dalton.
- In nucleus of eukaryotes the DNA is associated with histone protein to form nucleoprotein. Histone occupies major groove of DNA at 30° angle.

- Bond between DNA and Histone is salt linkage (Mg^{+2}).
- DNA in chromosomes is linear while in prokaryotes, mitochondria and chloroplast is circular.
- In $\phi \times 174$ bacteriophage the DNA is single stranded and circular isolated by Sinsheimer. G-4, S-13, M-13, F_1 and Fd-Bacteriophages also contain ss-circular DNA.

Types of DNA

On the basis of direction of twisting, there are two types of DNA.

1. Right Handed DNA -

Clockwise twisting e.g. The DNA for which Watson and Crick proposed model was 'B' DNA. Other e.g. of right handed DNA.

DNA	Helix Length	No. of base pairs	Distance between two pairs	Diameter
'A'	28 Å	11 pairs	2.56 Å	23 Å
'B'	34 Å	10 pairs	3.4 Å	20 Å
'C'	31 Å	9.33 pairs	3.32 Å	19 Å
'D'	24.24 Å	8 pairs	3.03 Å	19 Å

2. Left handed DNA -

Anticlockwise twisting e.g. Z-DNA-discovered by Rich. Phosphate and sugar backbone is zig-zag. Units of Z-DNA are dinucleotides (Purine and pyrimidine in alternate order)

Helix length - 45.6 Å

Diameter - 18.4 Å

No. of Base pairs - 12 (6 dimers)

Distance between base - pairs - 3.75 Å

- Palindromic DNA - Wilson and Thomas

$\longrightarrow$

C C G G T A C C G G

G G C C A T G G C C

$\longleftarrow$

Sequence of nucleotides same from both ends.

Special Points :

- DNA molecule is Dextrorotatory while RNA molecule is Laevorotatory.
- C-value = Total amount of DNA in a haploid genome of organism.

THE SEARCH FOR GENETIC MATERIAL

The experiments given below prove that DNA is the genetic material.

(I) **Evidence from bacterial transformation**. The transformation experiments, conducted by Frederick Griffith in 1928, are of great importance in establishing the nature of genetic material.

He used two strains of bacterium Diplococcus or Streptococcus pneumoniae or Pneumococcus i.e., S-III and R-II.

(1) **Smooth (S)** or **capsulated** type which have a mucous coat and produce shiny colonies. These bacteria are virulent and cause pneumonia.

(2) **Rough (R)** or **non-capsulated** type in which mucous coat is absent and produce rough colonies. These bacteria are nonvirulent and do not cause pneumonia.

The experiment can be described in following four steps:

(a) Smooth type bacteria were injected into mice. The mice died as a result of pneumonia caused by bacteria.

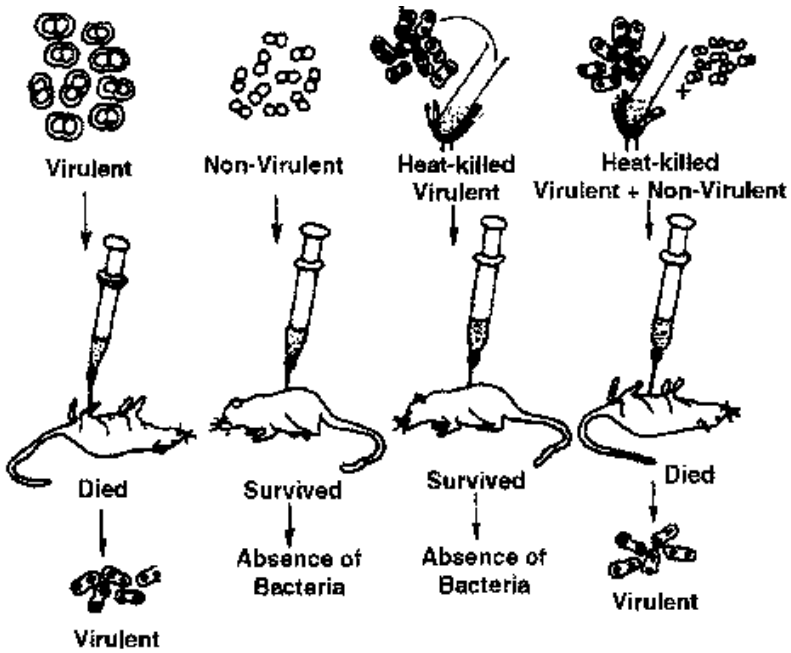
(b) Rough type bacteria were injected into mice. The mice lived and pneumonia was not produced.

(c) Smooth type bacteria which normally cause disease were **heat killed** and then injected into the mice. The mice lived and pneumonia was not caused.

(d) Rough type bacteria (**living**) and smooth type **heat-killed** bacteria (both known not to cause disease) were injected together into mice. The mice died due to pneumonia and virulent smooth type living bacteria could also be recovered from their bodies.

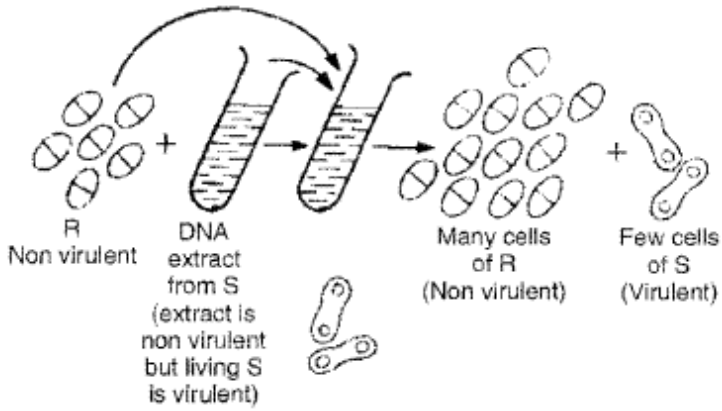
He concluded from fourth step of the experiment that some rough bacteria (nonvirulent) were transformed into smooth type of bacteria (virulent). This occured perhaps due to absorption of some **transforming substance** by rough type bacteria from heat killed smooth type bacteria. This transforming substance from Smooth type bacteria caused the synthesis of capsule which resulted in production of pneumonia and death of mice. Therefore, transforming principle appears to control genetic characters (for example, capsule as in this case). **However the biochemical nature of genetic material was not defined from his experiments**. Later, **Avery, Macleod** and **McCarty** (1944) repeated the experiment in vitro to identify transforming substance. They proved that this substance is DNA.

Pneumococcus bacteria cause disease only when capsule is present. Capsule production is under genetic control.



Bacterial transformation experiments conducted by Griffith

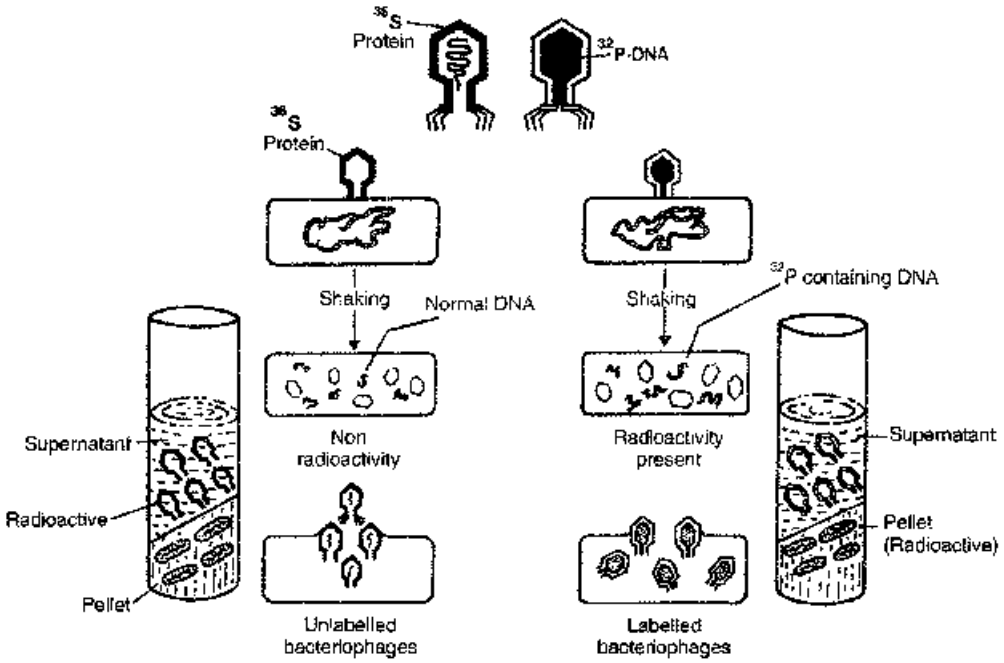
In the experiments, rough type bacteria (non-capsulated and non-virulent) were grown in a culture medium to which DNA extract from smooth type bacteria (capsulated and virulent) was added. Later, the culture showed the presence of smooth type bacteria also in addition to rough type. This is possible only if DNA of smooth type was absorbed by rough bacteria type which thus developed capsule and became virulent. **This process of transfer of characters of one bacterium to another by taking up DNA from solution is called transformation**. When DNA extract was treated with DNAase (an enzyme which destroys DNA), transformation did not occur. The transformation occurs when proteases and RNases were used. **This clearly shows that DNA is the genetic material**.



In vitro experiment of Avery and others demonstrating that DNA is genetic material

(II) Evidence from experiments with bacteriophage. T_2 bacteriophage is a virus that infects bacterium Escherichia coli and multiplies inside It T_2 phage is made up of DNA and protein coat. Thus, it is the most suitable material to determine whether DNA or protein contains information for the production of new virus (phage) particles. Hershey and Chase (1952) demonstrated that only DNA of the phage enters the bacterial cell and, therefore, contains necessary genetic information for the assembly of new phage particle.

The functions of DNA and proteins could be found out by labelling them with radioactive tracers. DNA contains phosphorus but not sulphur. Therefore, phage DNA was labelled with P^{32} by growing bacteria infected with phages in culture medium containing $^{32}PO_4$. Similarly, protein of phage contains sulphur but no phosphorus. Thus, the phage protein coat was labelled with S^{35} by growing bacteria infected with phages in another culture medium containing $^{35}SO_4$. Both types of labelled phages were allowed to infect normally cultured bacteria in separate experiments. These bacterial cells were agitated in a blender and radioactivity was observed. The bacterial cells showed the presence of radioactive DNA labelled with P^{32} while radioactive protein labelled with S^{35}appeared on the outside of bacteria cells (i.e., in the medium). Labelled DNA was also found in the next generation of phage. This clearly showed that only DNA enters the bacterial host and not the protein. DNA, therefore, is the infective part of virus and also carries all the genetic information. **This provided the unequivocal proof that DNA is the genetic material**.



Hershey and Chase's experiments with bacteriophages showing that DNA is genetic material or DNA is infective part of virus

Properties of Genetic Material :

Following are the properties and functions which should be fulfilled by a substance if it is to qualify as genetic material.

(1) It should chemically and structurally be stable.

(2) The genetic material should be able to transmit faithfully to the next generation, as Mendelian characters.

(3) The genetic material should also be capable of undergoing mutations.

(4) The genetic material should be able to generate its own kind (replication).

This can be concluded after examining the above written qualities, that DNA being more stable is preferred as genetic material, as

(a) Free 2'OH of RNA makes it more labile and easily degradable. Therefore DNA in comparison is more stable.

(b) Presence of thymine at the place of uracil also confers additional stability to DNA.

(c) RNA being unstable, mutates at a faster rate.

RNA World

RNA was the first genetic material. There are evidences to suggest that essential life processes, such as metabolism, translation, splicing, etc. evolved around RNA. RNA used to act as a genetic material as well as a catalyst, there are some important biochemical reactions in living systems that are catalyzed by RNA catalysts and not by protein enzymes (e.g., splicing). RNA being a catalyst was reactive and hence unstable. Therefore, DNA has evolved from RNA with chemical modifications that make it more stable. DNA being double stranded and having complementary strand further resists changes by evolving a process of repair. RNA is adapter, structural molecule and in some cases catalytic. **Thus RNA is better material for transmission of information**.

RIBO NUCLEIC ACID (RNA)

Structure of RNA is fundamentally the same as DNA, but there are some differences. The differences are as follows :

(1) In place of De-Oxyribose sugar of DNA, there is present Ribose sugar in RNA.

(2) In place of nitrogen base Thymine present in DNA, there is nitrogen base uracil in RNA.

(3) RNA is made up of only one polynucleotide chain i.e. R.N.A. is Single stranded.

Exception - RNA found in Reo - virus is double stranded, i.e. it has two polynucleotide chains.

Types of RNA :

1. Genetic RNA or Genomic RNA - In the absence of DNA, sometime RNA working as genetic material and genomic RNA transfer informations from one generation to next generation.

eg. Reo virus, TMV, QB bacteriophage.

Non-genetic RNA - 3 types -

(A) r-RNA (B) t-RNA (C) m-RNA

(1) Ribosomal RNA (r–RNA) :

- This RNA is 80% of the cell's total RNA
- It is found in ribosomes and it is produced in nucleolus.
- It is the most stable form of RNA.
- There are present 80s type of ribosomes in Eukaryotic cells. Their subunits are 60s and 40s . In 60s sub unit of ribosome three type of r-RNA are found - 5s, 5.8s, 28s
- In the same way 40s sub unit of ribosome has only one type of r-RNA = 18s.
- So 80s ribosome has total 4 types of r-RNA.
- Prokaryotic cells have 70s type of ribosomes and its subunits are 50s and 30s.

- 50s sub unit of ribosome contains 2 molecules of r-RNA = 5s and 23s.
- 30s sub unit of ribosome has 16s type of r-RNA.
- So 70s RNA has total 3 types of r-RNA.

Functions -

- At the time of protein synthesis r-RNA provides attachment site to t-RNA and m-RNA and attaches them on the Ribosome.
- The bonds formed between them are known as Salt linkages. It attaches t-RNA to the larger subunit on the Ribosome and m - RNA to smaller sub-unit of ribosome.

(2) Transfer - RNA (t-RNA) -

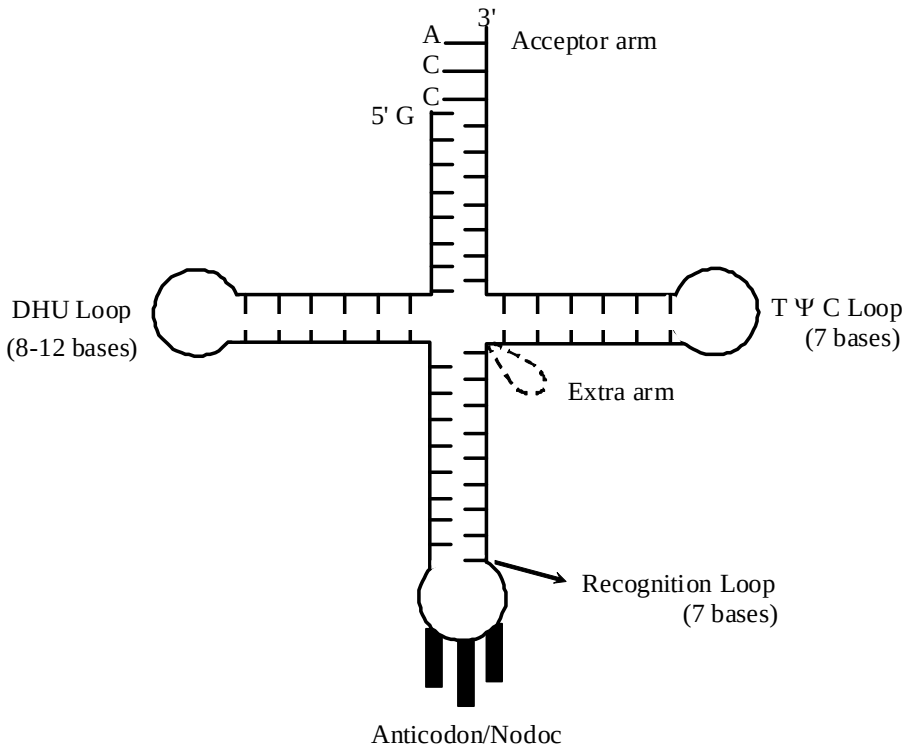
- It is 10-15% of total RNA.
- It is synthesized in the nucleus by DNA.
- It is also known as soluble RNA (sRNA)
- It is also known as Adapter RNA.
- It is the smallest RNA (4s).

Function - At the time of protein synthesis it acts as a carrier of amino-acids.

Discovery - t-RNA was discovered by Hogland, zemecknike and Stephenson.

Structure - The structure of t-RNA is most complicated.

A scientist named Holley presented Clover leaf model of its structure. In two dimensional structure the t-RNA appears clover leaf like but in three dimensional structure (by Kim) it appears L-shaped.



- The molecule of t-RNA is of single strand.
- There are present three nucleotides in a particular sequence at 3′ end of t RNA and that sequence is = CCA.
- All the 5′ ends i.e. last ends are having G(guanine).
- 3′ end is known as Acceptor end.
- t-RNA accepts amino acids at acceptor points. Amino acids binds to 3′ end by its -COOH group.

- The molecule of t-RNA is folded and due to folding some complementary nitrogenous bases comes across with each other and form hydrogen bonds.
- There are some places where hydrogen bonds are not formed, these places are known as **loop**.

Loops -

There are some abnormal nitrogenous bases in the loops, that is why hydrogen bonds are not formed. e.g. Inosine (I), Pseudouracil (Ψ) Dihydrouridine (DHU)

(i) T ψ C Loop or Attachment loop -

This loop connects t-RNA to the larger subunit of ribosome.

(ii) Recognition Loop -

- This is the most specific loop of t-RNA and different types of t-RNA are different due to this loop. There is a specific sequence of three nucleotides called **Anticodon**, is present at the end of this loop.
- On the basis of Anticodon, there are total 61 types of t-RNA, or, we can also say that there are 61 types of Anticodon.
- t-RNA recognizes its place on m-RNA with the help of Anticodon.
- The anticodon of t-RNA recognizes its complementary sequence on m-RNA. This complimentary sequence is known as codon.

(iii) DHU Loop -

- It is also known as Amino-acyl synthetase recognition loop. Amino-acyl synthetase is a specific type of enzyme. The function of this enzyme is to activate a specific type of amino acid. After activation this enzyme attaches the aminoacid to the 3 end of t-RNA.
- There are 20 types of enzymes for 20 types of aminoacids.
- The function of DHU loop is to recognize this specific Aminoacyl synthetase enzyme.

(3) Messenger RNA (m-RNA) -

- The m-RNA is 1-5% of the cell's total RNA.

  Discovery - Messenger RNA was discovered by Huxley, Volkin and Astrachan. The name m-RNA was given by Jacob and Monad.
- The m-RNA is produced by genetic DNA in the nucleus. This process is known as Transription.

GENETIC CODE

Term Given by George Gamow.

- The relationship between the sequence of amino acids in a polypeptide chain and nucleotide sequence of DNA or m-RNA is called genetic code.
- There occur 20 types of amino acids which participate in protein synthesis. DNA contains information for the synthesis of any types of polypeptide chain. In the process of transcription, information transfer from DNA to m-RNA in the form of complementary N_2-base sequence.
- m-RNA contains code for each amino acid and it is called **codon**. A codon is the nucleotide sequence in m-RNA which codes for particular amino acid; wherease the genetic code is the sequence of nucleotides in m-RNA molecule, which contains information for the synthesis of polypeptide chain.

Triplet Code -

- The main problem of genetic code was to determine the exact number of nucleotide in a codon which codes for one amino acid.
- There are four types of N_2-bases in m-RNA (A, U, G, C) for 20 type amino acids.

	U	C	A	G	
U	UUU Phe UUU UUU Leu UUU	UUU UCC UCA UCG Ser	UAU Phe UUU UAA Ochre (terminator) UAG Amber (terminator)	UGU Cys UGC UGA Terminator UGG Try	U C A G
C	CUU CUC CUA CUG Leu	CCU CCC CCA CCG Pro	CAU His CAC CAA CAG Gln	CGU CGC CGA CGG Arg	U C A G
A	AUU AUC AUA IIe AUG Met	ACU ACC ACA ACG Thr	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA AGG Arg	U C A G
G	GUU GUC GUA GUG Val	GCU GCC GCA GCG Ala	GAU Asp GAC GAA Glu GAG	UGU UGC UGA UGG Gly	U C A G

Triplet codons of mRNA for amino acids represented in tabular form.

- If genetic code is singlet i.e. codon is the combination of only one nitrogen base, then only four codons are possible A, C, G and U. These are insufficient to code for 20 types amino acids.

A	Codons
C	
G	
U	

Singlet Code : 4 × 1 = 4 codons

- Singlet code = 4 = 4 × 1 = 4 codons
- If genetic code is doublet (i.e. codon is the combination of two nitrogen bases) then 16 codons are formed.
- Doublet code = 42 = 4 × 4 = 16 codons.
- 16 codons insufficient for 20 amino acid

AA	AC	AG	AU
CC	CA	CG	CU
GG	GA	GC	GU
UU	UA	UG	UC

Doublet Code : 4 × 4 = 16 condons

Gamow -

- (1954) Pointed out the possibility of three letter code (Triplet code).
- Genetic code is triplet i.e. one codon consists of three nitrogen base.
  Triplet code = $43 = 4 \times 4 \times 4 = 64$ codons
- In this case there occurs 64 codons in dictionary of genetic code.
- 64 codons are sufficient to code 20 types of amino acids.

Characteristic of Genetic Code -

(1) Triplet in Nature

- A codon is composed of three adjacent nitrogen bases which specifies the one amino acid in polypeptide chain.
  For Ex. :
- In m-RNA if there are total 90 N_2 - bases.
- Then this m-RNA determines 30 amino acids in polypeptide chain.
- In above example, number of Nitrogen bases are 90 so codons ==> 30 and 30 codons decide 30 amino acid in polypeptide chain.

(2) Universality

The genetic code is applicable universally. The same genetic code is present in all kinds of living organism including viruses, bacteria, unicellular and multicellular organism.

(3) Non-Ambiguous -

- Genetic code is non ambiguous i.e. one codon specifies only one amino acid and not any other.
- In this case one codon never code two different amino acids. Exception GUG codon which code both valine and methionine amino acid.

(4) Non-Overlapping -

A nitrogen base is a constituent of only one codon.

(5) Comma less -

- There is no punctuation (comma) between the adjacent codon i.e. each codon is immediately followed by the next codon.
- If a nucleotide is deleted or added, the whole genetic code read differently.
- A Polypeptide chain having 50 amino acids shall be specialized by a linear sequence of 150 nucleotides. If a nucleotide is added in the middle of this sequence, the first 25 amino acids of polypeptide will be same but next 25 amino acids will be different.

(6) Degeneracy of Genetic code -

- There are 64 codons for 20 types of amino acids, so most of the amino acids (except two) can be coded by more than one codon. Single amino acid coded by more than one codon is called "Degeneracy of genetic code". This incident was discovered by Baurnfield and Nirenberg.
- Only two amino acids Tryptophan and Methionine are specified by single codon.

  UCG for Tryptophan

  AUG for methionine

- All the other amino acid are specified or coded by 2 to 6 codons.
- Leucine, serine and arginine are coded or specified by 6-codons.
  Leucine = CUU, CUC, CUA, CUG, UUA & UUG
  Serine = UCU, UCC, UCA, UCG, AGU, AGC
  Arginine = CGU, CGC, CGA, CGG, AGA, AGG
- Degeneracy of genetic code is related to third position (3 - end of triplet codon). The third base is described as "Wobby base"

Exception -

Different Codon -

- Normally UAA and UGA are chain termination codon but in Paramecium and some other ciliated, UAA and UGA code for glutamine amino acid.

Mitochondrial Gene -

- Normally AGG and AGA code for Arginine amino acid but in human mitochondria these function as stop codon.
- UGA, a termination codon corresponds to tryptophan while AUA (Codon for isoleucine) denotes methionine in human mitochondria.

Chain Initiation and Chain Termination Codon -

- Polypeptide chain synthesis is signalled by two initiation codons AUG or GUG.
- AUG codes methionine amino acid in eukaryotes and in prokaryotes AUG codes N-formyl methionine.
- Some times GUG also functions as start codon it codes for valine amino acid normally but when it is present at starting position it code for methionine amino acid.
- Out of 64 codons 3-codons are stopping or nonsense or termination codon.
  Nonsense codons do not specify any amino acid.
  UAA (Ochre)
  UAG (Amber) Non-Sense Codon
  UGA (Opal)
- So only 61 codons are sense codons which specify 20 amino acid.

WOBBLE HYPOTHESIS

- It was propounded by CRICK.
- Normally an anticodon recognizes only one codon, but sometimes an anticodon recognise more than one codon. This known as Wobbling. Wobbling normally occurs for third nucleotide of codon.
- For e.g. Anticodon AAG can recognize two anticodons i.e. UUU and UUC, both stand for phenyl alanine.

Types of m-RNA : m-RNA is of 2 types -

(1) Monocistronic - The m- RNA in which genetic signal for the formation of only one polypeptide chain.

(2) Polycistronic - The m-RNA, in which genetic signal is present for the formation of more than one polypeptide chains.

- Non sense codons are found in middle position in polycistronic m-RNA.

CENTRAL DOGMA

- Central dogma term was given by **Crick**.
- The formation (production) of m-RNA from DNA and then synthesis of protein from it, is known as **Central Dogma**.

$$\text{DNA} \xrightarrow{\text{Transcription}} \text{RNA} \xrightarrow{\text{Translation}} \text{Protein}$$

- It means, it includes transcription and translation.
- The central dogma scheme of protein synthesis was presented by **Jacob and Monad**.
- The delailed study of central dogmas is done by **Nirenberg, Mathai and Khorana.**
- **Beedle and Tatum** studied central dogma in a fungus ***Neurospora***.

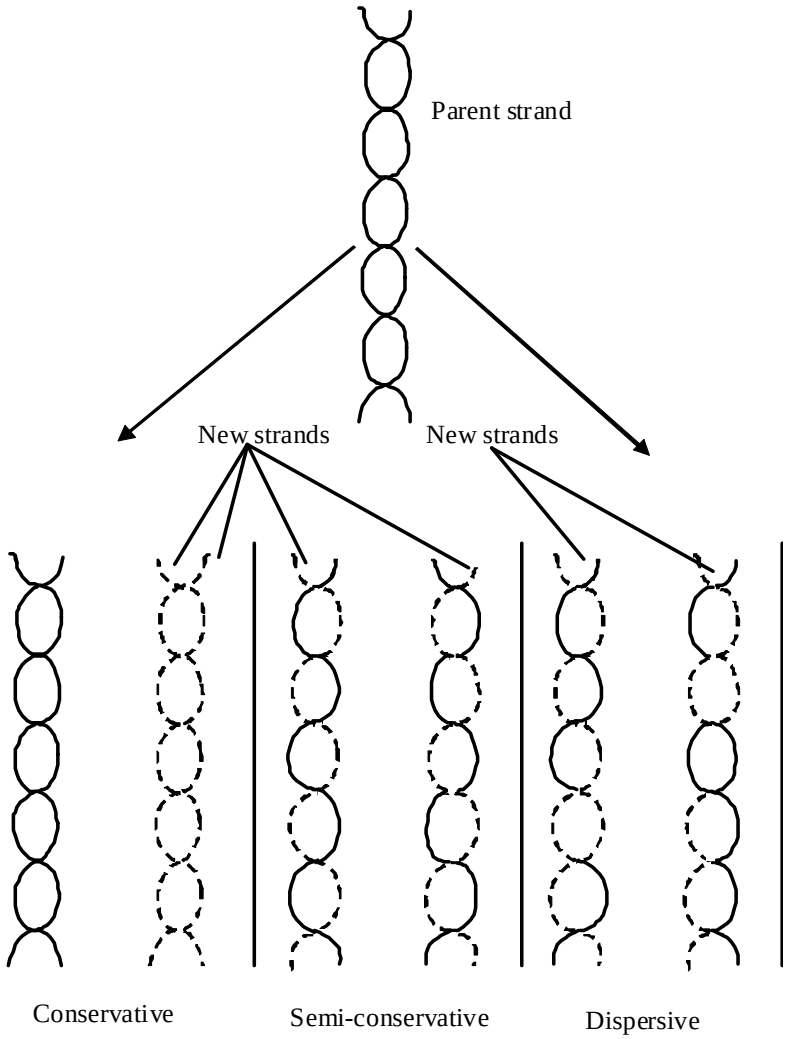
$$\text{Replication} \circlearrowleft \text{DNA} \underset{\text{Reverse Transcription}}{\overset{\text{Transcription}}{\rightleftharpoons}} \text{RNA} \circlearrowleft \xrightarrow{\text{Translation}} \text{Protein}$$

Reverse Transcription -

- The formation of DNA from RNA is known as **Reverse - transcription**. It was discovered by Temin and Baltimore in Rous - sarcoma virus. So it is also called **Teminism**.
- ss-RNA of Rous-Sarcoma virus (Retro virus) produces ds-DNA in host's cell with the help of enzyme reverse transcriptase (DNA Polymerase). This DNA is called **c-DNA (Complimentary DNA)**. Some times this DNA moves in host genome. Such mobile DNA is called **"Retroposon" (Oncogene)**.

D.N.A. REPLICATION

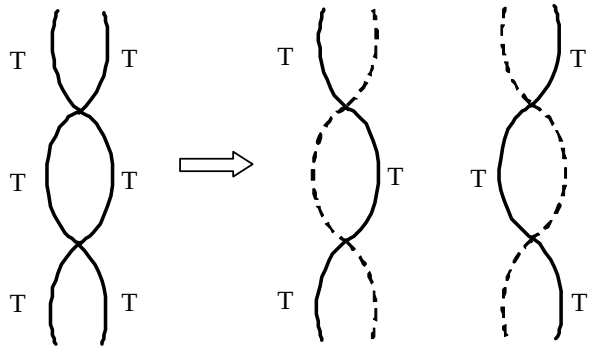
- D.N.A. is the only molecule capable of self duplication so it is termed as a **"Living molecule"**.
- All living beings have the capacity to reproduce because of this characteristic of D.N.A.
- D.N.A replication takes place in **"S - Phase"** of the cell cycle. At the time of cell division, it divides in equal parts in the daughter cells. Delbruck suggested three methods of DNA-replication i.e.
  (1) Dispersive
  (2) Conservative
  (3) Semi-conservative



DNA replication

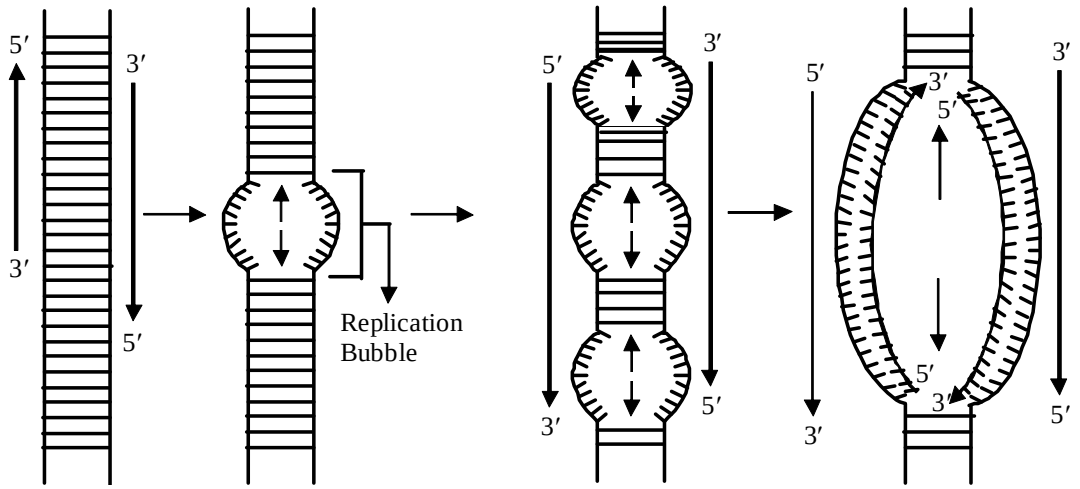
SEMI CONSERVATIVE MODE OF DNA REPLICATION

Semi conservative mode of DNA replication was first theoritically proposed by Watson & Crick. Later on it was experimentally proved by Meselson & Stahl (1958) on E-Coli and Taylor on Vicia faba. To prove this method , they used Radiotracer Technique in which Radioisotops are used. Meselson and Stahl used N15 and Cairns (1963) used radioactive Thymidine (with H3).



- Due to the replication of active Thymidine containing DNA., two DNA. molecules were obtained in which 50% radioactivity was found.
- When these two D.N.A. molecules containing active Thymidine were made to replicate, the next time four D.N.A. molecules were obtained. Out of these 4 D.N.A., 2 D.N.A. molecules were radioactive and remaining 2 were not radioactive.
- In the same sequence, the obtained DNA. molecules were further made to replicate then also, the no. of radioactive DNA remains 2.

MECHANISM OF DNA REPLICATION



The following steps are included in DNA replication -

(1) Unzipping -

- The separation of 2 chains of DNA is termed as unzipping and it takes place due to the braking of H bonds. The process of unzipping starts at a certain specific point which is termed as initiation point or origin of replication . In procaryotes there occur only one origin of replication but in eucaryotes there occur many origin of replication i.e. unzipping starts at many points simultaneously.
- The enzyme responsible for unzipping (breaking the hydrogen bonds) is Helicase (= Swivelase). In the process of unzipping Mg^{+2} act as cofactor. Unzipping takes place in alkaline medium.

- At the place of origin, the topoisomerase enzyme (a type of endonuclease) induces a cut in one strand of DNA (Nicking) to relax the two strands of DNA.
- A protein, "Helix destabilizing protein" prevents recoiling of two separated strands during the process of replication. An another protein SSB (single stranded DNA binding protein) prevents the formation of bends of loops in separated strands.

DNA-Gyrase : A type of topoisomerase prevent supercoiling of DNA.

Note -

The process of DNA replication takes a few minutes in prokaryotes and few hours in Eukaryotes.

(2) Formation of New Chain -

- To start the synthesis of new chain, special type of RNA. is required which is termed as R.N.A Primer. The formation of RNA. primer is catalysed by an enzyme - RNA. Polymerase (primase) Synthesis of RNA - primer takes place in 5' $\rightarrow$ 3" direction. After the formation of new chain, this R.N.A. is removed. For the formation of new chain Nucleotides are obtained from Nucleoplasm. In the nucleoplasm, Nucleotides are present in the form of triphosphate like dATP, dGTP, dCTP, dTTP etc.
- During replication, the 2 phosphate groups of all Nucleotides are separated. In this process energy is yielded which is consumed in D.N.A replication. So, it is clear that D.N.A. does not depend on mitochondria for it's energy requirements.
- The formation of new chain always takes place in 5' - 3" direction. As a result of this, one chain of D.N.A is continuously formed and it is termed as Leading strand. The formation of second chain begins from the centre and not from the terminal points, so this chain is discontinuous and is made up of small segement called **Okazaki Fragments**. This discontinous chain is termed as Lagging strand. Ultimately all these segments joined together and complete new chain is formed.
- The Okazaki segment are joined together by an enzyme DNA Ligase. (Khorana)
- The formation of new chains is catalysed by an enzyme DNA polymerase. In prokaryotes it is of 3 types :

(1) DNA - Polymerase I : This was discovered by **Kornberg** (1957). So it is also called as **Kornbergs enzyme**. Kornberg also synthesized DNA first of all, in the laboratory. This enzyme functions as exonuclease. It separates RNA - primer from DNA and also fills the gap. It is also known as DNA- repair enzyme.

(2) DNA - Polymerase II : It is least reactive in replication process. It is also helpful in DNA-repairing in absence of DNA-polymerase-I and DNA polymerase-III.

(3) DNA - Polymerase III : This is the main enzyme in DNA - Replication . It is most important. It was discovered by **Delucia and Cairns**. The larger chains are formed by this enzyme. This is also known as **Replicase**.

DNA - polymerase III is a complex enzyme composed of seven polypeptides α, α, θ, β, γ, δ, γ_2.

In Eucaryotes, there occur five types of DNA-polymerase enzyme.

(i) α-DNA - polymerase = Similar to DNA - polymerase I

(ii) β-DNA - polymerase = It concerned with DNA repair.

(iii) γ-DNA - polymerase = It concerned with replication of cytoplasmic DNA

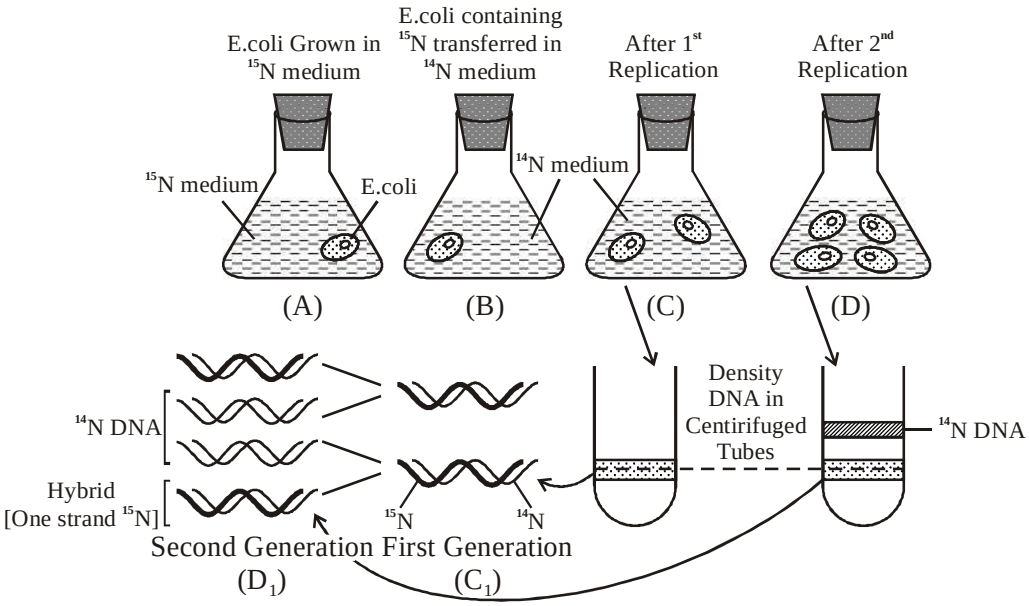
(iv) δ-DNA - polymerase = Similar to DNA - polymerase II

(v) ε-DNA - polymerase = Similar to DNA - polymerase III

- Thus DNA - Replication process is completed with the effect of different enzymes.
- In the semi conservative mode of replication each daughter DNA molecule receives one chain of polynucleotides from the mother DNA - molecule and the second chain is synthesized.

Special Point :

All DNA polymerase I, II and III enzymes have 5'-3" polymerisation activity and 3'-5" exonuclease activity.



Meselson and Stahl's Experiment

TRANSCRIPTION

- Formation of RNA over DNA templet is called transcription. Out of two strand of DNA only one strand participates in transcription and called **"Antisense strand"**.
- The segment of DNA involved in transcription is **"Cistron"**.
- RNA polymerase enzyme involved in transcription. In eukaryotes there are three types of RNA polymerases.
  - **RNA polymerase-I** for 28s rRNA, 18s RNA, 5.8s rRNA
  - **RNA polymerase-II** for m-RNA.
  - **RNA polymerase enzyme-III** for t-RNA, 5s RNA, SnRNA
- In eukaryotes RNA polymerase enzyme composed of 10-15 polypeptide chains.
- Prokaryotes have one type of RNA polymerase which synthesizes all types of RNAs.
- RNA polymerase of E. Coli has six polypeptide chains β, β′, α, α, ω, and σ.
- σ Polypeptide chain is also known as **σ factor** (sigma factor).
- Core enzyme + Sigma factor ⇒ RNA Polymerase
  (β, β′, α, α, ω) + (σ)

Following steps are present in transcription -

(1) Initiation -

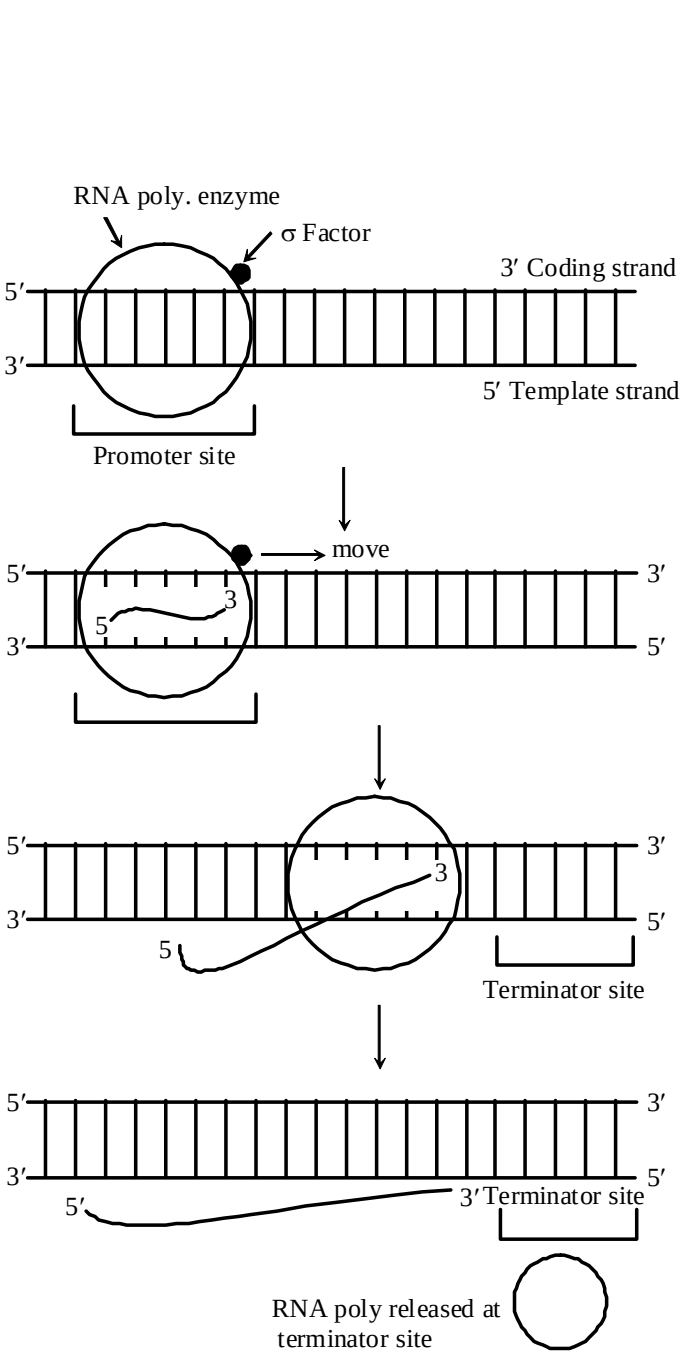
- DNA has a "Promoter site or initiation site" where transcription begins and a "Terminator site" where transcription stops.
- Sigma factor (σ) recognizes the promoter site of DNA.
- With the help of sigma factor RNA polymerase attached to a specific site of DNA called ''**Promoter site**''.
- In prokaryotes before the 10 N_2 base from "Promoter site" a sequence of 6 base pairs (TATAAT) is present on DNA, Which is called ''**Pribnow box**''.
- In eukaryotes before the 20 N_2 base from "Promoter site" a sequence of 7 base pairs (TATAAA) or (TATATAT) is present on DNA which is called **"TATA box or Hogness box"**.
- At promoter site RNA polymerase enzyme breaks H-bonds between two DNA strands and separates them One of them strand takes part in Trancription. Transcription proceeds in 5′ → 3′′ direction.
- Ribonucleotide triphosphate come to lie opposite complementary nitrogen bases of anti sense strand.
- These Ribonucleotides present in the form of triphosphate ATP, GTP, UTP and CTP in nucleoplasm. When they used in transcription, pyrophosphates hydrolyse two phosphates from each activated nucleotide. This releases energy.
- This energy used in process of transcription.

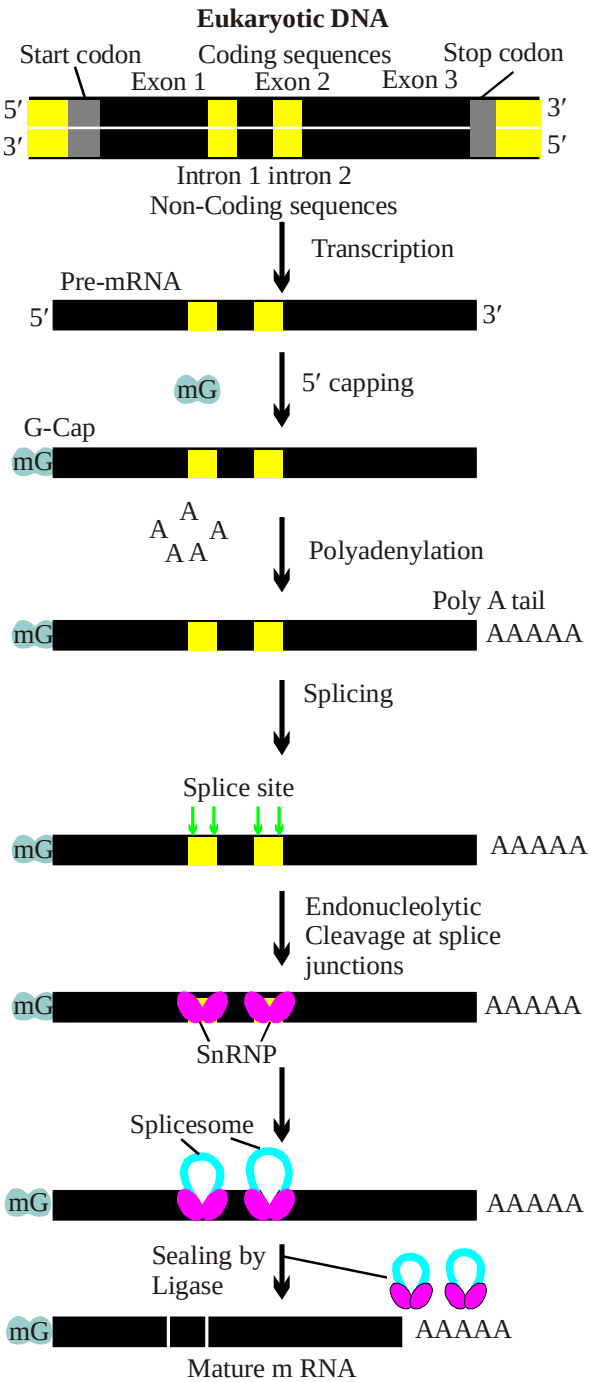
(2) Elongation -

- RNA polymerase enzyme establishes phosphodiester bond between adjacent ribonucleotides.
- Sigma factor separates and core enzyme moves along the anti sense strand till it reaches terminator site.

(3) Termination -

- When RNA polymerase enzyme reaches at terminator site, it separates from DNA templet.
- In terminator site on DNA, N_2 bases are present in palindromic sequence.
- In most cases RNA polymerase enzyme can recognize the "Terminator site" and stop the synthesis of RNA chain, but in prokaryotes, it recognizes the terminator site with the help of Rho factor (factor).
- Rho (ρ) factor is a specific protein which helps RNA polymerase enzyme to recognize the terminator site.





Post : Transcription in eukaryotes

PROTEIN-SYNTHESIS

(1) Activation of Amino acid -

- 20 types of amino acid participate in protein synthesis.
- Amino acid reacts with ATP to form "Amino acyl AMP enzyme complex", which is also known as 'Activated Amino acid.'

$$\text{Amino acid} + \text{ATP} \xrightarrow[\text{t-RNA synthetase}]{\text{Amino acyl}} \text{Amino acyl-enzyme complex} + \text{PP}$$

- This reaction is catalyzed by a specific 'Amino acyl t-RNA synthetas' enzyme
- There is a separate 'Amino acyl t-RNA synthetase' enzyme for each kind of amino acid.

(2) Charging of t-RNA -

- Specific activated amino acid is recognized by its specific t-RNA.
- Now amino acid attaches to the 'Amino acid attachment site' of its specific t-RNA and AMP and enzyme are separated from it.

$$\text{Amino acyl AMP-enzyme complex} + \text{t-RNA} \rightarrow \text{Amino acyl t-RNA complex} + \text{AMP} + \text{enzyme}$$

- Amino acyl t-RNA complex is also called '**Charged t-RNA**'.
- Now Amino acyl t-RNA moves to the ribosome for protein synthesis.

(3) Translation :

(A) Initiation of polypeptide chain

- In this step 30 's' and 50 's' sub units of Ribosome, GTP, Mg^{+2}, charged t-RNA, m-RNA and some initiation factors are required.
- In prokaryotes there are three initiation factors present - IF1, IF2, IF3.
- In Eukaryotes there are more than 3 initiation factors are present. 16 initiation factors have been identified in red blood cells-

  elF1, elF2, elF3, elF4A, elF4B, elF4C, elF4D, elF4F, elF5, elF6
- Initiation factors are specific protein.
- GTP and initiation factors promote the initiation process.
- In starting the both sub units of ribosome are separated with the help of IF3 factor.
- In prokaryotes with the help of "S D sequences" (Shine-Delgarno sequence) m-RNA recognizes the smaller sub unit of ribosome. A sequence of 8 N_2 base is present before the 4-12 N_2 base of initiation Condon on mRNA, called **"SD sequence"** In smaller subunit of ribosome, a complementary sequence of "SD sequence" is present on 16 'S' rRNA, which is called **"Anti Shine-delgarno sequence"**. (ASD sequence)
- With the help of 'SD' and 'ASD' sequence m-RNA recognizes the smaller sub unit of ribosome.
- While in Eukaryotes smaller sub unit of ribosome is recognised by "7mG cap".
- In Eukaryotes, 18 'S' rRNA of smaller sub unit has a complementary sequence of "7mG cap".

$$30\text{'S' sub unit} + \text{m-RNA} \xrightarrow[Mg^{+2}]{\text{IF3}} 30\text{'S' m-RNA-complex}$$

- This "30 'S' m-RNA - complex" reacts with 'Formyl methionyl t-RNA-complex' and "30 'S' mRNA -Formyl methionyl t-RNA-complex" form. This t-RNA attaches with codon part of m-RNA. A GTP molecule is required.

$$30'S'm-RNA-complex + Formylmethionylt-RNA\,complex$$
$$GTP \downarrow {}^{IF2,IF3}_{Mg^{+2}}$$
$$30'S'm-RNA\,formylmethionylt-RNA-complex$$

- Now larger sub unit of ribosome (50'S' Sub unit) joins this complex. The initiation factor released and complete 70 'S' ribosome is formed.
- In larger sub unit of ribosome there are three sites for t-RNA.

  'P' site = Peptidyl site

  'A' site = amino acyl site

  E-site = exit site
- Starting codon of m-RNA is near to 'P' site of ribosome, so t-RNA with formyl methionine amino acid first attached to 'P' site of ribosome and next codon of m-RNA is near to 'A' site of ribosome. So new t-RNA with new amino acid always attach at 'A' site of ribosome but in initiation step 'A' site is empty.

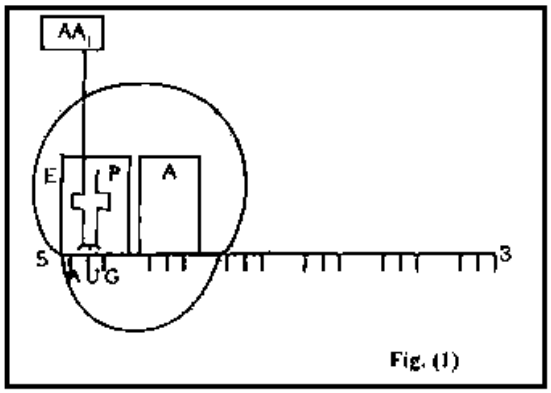


Fig. (1)

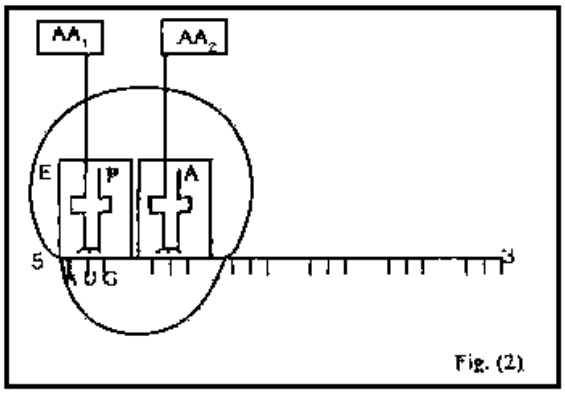


Fig. (2)

(B) Chain elongation

- New tRNA with new Amino acid at 'A' site of Ribosome.
- First of all t-RNA of P-site is discharged so-COOH of p-site A.A. becomes free.
- Now peptide bond formation takes place between -COOH group of P site amino acid and $-NH_2$ group of A site amino acid.
- Peptidyl transferase enzyme induces the formation of peptide bond. In Peptide bond formation, a 23 'S' r-RNA, 28 'S' r-RNA in eukaryotes is also helpful. This r-RNA acylt acts as an enzyme so it is also called **"Ribozyme"**.
- After formation of peptide bond t-RNA of P site released from ribosome via E-site and dipeptide attaches with A site.
- Now t-RNA of A site is transferred to P site and A site becomes emplty.
- Now ribosome slides over m-RNA strand in 5' $\rightarrow$ 3" direction. Due to sliding of ribosome on m-RNA, new condon of m-RNA continously available at A site of ribosome and according to new codon of m-RNA new amino acid attaches in polypeptide chain.
- Translocase enzyme helpful in movement of ribosome. GTP provides energy for sliding of ribosome.
- In elongation process some protein factors are also helpful, which known as **'Elongation factors'**.
- In prokaryotes three 'Elongation factors' are present -EF - Tu, EF - Ts, EF - G..
- In Eukaryotes two elongation factors are present-eEF1, eEF2.

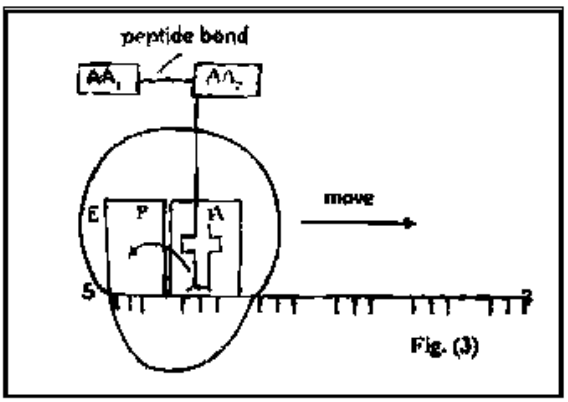


Fig. (3)

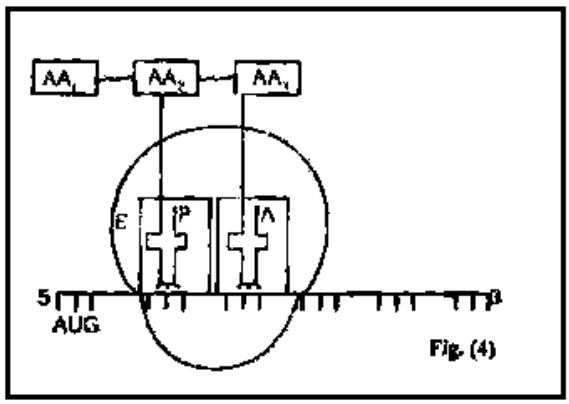


Fig. (4)

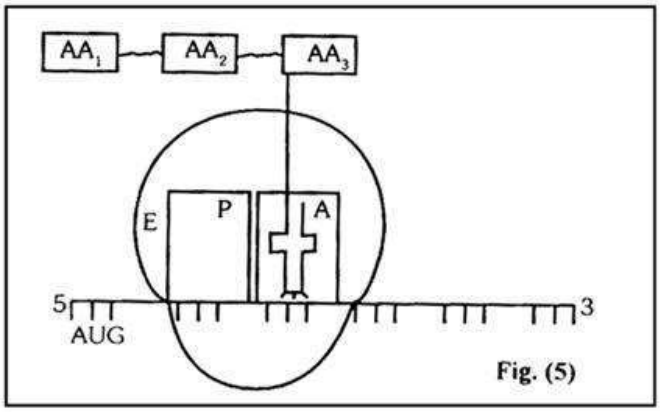


Fig. (5)

(C) Chain - Termination

- Due to sliding of ribosome over m-RNA when any Nonsense codon (UAA, UAG, UGA) available at A site of ribosome, then polypeptide chain terminate.
- The linkage between the last t-RNA and the polypeptide chain is broken by three release factor called **RF1, RF2, RF3** with the help of GTP.
- Peptidyl transferase enzyme also catalysed the releasing process.
- In eukaryotes only one Release factor is known - **eRF1**.

SPECIAL POINTS :

1. The chargraff's rule is not valid (true) for RNA. It is valid only for double helical DNA.
2. The duplication of DNA was first of all proved in E.coli bacterium.
3. E.coli Bacterium is mostly used for the study of DNA duplication.
4. **Hargovind singh Khurana** first of all recognized the triple codon for Cysteine and Valine amino acids
5. Cytoplasmic DNA is 1-5% of total cells **DNA**.
6. Three lady scientists named Avery, Mc-Leod and Mc Carty (by their transrformation experiments on bacteria) proved that DNA is a genetic material.
7. Hershey and chase first of all proved that DNA is genetic material in bacteriophages.
8. Frankel and Conret proved, RNA as a genetic material in viruses (g-RNA).
9. AUC, ACU, AUU } These anticondons do not exist.
10. The structure formed by the combination of m-RNA and Ribosomes is known as polyribosomes / Polysomes / Ergosomes.
11. The formation of t-RNA takes place from the heterochromatin part of DNA.

12. The formation of m-RNA takes place from the Euchromatin part of DNA.
13. m-RNA is least stable. It is continuosly formed and finished.
14. In cytoplasm, t-RNA is present in the form of soluble colloid.
15. **Nucleases -** These breaking enzyme of nucleic acids are of two types :
    (i) Endo - Nucleases - These break down the nucleic acids from the inside.
    (ii) Exo-nucleases - These break down the nucleic acids from the ends (terminals ends) These separate each nucleotide.
16. Tay-Sachs-diseases. This disease takes place due to excess storage of glycolipids
17. Excess storage of cerebrosides leads to Guacher's disease.

Some Inhibitors of Bacterial Protein Synthesis	
Antibiotic	**Effect**
Tetracycline	Inhibits binding of amino-acyl tRNA to ribosome
Streptomycin	Inhibits initiation of translation and causes misreading
Chloramphenicol	Inhibits peptidyl transferase and so formation of peptide bonds
Erythromycin	Inhibits translocation of ribosome along mRNA
Neomycin	Inhibits interaction between t-RNA and mRNA

18. **Spilt gene :** Discovered by **Sharp and Roberts** in Adenovirus 2 They were awarded by Nobel Prize in 1993. Gene which contains non functional part along with functional part is known as split gene. Non functional part is called **intron** and functional part is called **exon**. By transcription split gene produces a RNA which contains coding and non coding sequence and called **hn RNA (Hetero genous nuclear RNA)**. This hn RNA is unstable. Now 200 nucletides of adenylic acid are added to its 3' end, which is called **poly 'A' tail**. Now it becomes stable. 7 methyl guanosine is also added to its 5' end a cap like structure is formed. It is called **capping**. By the process of RNA splicing hn-RNA produces functional RNA that is exonic RNA. In RNA splicing non coding parts removed with the help of ribonuclease enzyme and coding part join together with the help of RNA ligase. Some specific proteins are also helpful in RNA-splicing called **'Small nuclear ribonucleoprotein'** or 'SnRNP' or 'Snurps'. These SnRNP proteins combine with some other proteins and SnRNA and form spliceosome complex. This spliceosome complex uses energy of ATP to cut the RNA, releases the non-coding part and joins the coding-part to produce functional RNA.

    Noncoding part of hn RNA remained inside the nucleus and not translated into protein. Only coding part moves from nucleus to cytoplasm and translated into protein.

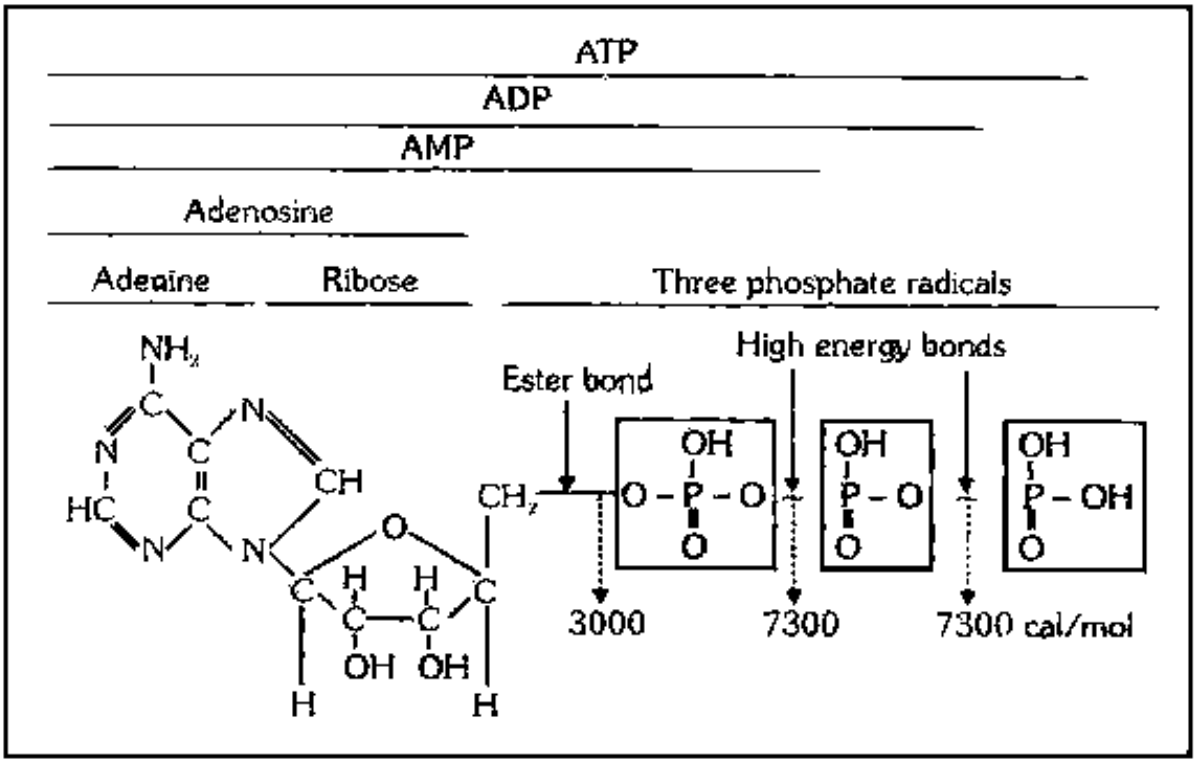
    Mostly prokaryotic genes are example of non split gene.

Special Points :

- In human mitochondria, 4 initiation codons present : AUG, AUA, AUU, AUC.
- **Mic RNA :** It is synthesized sometime on the sense of DNA which is complementary of Antisense strand which is used for mRNA synthesis. Such RNA is used for regulation of gene expression at the level of translation.

- **Higher Energy Nucleotide :** Nucleotides which contain more than one phosphate i.e. ATP, ADP.

ATP : Discover-Karl Lohmann. It is made up by Adenine, D-Ribose and three phosphate. It is a high energy compound that release energy when the bond between the phosphate is broken. In ATP two high energy bonds are present. ATP is also called **energy currency** of cell.



- **Iodine number :** It is the amount of iodine in gram absorbed by 100 gram fat. It is used to determine the degree of unsaturation of fat.
- **Second genetic code :** Interaction between specific t-RNA and amino acyl synthetase enzyme is known as **second genetic code**.

  GLUT-4 (Glucose transport 4) Proteins : It is a transport protein that allows glucose to enter a cell. GLUT-4 moves into the plasma membrane in response to insulin or muscle contraction. When amount of glucose increased in blood, more insulin is secreted GLUT-4 then responds to the presence of the insulin and enters the plasma membrane, allowing glucose to enter the cell.
- **DNA-quenching :** Rapid cooling of denatured DNA, fix it in permanently denatured from, it is called **DNA quenching**.
- $\phi \times 174$ bacteriophage has 5386 nucleotides, λ-bacteriophage has 48502 base pairs, Escherichia coli has 4.6×10^6 base pair and 6.6×10^6 base pairs in human (2n).
- 2-OH groups present at everynucleotide in RNA as reactive group and makes RNA labile and easily degradable and RNA also has catalytic function so it is more reactive. DNA is chemically less reactive and structurally more stable as compared to RNA.
- DNA is more stable so preferred for storage of genetic information but for the transmission of genetic information RNA is better.
- An mRNA also have some additional sequences that are not translated and are referred as untranslated regions (UTR). The UTRs are present at both 5'end (before start codon) and at 3' end (after stop codon).

- **RNA Interference :** It is a method of gene silencing. In this method a ds RNA is inserted in a cell and enzyme Dicer break this ds RNA into small ds fragments of 20-25 base pairs with a few unpaired overhang bases on each end. This short ds fragments are called small interfering RNA (si RNA). Now siRNA associated with specific protein to form a complex RISC (RNA induced silencing complex). Now RISC attached with targeted m-RNA and inhibit its translation.
- For RNA-interference in Caenorhabditis elegans Andrew fire and Craig C. Mello got Noble Prize in 2006 in physiology and medicine.

GENE EXPRESSION

The second important characteristic (first is transmission) of the gene is to store and express the genetic information that will contribute towards the phenotype.

DNA carries information for the synthesis of all proteins required for the function of a cell. A close relationship between genes and enzymes (or gene control the metabolism) was first discovered by a British physician **Archibald Garrod** in 1909 (Father of human biochemical genetics. Concept - **One mutant gene one metabolic block**). He observed that certain hereditary diseases in man such as **alkeptonuria** (black urine disease), **albinism** (absence of melanin pigment) **phenylketonuria** etc. are inborn errors of metabolism and are due to the defect in the enyme that catalyses the conservation of one metabolic substance to another. Thus, the inherited genetic defect is reflected in the deficiency of an enzyme.

Beadle and Tatum's Hypothesis (One gene one enzyme hypothesis)

The concept that genes have the information to produce enzymes, or gene metabolism relationship was experimentaly proved by **Beadle** and **Tatum** (1948), on the basis of experiments conducted on pink bread mould **(Neurospora crassa).** This mould can normally grow in a simple minimal medium containing salts and sugar, making all other chemicals such as amino acids, purines, pyrimidines etc. through enzyme catalysed reactions. This wild type of the mould is called '**protoroph**'. Beadle and Tatum exposed the pink bread mould to X-rays, which can bring about a change in the nucleotide sequence of DNA and thus causes mutation. They found that the mutants were unable to grow on a minimal medium. Each type of mutant required some extra nutrient in the minimal medium for it's normal growth. Such nutritional mutants are called '**auxotrophs**'. They obtained different nutritional mutants requiring amino acids ornithine or citrulline or arginine for growth. The mutants could be classified into three types:

Some could grow on ornithine -, or citrulline -, or arginine - containing medium,

Some could grow on citrulline - or arginine containing medium,

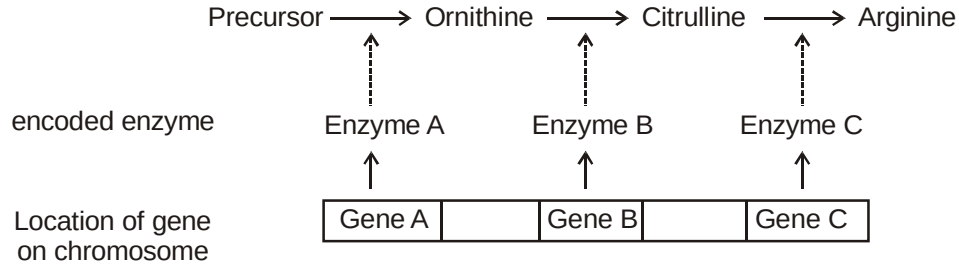
Some could grow on arginine supplemented medium

Effect of medium supplemnts on the growth of mutants Neurospora crassa

	Growth on Medium supplemented with		
Mutant Type	Ornithine	Citrulline	Arginine
I	+	+	+
II	–	+	+
III	–	–	+

+ = growth – = No grwoth

Biochemical Pathway



- This shows that all mutants could grow on arginine supplemented medium suggesting that arginine is the final product of this pathway.
- Since some mutants could not grow on ornithine, this compounds must be synthesized earlier than citrulline and or arginine.
- Beadle and Tatum taking clue from this growth behaviour of Neursopora and other experiments, proposed the **arginine biosynthetic pathway.** The precursor compound first gives rise to ornithine, ornithine then gives rise to citrulline and the latter is finally converted into arginine; each of these steps is mediated by an enzyme.
- The mutant of **class I**, could grow on ornithine, citrulline or arginine suggesting that they lack the capacity to synthesize ornithine, but beyond that they could complete the pathway.
- Similarly, mutants of **class II**, could not convert ornithine to citrulline, but if supplied circulline could Synthesize arginine.
- The last mutants of **class III** could not convert citrulline to arginine and had to be supplied Arginine for growth.
- Beadle and Tatum reasoned that these defects could arise due to defective enzymes in each mutant. Since such changes were mutational, they held that one gene controls one enzyme in a pathway leading to their famous '**One gene one enzyme hypothesis**".

  The hypothesis states that each gene controls synthesis of a specific enzyme or protein. Beadle and Tatum were awarded with Noble prize for this work in 1958. Their work founded the new science of '**biochemical genetics**'. Beadle and Tatum used **total isolation method** to detect the nutritional mutant of Neurospora. **Modification of Beadle and Tatum's Hypothesis** : One gene one enzyme hypothesis held that a gene has information to produce one enzyme. The enzymes are proteins, but all proteins are not enzymes. Recently some RNAs have also been found to mainfest enzyme activity. Proteins are complex molecules and may be composed of one or more polypetide chains. For example, haemoglobin consists of four polypetide chains - **2[redacted] and 2[redacted] chains**. Thus, more than one gene may control the synthesis of a protein. It is now held that one gene is responsible for the formation of one polypetide chain. Therefore, one gene one enzyme hypothesis has been replaced by '**one gene one polypetide hypothesis**' Further modification came when one gene was identified as a **functional unit** or **cistron** and the same was called '**one cistron-one polypeptide hypothesis**'.

REGULATION OF GENE EXPRESSION

- The mechanism which stimulates the expression of certain genes and inhibits other is called **regulation of gene expression.**
- It is possible only if the organism has a mechanism of regulating gene activity by allowing some to function and others to restrain their activity through switching on and switching off system. This means, the genes are turned 'on' or 'off' as per requirement.
- A set of genes is 'switched on' when enzymes are required to metabolise a new substrate. The enzymes produced by these genes metabolise the substrate.

- The molecules of metabolite the come to switch on of the genes are termed as **inducers** and the phenomenon is called **induction**.
- Similarly, certain genes which are in their 'switch on state, continue to synthesise a metabolite till the later is produced in amount more than required or, it is supplied to the cell from outside. In other words genes continue to express themselves till the end product inhibits or repress their expression Inhibition by end product is known as '**feed back repression**'.

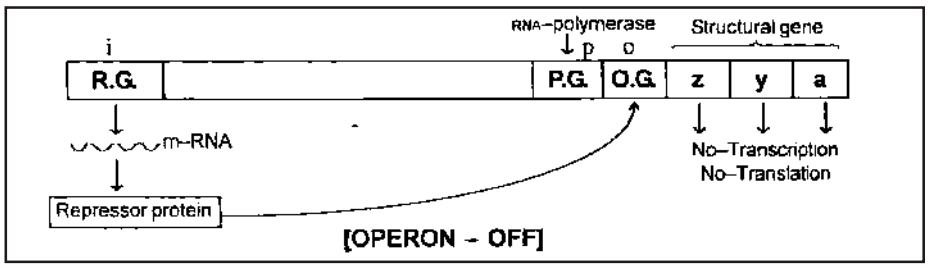
OPERON CONCEPT :

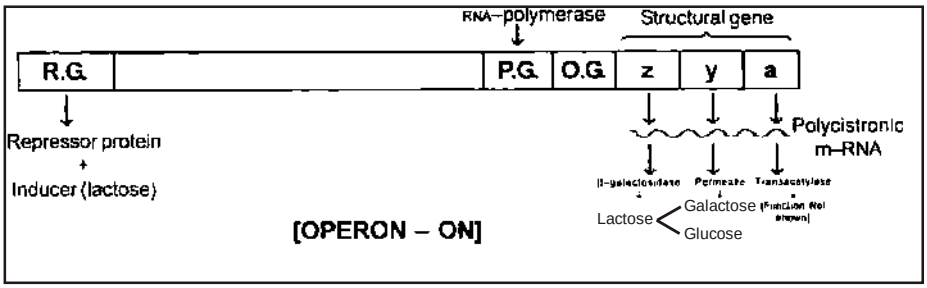
- In 1961, two French microbiologist **Francis Jocob** and **Jacques Monad** at the Pasteur Institute in paris, proposed a mechanism called **operon model** for the regulation of gene action in E. coli.
- An operon is a part of genetic matierial or DNA, which acts as a single regulated unit having one or more structural genes-an operator gene, a promoter gene, a regulator gene.
- Openon is **unit of Transcription.**
- Operons are of two types (i) **Inducible,** (ii) **Repressible.**

(i) Inducible System (Lac operon of E. Coli)

An inducible operon system normally remains in **switched off** condition and begins to work only when the substance to be metabolised (Inducer) by it is present in the cell. Inducible operon system generally occurs in catabolic pathways. e.g. Lac operon of E. coli.

Active repressor + inducer = inactive repressor





An inducible opeon system consists of four types of genes :

(a) Structural genes : These genes synthesise mRNAs, which in turn synthesis polypeptide or enzyme over the ribosomes. An operon may have one or more structural genes. Each structural gene of an operon is called cistron. The lac operon (lactose operon) of Escherichia coli contains three structural genes (z, y and a). These genes occur adjacent to each other and thus are linked. They transcribe a polycistronic mRNA molecule, that helps in the synthesis of three enzymes **β-galactosidase or Lactase**, **lactose permease** and **transacetylase**.

(b) Operator gene : It lies adjacent to the structural genes and directly controls the synthesis of mRNA over the structural genes. It is switched off by the presence of a repressor. An inducer can take away the repressor and switch on the gene that directs the structural genes to transcribe.

(c) Promoter gene : This gene is the site for initial binding of RNA polymerase. When the operator gene is turned on, the enzyme RNA polymerase moves over it and reaches the structural genes to perform transcription.

(d) Regulator gene : It produces a repressor that binds to operator gene and stops the working of the operator gene.

- **Repressor :** It is a protein, produced by the regulator gene. It binds to the operator gene so that the transcription of structural gene stops. Repressor has two allosteric site (1) operator gene (2) effective molecule (inducer / corepressor)
- **Inducer :** It is a chemical (substrate, hormone or some other metabolite) which after coming in contact with the repressor, forms an **inducer repressor complex**. This complex cannot bind with the operator gene, which is thus switched on.

  The inducer for lac operon of *Escherichia coli* is lactose. When the sugar lactose is added to the culture of E. coli, a few molecules of lactose gets into the bacterial cells by the action of the enzyme permease, a small amount of this enzyme is present in the cell even when the operon is not working. These few lactose molecules are then converted into an active form which acts as an inducer and binds to the repressor protein. (allolactose an isomer of lactose) **Allolacotse is real or true inducer of lac operon** The inducer repressor complex fails to join with the operator, which is turned on. The three genes are expressed as three enzymes to metabolise lactose. Gratuitous inducer → Some molecules resemble with natural inducer but are **not metabolize** by the enzyme. Example : **Isopropyl this galactoside (IPTG) :** This resembles lactose and thus have the property of induction. Such inducer which induces enzyme synthesis, without getting metabolized are called **gratuitous inducer.**

(ii) Repressible System (Triptophan operon of E. coli)

A repressible operon system is normally in it's **switch on** state and continue to synthesise a metabolite till this metabolite is produced in amount more than required, or else it becomes available to the cell from outside. Repressible operon system is commonly found in anabolic pathway. e.g. Tryptophan operon of E.coli.

[Inactive repressor + co-repressor = active repressor]

- **Trytophan operon** of Escherichia coli is an example of repressible system. It consists of the following:

(a) Structural operon These genes are meant for transcription of mRNA which in turn synthesis enzyme :Tryptophan operon has five structural genes E.D.C. B and A. They lie in continuation and synthesis enzymes for five steps of tryptophan synthesis.

(b) Operater gene (trp O) It lies adjacent to the structural genes and controls the functioning of the structural genes. Normally, it is kept switched on, because the apo-repressor produced by the regulator gene does not bind to it. The operator gene is switched off when a co-repressor is available alongwith apo-repressor.

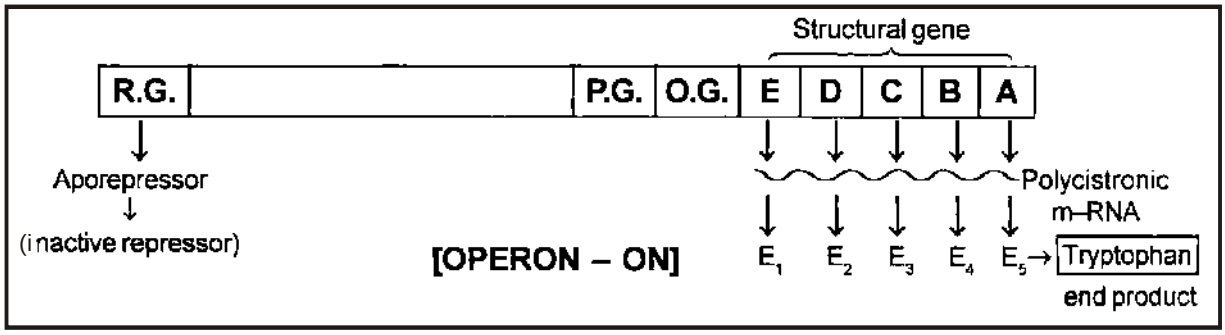
(c) Promoter gene (trp P). It marks the site at which the RNA polymerase enzyme binds. When the operator gene is switched on, it moes from promotor gene to structural genes for transcription.

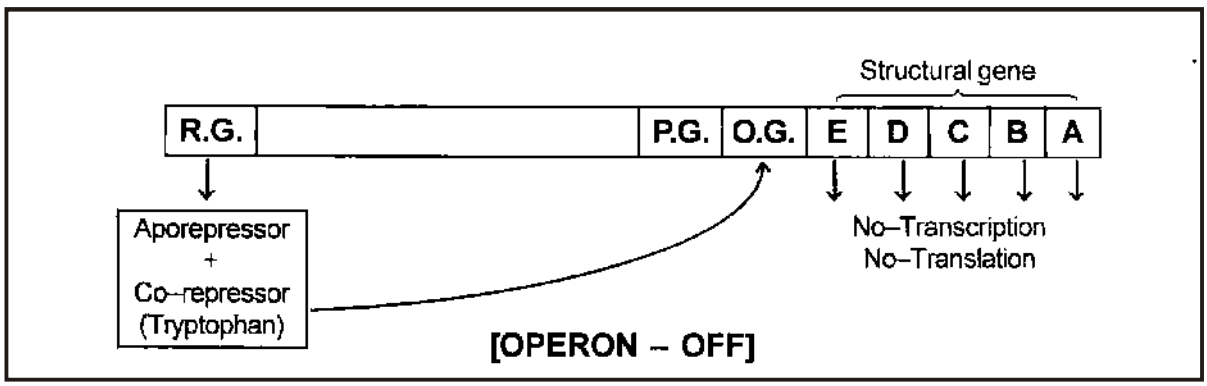
(d) Regulator gene (trp R). It produces a regulatory protein called apo-repressor for (Inactive repressor) blocking the activity of operator gene.

(e) Apo-repressor. (Inactive repressor) It is a regulatory protein synthesised by regulator gene. When a co-repressor substance is available in the cell, the apo-repressor combines with the co-repressor to form a apo-repressor co-repressor complex. This complex binds with the operator gene and switches it off. Presence of apo-repressor alone, the operator gene is kept **switched on** because, by itself the apo-repressor-is unable to back the working of operator gene.

Co-repressor – It is an end product of reaction by enzyme produced by the structure gens. In the presence of tryphoton some molecules of tryptopham acts as co-repessor, co repressor bind with inactive

repressor, inactive repressor. **co-repressor complex** bind with operator region and prevent the binding of RNA polymerase to the promoter, the trp-operon is off.





Differeces between Induction and Repression

Sr.No.	Induction		Repression
1	It is switching on of an operon which is normally in switched off state (off-on).	1	It is switching-off an operon which is normally in switched on state (on-off).
2	It starts transcription and translation.	2	It stops transcription and translation.
3	It is caused by a new metabolite which needs enzymes to get metabolised.	3	It is caused by incresed formation or availability of a metabolite (Feedback repression).
4	It generally operates in a catabolic pathway.	4	It generally operates in an anabolic pathway.

The **repressor molecules has key role in regulation** of lac-operon. Repressor molecule active or inactive. Active repressor may be inactive by addition of an inducer while the inactive repressor can be made active by addition of a co-repressor.

Because the product of regulator gene the repressor act by shutting off the transcription of structural gene the operon model, as originally proposed by Jocob & Monab is referred as **negative** control system.

GENE EXPRESSION IN EUKARYOTES :

- Openon concept is not applicable for eukaryotes
- The most popular model is known as'**Britten-Davidson model**' or '**Gene-battery model**' proposed by **Britten** and **Davidson** in 1969.
- A set of structural genes controlled by one sensor site combindly called battery.
- Gene battery model assumes the presence of four class of sequences

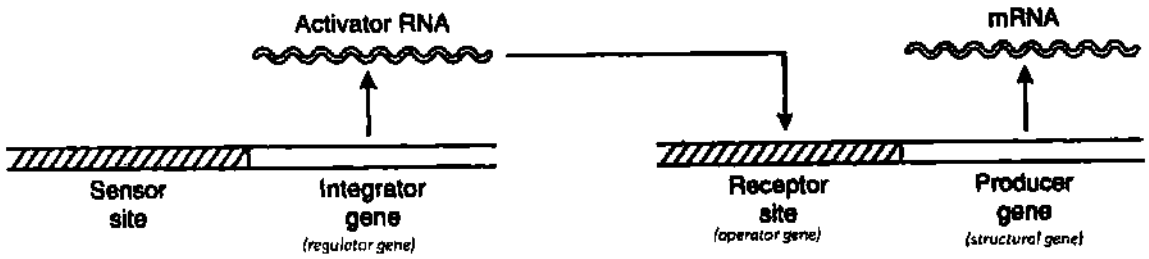
(a) Producer gene : A producer gene is comparable to structural gene of prokaryotic operon.

(b) Receptor site : A receptor site is comparable to **operater gene** of bacterial operon and one such receptor site is assumed to be present adjacent to each producer gene.

(c) Integrator gene : Integrator gene is comparable to **regulator gene** and is responsible for synthesis of an **activator RNA**. It activates the receptor site.

(d) Sensor site : A sensor site regulates the activity of integrator gene. Activator gene can be transcribed only when the sensor site is activated.

The sensor sites are recoginzed by agents which change the patterns of gene expression like hormones and proteins. When a transcription factor (protein, hormone) bind to the sensor site it cause the transcription of integrator.



Britten-Davidson model or Gene-battery model

TYPES OF GENE

All the genes do not play the same role nor all genes are active all the time. With regard to their role and activity, the genes are of following types :

(1) Jumping Genes :

It is a segment of DNA which moves from one chromosome to another chromosome within the genome of an indivisual. McClintock (1983) got nobel prize for the discoevery of jumping gene in maize. Two transposable controling elements (Ds) and activator (Ac), which can jump to any chromosome from their original location on chromosome 9. Also in bacteria plasmid transposone carry gene for antibiotic resistance (ampicilline).

Other Examples :

Transposable element (TE) in Drosophila - As much as 10% of the genome consist of transposons, most important of these are **copia like element, Fold back (FB)** (for eye colour), and **P** and **I** element (for sterlity). Ty elment in yeast.

(2) Overlapping Gene : A few genes in certain bacteria and animal viruses code for two different polypetides. These are called overlapping genes. For example – in $\phi \times 174$ virus, SV -40 virus.

(3) Constitutive genes (House keeping genes): These genes are expressed constantly, because their products are constant needed for cellular activity e.g. genes for glycolysis, gene of ATPase enzyme.

(4) Non-constitutive genes (Smart gene or Luxary gene) – These genes remain silent and are expressed only when the gene product is needed. They are switched 'on' or 'off' according to the requirement of cellular activities. Non-constitutive genes are of two types; **inducible and repressible**. The inducible

genes are switched on in presence of a chemical substance called **inducer**, required for the functioning of gene activity. The repressible genes continue to express themselves till a chemical, often an end product of the metabolism inhibits or represses their activity. Such type of inhibition is called **feed back inhibition** or **feed back repression.**

(5) Homeotic genes : Homeotic gene regulates the organ differentiation in embryo.

Homeobox : related to transcription of homeotic gene.

If mutation takes place in homoetic gene organ formation is disturbed.

(6) Pseudoallele : Allele which is located on non homologous chromosome or gene which is located on different locus on homologous chromosome produces identical phenotype called as pseudoallele. eg Duplicate gene

(7) Isoallele : If several allels exhibit same penotype then they are said to **Isoallele.** In Drosophila allele W^{+c} W^{+S} W^{+9} $\rightarrow$ produce red eye colour

(8) Hybrid vigour / Heterosis – Superiority of offsprings over it's parents is called as **Hybrid vigour** or **Heterosis**.

Hybrid vigour can be maintained for long time in vegetaively propagated crops.

Hybrid vigour can be lost by inbreeding (selfing) because inbreeding induces the Homozygosity and reduced hetrozygocity in offsprings. Loss of Hybrid vigour due to inbreeding, is called as **inbreeding depression**.

ORIGIN OF LIFE AND EVOLUTION

Big-Bang Theory :

This theory was proposed by **Abbe Lemaitre.** According to it, the universe originated about 15 billion years ago due to a thermonuclear explosion of a dense enetity. This thermonuclear explosion is called **Big-bang.**

About 4.6 billion years ago, the origin of our solar system took place by the gaseous clouds formed due to this explosion.

These gaseous clouds collapsed and converted into flat disc-like structure made up of atoms and small particles due to their own gravitational pull.

These flat-disc like structure is called **SOLAR-NEBULA.**

The very hot central part of this solar Nebula became still hotter & converted into the **sun.** Now, due to condensation of atoms & dust particles moving around the sun formation of the other planets took place **[Mercury, venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune]**.

The solid part of our planet earth was called Lithosphere & the gaseous part was known as atmosphere.

When the earth's surface cooled down and its temperature decreased to 100°C, water formed on it.

Ancient Theories for origin of life :

1. Theory of special creation –

The greatest supporter of this theory was **father Suarez** According to Bible life and everything was created by god in 6 days.

on first day : Earth and heaven

on second day : Sky and water

on third day : Land and plants

on forth day : Sun, moon and stars

on fifth day : Fishes and birds

on sixth day : Land animals and first man Adam and from his 12^{th} Rib first woman Eve.

According to **hindu mythology** the world was created by **God Brahma.** (The first man was **Manu** and the first woman was **Shraddha**)

According to it life has not changed ever since its origin.

Special creation theory lacks scientific evidences so is not accepted.

2. Theory of Spontaneous Generation (Abiogenesis or Autogenesis) –

This hypothesis was supported by ancient Greek philosophers like Thales, Anaximander, Xenophanes, Plato. Empedocles, Aristotle.

According to this theory life was originated from nonliving things spontaneously.

They believed that the mud of the **Nile** river could give rise to frogs, snakes, crocodiles.

Abiogenesis was strongly supported by **Von Helmont.** He claimed formation of mice in 21 days. If a sweat soaked dirty shirt is kept in wheat barn.

3. **Cosmozoic Theory –**

   Proposed by **Richter.**

   Protoplasm reached on earth in the form of **spores** or other simple particles from some unknown part of the universe with cosmic dust and they gave rise to various forms of life.

4. **Cosmic panspermia theory –**

   Proposed by **Arrhenius.**

   According to this theory organisms existed throughout the universe and their spores could freely travel through space from one star to the other.

5. **Theory of Eternity of Life –**

   Helmholz believed that life is **immortal.**

6. **Theory of Biogenesis –**

   Harvey (1651) and Huxley (1870) {Omnis vivum ex ovo or vivo.}

   New organisms can be originated on earth only by pre-existing life.

   This theory rejected the theory of Spontaneous generation but cannot explain origin of life.

   To prove Biogenesis and to disprove a biogenesis experiments were performed by –

- **Francesco Redi's Experiment (Italian 1668) –**

  He took cooked meat in three jars one was uncovered, the second was covered with parchment and the third was air tight.

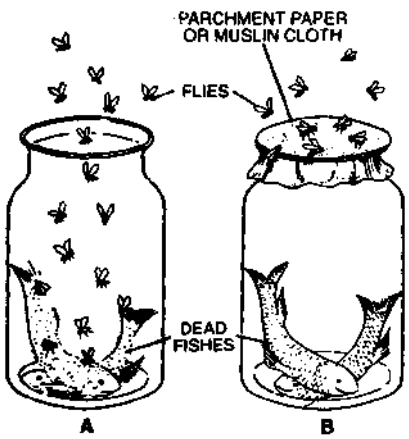
  He observed that maggots developed only in the uncovered jar while maggots could not developed in the meat in closed jars.

  This proved that larvae were formed from eggs laid by the flies in open jars. Since the meat in closed jars could not be visited by flies so no larvae could develop. Therefore life originated from pre existing life.

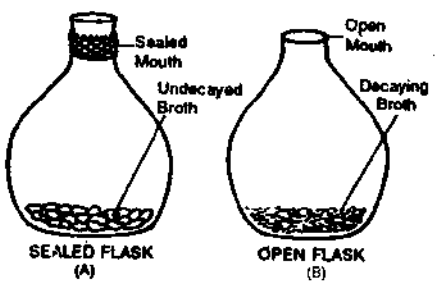
- **Lazzaro Spallanzani (Italian 1767) –**

  He boiled vegetables and meat to prepare a sterlized nutritive soup and he kept some of it in air sealed flasks and some in loosely corked flasks. He observed that the soup in sealed flask remained sterile while micro organisms appeared in the soup in loosely corked flasks.

  Thus even micro organisms were formed from pre existing ones in the air rather then spontaneously.



Francesco Redi's experiment



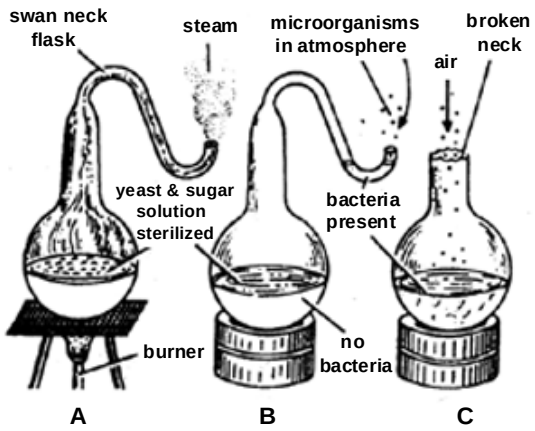
Spallanzani's experiment. A broth remained undecayed indefinitely in sealed jars. B, broth decayed in open jar.

Louis Pasteur (French 1862) –

Pasteur is popular for **Germ Theory of Diseases or Germ theory** and he disproved abiogenesis.

He prepared sterlized **syrup** of sugar and yeast by boiling them in flasks.

He took two flasks one of broken neck and another of curved neck (swan neck flask). No life appeared in swan neck flask because germ laden dust particles in the air were trapped by the curved neck which serves as filter while in broken neck flask colonies of microorganism were developed.



Louis Pasteur's Experiment

Modern theory of origin of life : (Oparin-Haldane theory of origin of life)

- **Naturalistic theory Or Theory of Chemical Evolution –**

  This theory was proposed by Russian Scientist **A.I. Oparin** and **J.B.S Haldane** (England born Indian scientist)

  Oparin's theory was published in his book 'ORIGIN OF LIFE'.

- **Important Points**

– According to this theory life originated by the composition of chemicals.

– Oparin's theory is based on Artificial Synthesis. So also called as **artificial synthetic theory.**

– Ist life originated in the water of oceans. So water is essential for origin of life.

– There is no life on moon due to absence of water.

– At the time of origin of life free O_2 was absent, so first life was **anaerobic.**

– In the primitive atmosphere free oxygen was present but complete oxygen consumed in composition so primitive atmosphere of earth was **reducing.**

– Oxygen was reproduced by photosynthesis and atmosphere converted in oxydising.

- **Chemical Evolution**

1. The atomic stage –

The earth was originated about 4.6 billion years ago. Early earth had free atoms of all elements which are essential for the formation of protoplasm.

The lightest atoms like **carbon, hydrogen, nitrogen and oxygen** formed the primitive atmosphere.

2. Molecular stage (Origin of molecules and simple Inorganic compounds) –

Free atoms combined to form molecules and simple inorganic compounds.

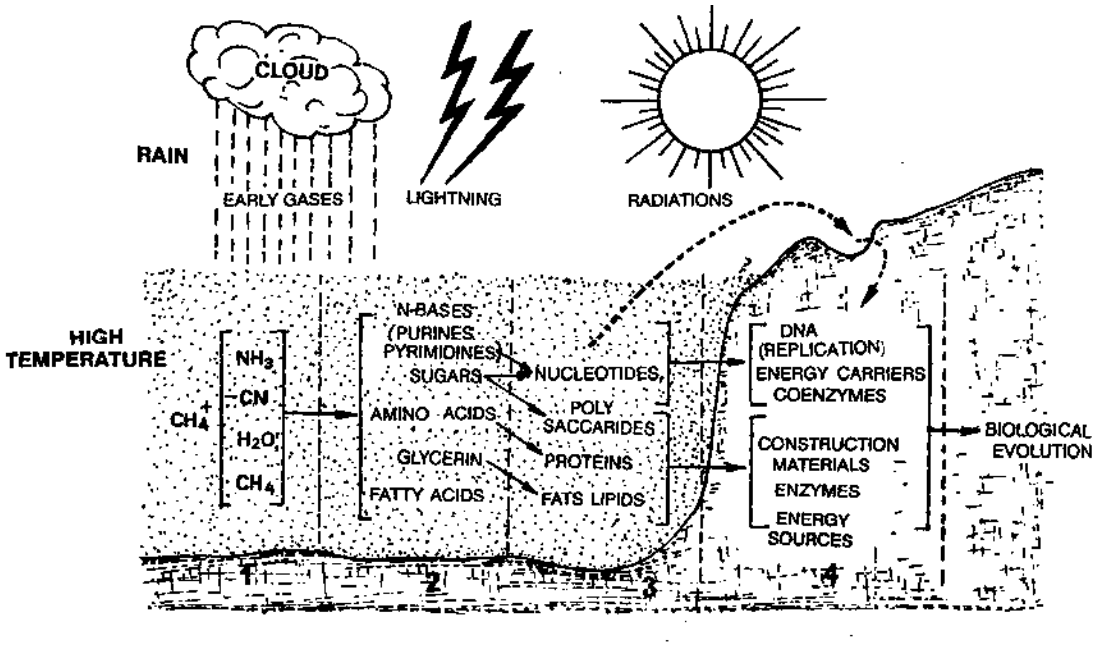
Due to presence of high temperature, active hydrogen atoms combined with all oxygen atoms to form water and leaving no free oxygen.

Thus the primitive atmosphere was **reducing** (without free oxygen) unlike present **oxidising** atmosphere (with free oxygen).

Hydrogen atoms also combined with nitrogen to from NH_3.

(The first molecular compounds formed were probably water and Ammonia).

These Lighter elements also formed CO_2, CO, N_2, H_2 etc.



Evolution of 'Biochemicals' in the origin of life.

3. Origin of early organic compounds –

The nitrogen and carbon of the atmosphere combined with metallic atoms forming nitrides and carbides. Water vapour and metallic carbides reacted to form to **first organic compound Methane (CH_4).** Later on **hydrogen cyanide (HCN)** was formed .

Water which formed on earth due to high temperature evaporated so **clouds** were formed.

Water vapour changed into rain drops and by the collection of water on earth primitive oceans were formed.

4. Origin of simple organic compounds –

Water of primitive oceans contained large amount methane, ammonia, hydrogen, cyanides, carbides, nitrides.

These early compounds interacted and formed simple organic compounds like, aldehyde, Ketones. Alcohols Pentose and hexose sugar, Amino Acids, Glycerol, Fatty Acids, Purines, Pyrimidines etc.

Energy was obtained from U.V. Rays of sunlight, cosmic rays and heat of volcanic eruptions.

5. Origin of complex organic compounds –

The small simple organic molecules combined to form large complex organic molecules, e.g –

- Amino acids Joined to form polypeptides and proteins, which were non-enzymatic.
- Simple sugar units combined to form polysaccharides.
- Fatty acids and glycerols united to form fats and lipids.
- Sugar, nitrogenous bases, phosphates combined into nucleotides which polymerized into nucleic acid, which unable to replicate.

These macromolecules forms main component of protoplasm hence the possibility of origin of life in primitive oceans could be established.

After long time the water of primitive oceans became rich mixture of organic compounds as a result of chemical evolution.

Haldane called this saturated water of oceans as prebiotic soup or hot dilute soup.

The major requirement for promoting polymerization is the availability of continuous source of energy and removal of water from the surface of reactants so that they can concentrate and prevent depolymerisation.

- **Experimental evidence for formation of simple organic compounds –**

  By Stanley Miller who was a student of **Harold Urey.**

  In this experiment Miller took the mixture of **methane, ammonia and hydrogen (ratio 2 : 1 : 2)** in a large flask and passed steam over it by boiling water and connecting it with a glass tube.

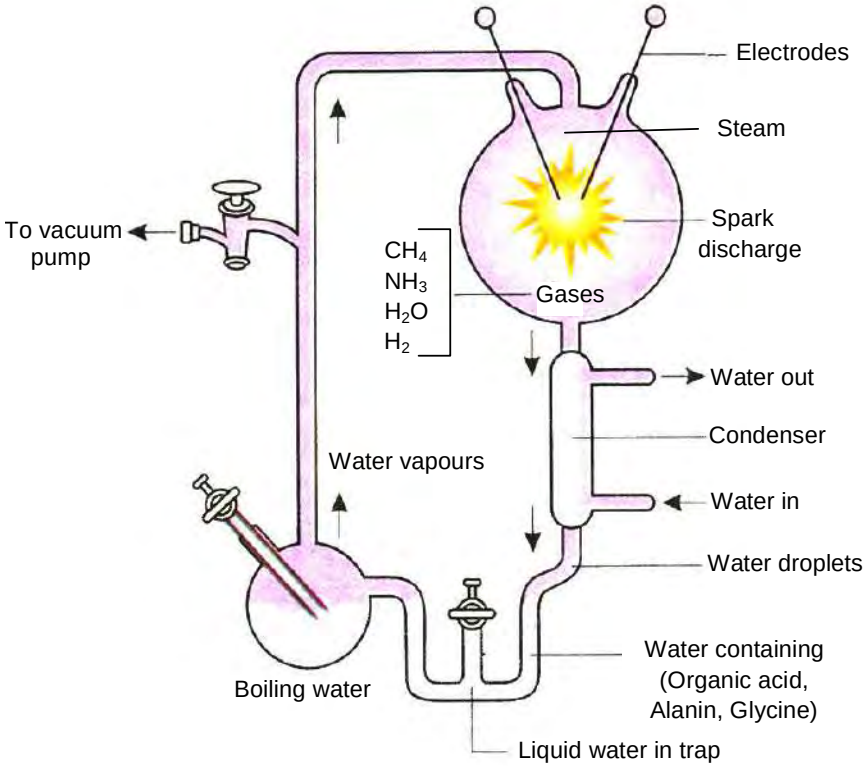
  Electric spark discharged in the mixture by using two tungsten electrodes as **source of energy.**

  After **18 days** this fluid was collected and analysed. This dark red fluid was found to contain.

  – Simple amino acids – glycine, alanine, aspartic acid.

  – Simple organic acids – formic, acetic, oxalic, lactic, succinic acids.

  – Pentose, hexose, aldehyde, ketone etc.



Diagrammatic representation of Miller's experiment

BIOLOGICAL EVOLUTION :

1. Origin of Protobionts and Nucleoprotein (Coacervates) :

Macromolecules which were synthesized abiotically in primitive ocean later came together and formed large colloidal drop like structures named as Protobionts **(Later called coacervates by oparin, Fox and called them Microsphere and Deamer called them vesicles).**

Each protobiont was **cluster** of macromolecule.

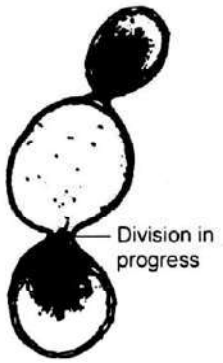
They contain proteins, nucleic acids, lipids, polysaccharides etc.

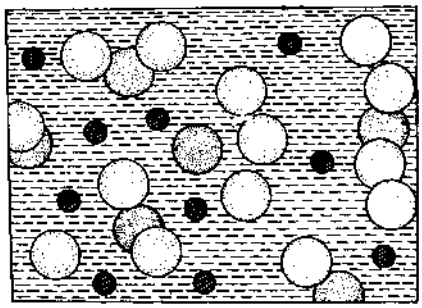
They grew by absorbing molecules from their environment.

They could divide by budding like bacteria, many chemical reactions including the decomposition of glucose took place inside the protobionts.

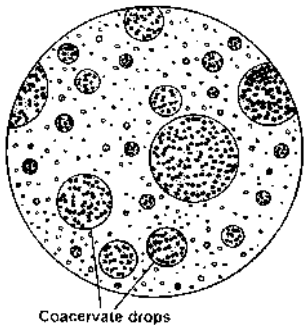
The sun provide energy for chemical reaction.

According to oparin **coacervates were the first sole living molecules** which gave rise to cell.





Fox Microspheres



Operin's Coacervates

Different type of Protobionts obtained by scientists

Oparin (1924) took a solution of carbohydrate and large protein. The solution was shaken. It caused separation of coacervates.

In coacervates higher concentration of protein, carbohydrate were present with small amount of water.

Oparin's coacervates could grow and exhibit simple form of metabolism. However a lipid membrane and reproduction was absent.

Fox (1957) obtain **microspheres** with a primitive membrane. He heated a dry mixture of Amino acids at 130° – 180° C. It formed **PROTEIDS/PROTENOIDS** (Polymer of amino acid).

When these proteids poured in Cool water along with lipids, microsphere get separated. (size 1-2 μ m) **Deamer** (1993) Microsphere and coacervates could fused to form protobionts having various type of chemicals like proteins, Nucleic acids, Carbohydrates etc. enclosed inside a lipid membrane. Deamer called them **vesicles.**

2. Origin of protocells [Eobiont :

The first living form named **protocell** originated in the primitive oceans.

The protocell were clusters of nucleo-proteins which formed by composition of nucleic acids and enzymetic proteins.

Nucleoproteins had the property of self duplication.

Nucleoproteins were first sign of life.

The protocell represented the beginning of life.

From protocells or eobionts few core of nucleoproteins gets separated free in oceans and became inactive but when they enter in another eobionts they became active so virus like structures were formed.

Origin of virus like structure is an example **retrogressive evolution** (complex to simple).

Important

Khorana (1970) artificially synthesized 77 nucleotide RNA molecule out side a living cell which suggests that probably RNA was the primordial genetic material rather than DNA.

Zaug, Thomas cech and Altman described that some RNA molecules have enzymatic activity hence probably the RNA enzymes called ribozymes were able to replicate the primordial RNA.

The discovery of RNA molecule working as enzyme has also changed our thinking about origin of life.

It is now believed that about 4 billion years ago earth was an 'RNA world' in which RNA molecule carried out all the process of life without the help of either protein or DNA,

By this discovery evolution is named as RNA world. ***[CBSE 2002]***

(1) It is estimated that life originated about 3.9 billion years ago as protocell (eobionts) in precrambian era which was anaerobic heterotrophic.

3. Origin of Prokaryotes –

As a result of mutation the protocells became more complex and efficient and used the materials available in the surrounding medium and condensed themselves into prokaryotic cells.

Thus the first living being were prokaryotic, like bacteria they were single celled and consisted of naked DNA. Nutritionally they were **chemoheterotrophs** (saprotrophs), respiration was **anaerobic.**

4. Origin of Autotrophism –

It includes the origin of **chemosynthesis** and **photosynthesis.**

(a) Origin of chemosynthesis :

Due to continue withdrawal of organic molecules by chemoheterotrophs organic material decreased in oceans.

Before the organic material disappeared in sea, new modes of Nutrition developed, one of them was **chemosynthesis**.

The organism which perform chemosynthesis are called as **chemoautotrophs.** They were anaerobic and synthesise organic molecules from inorganic material. The energy was obtained by oxidizing inorganic materials present in the sea.

Such mode of nutrition is found in Bacteria e.g. sulphur bacteria, nitrifying bacteria.

(b) Origin of Photosynthesis :

After some time bacteriochlrophyll developed in some autotrophic bacteria like organism.

They could absorb solar energy and convert it into chemical form these organism called **photoautotrophs.**

They utilize solar energy in synthesizing organic compounds. The process is called **photosynthesis.**
They were anaerobic and utilized hydrogen from sources other than water like H_2S.

Therefore, no oxygen was evolved and atmosphere remained reducing .

This stage of photosynthetic autotrophism is represented by planktonic sulphur bacteria of today.

$$6CO_2 + 12H_2S \xrightarrow{\text{Solar enery}} C_6H_{12}O_6 + 6H_2O + 12S$$

The Bacterio chlorophyll by molecular changes formed true chlorophyll.

Such organism which were bearing true chlorophyll are similar to today's **Cyanobacteria (B.G. Algae).**

They utilized water as hydrogen donor and evolved oxygen.

$$6CO_2 + 12H_2S \xrightarrow{\text{Solar enery}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Oxygen revolution –

Liberation of free O_2 by blue green algae like prokaryotes due to photosynthesis was a revolutionary change in the history of earth. It is called **oxygen revolution.**

It includes important changes like –

(1) Atmosphere of earth changed from reducing to oxidising, hence possibilities of further chemical evolution and abiogenesis got over, because chemical evolution always take place in reducing environment.

(2) Free O_2 oxidized CH_4 and NH_3 to form gases like CO_2 , N_2 and H_2O.

(3) Accumulation of fee O_2 formed a layer of **O_3 (ozone)** above the atmosphere of earth. Which started absorbing most of the U.V. rays of sunlight.

- **Origin of Eukaryotic cell –**

About 2.7 billion years ago conditions become suitable for aerobic respiration with the release of free O_2 . Aerobic respiration yields about **20 times more energy** then anaerobic respiration hence the prokaryotes adapted themselves for aerobic mode of respiration.

Nucleus, mitochondria and other cell organelles developed in the cell and free living eukaryotic cell like organism originated about 1.5 billion years ago in the primitive ocean.

1. Free Atoms	H (Hydrogen), C(Carbon), N(Nitrogen)
↓	
2. Inorganic Molecules	H_2(Hydrogen), H_2O (Water), CH_4(Methane), NH_3(Ammonia), CO_2(Carbon Dioxide)
↓	
3. Simple organic Molecules	CH_4H_2O ⟶ Sugars, Fatty acids, Glycerol
	$CH_4.H_2O, NH_3$ ⟶ Amino Acids
	$CH_4.H_2O, NH_3$, HCN ⟶ Nitrogenous Bases (Purines, Pyrmidiens)
4. Complex organic Molecules	Sugar + Sugar ⟶ Polysaccharides
	Fatty Acids + Glycerol ⟶ Fats
	Amino acid + Amino Acid ⟶ Proteins
	Nitrogen Bases + Sugars + Phosphates ⟶ Nucleotides, Adenosine phosphates
	Nucleotides + Nucleotides ⟶ Nucleic a cids
5. Coacervates or Microspheres	Aggregates of large complex organic molecules capable of growth and d ivision
↓	
6. Eobionts	Nucleic Acid — Controlled coacervates
↓	
7. First primitive cells	Lipid – Protein membrane-bound units with enzyme-controlled metabolism and nucleic acid regulation without organised nucleus

Special Points :

1. Life originated in water.
2. Atmosphere of earth just before the origin of life consisted of CH_4, NH_3, H_2 and water vapours.
3. O_2 was absent in the atmosphere at the time of origin of life.
4. English scientist J.B.S. Haldane worked on origin of life and settled in India.
5. Gaseous mixture used by miller for synthesis of amino acids throught heat and electric discharge included CH_4, NH_3, H_2 and water vapours.
6. Moon does not posses life because it is without water.
7. The age of big bang is roughly 104 millions years.
8. Spontaneous generation theory of origin of life was disproved through experiment involving swan neck flasks by Louis Pastuer.
9. Experiment proof that some simple molecules like H_2, NH_3, CH_4 and H_2O gave rise to amino acids during origin of life was provided by stanley miller.
10. Oxygen was not present freely in the early atmosphere of the earth.

11. Rapid increases in world population in recent times is primerily due to decrease in death rate. (Mortality).
12. Earth originated in the past period of about 4.5 billion years.
13. Experiment to prove that synthesis of organic compounds formed the basis of life performed by stanley. miller.
14. Present population explosion is mainly due to better health care.
15. Indian population has growth rapidly in the present century because of more children reaching reproductive age.
16. The first organisms were chemoheterotrophs.
17. The scientist associated with formulation of modern theory of origin of life and having written "origin of life" was oparin [he was Russian Scientist].
18. World population has grown rapidly in the past 250 years because of industrial resolution.
19. Planet nearest to sun in "Mercury".
20. Ozone layer is important as it filters out ultra-violet radiations.
21. Under certain conditions, scientists have got cell like structures but without its true organisation. They are called "Coacervates".
22. The correct sequences during formation of chemicals on early earth is Ammonia, Proteins, Carbohydrate, Nucleic acid.
23. Biogenesis is the name of theory which states that life develops from life.
24. Saturn is a planet of our solar system which has nine moons.
25. An ideal agriculture should lay stress on "Permaculture".
26. Rising of mountain is due to aggregation.
27. N_2 gas is dissolved in blood but has no metabolic OR Chemical activity.
28. Rodents possess growing, Incisors.
29. Panther is the fastest land animal.
30. Coacervates were formed by polymerisation and aggregation.
31. Balance of nature is maintained by photosynthesis and respiration.
32. Our galaxy is milky-way.
33. Big-bang theory was proposed by "Lemaitre".
34. Tethys sea occured in the region of present day Anes.
35. Organic compounds first evolved on earth required for origin of life were protein and nucleic acids.
36. CH_4 was a compound who important in prebiotic evolution.
37. Approximate age of earth is 4600 million years.
38. Nucleic acids are the most essential for origin of life.
39. Chemical theory of origin of life was given by oparin and Haldane.
40. Oldest rock is dated 3.8 billion years.
41. Flow of energy in ecosystem is unidirectional.
42. Father Saurez was one of the greatest advocates of the theory of special creation.
43. Cyanobacteria - like organisms developed on earth 3600 billion years ago.
44. Presence of NaCl in fluid indicates that life originated in primitive ocean.
45. Theory of spontaneous creation was supported by Van helmont.
46. Protobiogenesis occured more than 3.5 billion years ago.

47. Evolution up to formation of coacervates termed as **chemical evolution,** in which complex organic compound were formed which were essential for formation of cellular structure.
48. Evolution from coacervates to simple cell structure known as **biological evolution.**
49. From simple cell to recent…..evolution is called **organic evolution,** in which organism developed structures and modified them by which they became more adaptive in their changing environment.
50. First protein which is formed during evolution in primitive oceans were not structural.
51. First nucleic acid which was formed in primitive oceans from combination of nucleotides, did not have power of replication. They obtained power of replication later by mutation.
52. Evolution term introduced by - **Herbert Spencer.**
53. **What is evolution ?**

    The word evolution means to unfold or unroll or to reveal hidden potentialities. Evolution simple means an orderly change from one condition to another.
54. **Stellar Evolution –**

    Changes in planets and stars from their origin to death.
55. **Inorganic evolution –** The matter, elements change in time called Inorganic evolution.
56. Evolution is a slow but continuous process which never stop-**Buffon.**
57. **Dollo's low –** it states that evolution is irreversible.
58. Accroding to **Theodosius Dobzhansky** (1973), nothing is biology makes sense except in the light of evolution.
59. **Scala nature or ladder of nature : –**

    Aristotle represented the evolution of complex organism from simple organism in the form of a ladder which is called **Scala Nature or Ladder of nature.**

    He kept simple organism at the bottom of ladder and complex organism at the top of this ladder.

    George cuvier studied the evolutionary history of organism by studying fossils and rejected Scala nature.
60. **The history of life actually comprises two events :**
    (i) The origin of life
    (ii) Evolution of life [the mechanism involved in the changes of living organisms through time]
61. Two great themes of evolutionary biology :
    (i) The diversity of life, including both the differences and similarities.
    (ii) The characteristics of organism, both adaptive and non-adaptive.
62. For origin of life, at least **three conditions** needed to have been fulfilled.
    (i) There must have been a supply of replicators i.e. self producing molecules.
    (ii) Copying of these replicators must have been subject to error via mutation.
    (iii) The system of replicators must have required a perpetual supply of free energy and partial isolation from the general environment.
63. Cosmology–Study of universe.
64. Biological evolution is also known as biogeny.
65. Unit of evolution is population.
66. Oparin's theory also known as primary abiogenesis.
67. Evolutionary biology-Study of history of life forms on earth.

ORGANIC EVOLUTION

1. Though life originated by chemical evolution on primitive earth, was later replaced by organic evolution.
2. Organic evolution states "Descent with modification". i.e. the present day complex organism have evolved from earlier simpler organism by small but gradual changes which have occurred over millions of years.
3. Though living organisms show diversity in size, structure, function, behaviour etc. they also show basically similar metabolic processes indicating **common ancestory.**
4. Concept of evolution was given by Empedocles. He is also called **founder of concept of evolution.** But Buffon explained the organic evolution properly & scientifically. Thus father of evolutionary concept is Buffon.

   Evolution can be of following types :

   (a) Progressive evolution : Evolution from simplicity to complexity

   (b) Retrogressive evolution : Evolution from complexity to simplicity

   Example :

   Virus : Virus was originated from bacteria which were intracellular obligate parasites.

   (c) Microevolution : Changes in variety or subspecies due to crossing over or Gene mutation Microevolution – changes below the species level.

   (d) Macroevolution – (Changes in Genus or Species) When there is a change in species or Genus due to evolution. In this there is a major change in chromosome number

   (e) Megaevolution : Changes in **Family** or **Order** or **Class** is called Megaevolution.

   (f) Convergent evolution : Same character in different groups of animals

   Example : (Analogous organ) Wings are present in insects, birds and bat but they all are from different groups

   (g) Divergent evolution : (Adaptive radiations) Development of different structure from same part of ancestors. **Example :** Homologous organ Limbs of horse, hands of man, wings of bat. They all have same origin.

   Development of different structure from same part of embryo. Only there is change in external morphology but internal morphology remains same.

EVIDENCES OF ORGANIC EVOLUTION

SOME IMPORTANT EVIDENCES

1. Palaeontological Evidences
2. Morphological and Anatomical Evidences
3. Evidences from vestigial organs
4. Evidences from connecting links
5. Evidences from Atavism (Reversion)
6. Evidence from physiology and biochemistry
7. Evidences from bio geographical distribution

8. Evidences from Embryology
9. Evidences from Taxonomy

1. Palaeontological Evidences –

The study of fossils is known as : **Palaeontology.**

Fossils word : **Taken from Fossilis/Fossolium**

Father of palaeontology : **Leonard da vinci**

Founder of modern palaeontlogy : **George cuvier**

Birbal Sahni is famous for Indian palaeonotology.

He is father of **Indian Palaeobotany**.

Birbal Sahni Institute of Palaeobotany (BSIP) situated in Lucknow.

Two branches of palaentology –

1. **Palaeobotany :** Study of plant fossils
2. **Palaeozoology :** Study of Animals fossils

Definition of Fossils was given by Charls Lyell "Impression of past found in Rocks called fossils" **fossils provide one of the most acceptable evidence in support of organic evolution.**

- **Types of Rocks –**

(a) Sedimentary Rocks –

These are formed at the bottom of ancient oceans by deposition of sediments of sand, lime, coal and minerals which slowly change into hard layers .

Sedimentry rocks are also called as stratified rocks. Eg. Lime Stone, Sand Stone.

Fossils are mostly found in sedimentary rocks.

(b) Igneous rocks –

Such rocks are formed by ancient volcanic deposits which slowly cooled down and hardened as rocks.

Fossiles are absent in it.

e.g. **Granite rocks.**

(c) Metamorphic rocks –

These are formed by change in chemical composition of sedimentary rock and igneous rocks or metamorphosis. Such metamorphosis may be caused by pressure heat and physical movements. e.g. Marble Slate rocks. Fossils are also absent in it – due to chemical changes in the fossils are destroyed.

- **Type of Fossils :**

(a) Unaltered Fossils :

In this type whole bodies of extinct organisms are found frozen in ice at the polar regions eg. Wooly mammoths (25000 yrs before extinct fossils were found from Siberian region)

(b) Petrified fossils – Most common type of fossil.

Replacement of organic part by mineral deposits is called **petrification.**

These fossils consists of only the hard parts e.g. bones, teeth, shells, wood etc. of extinct organisms.

In human body first fossilization occurs of teeth.

(c) Mould fossils –

Here no part of the original organism is present, only an impression of the external structure of body is preserved in wet soil.

(d) Cast fossils –

Sometimes minerals fills in the mould, resulting in cast fossils

(e) Print Fossils –

Foot print or prints of wings, skin, leaves, stems etc made in soft mud which subsequently become fossilized are a common type of fossils.

(f) Coprolites –

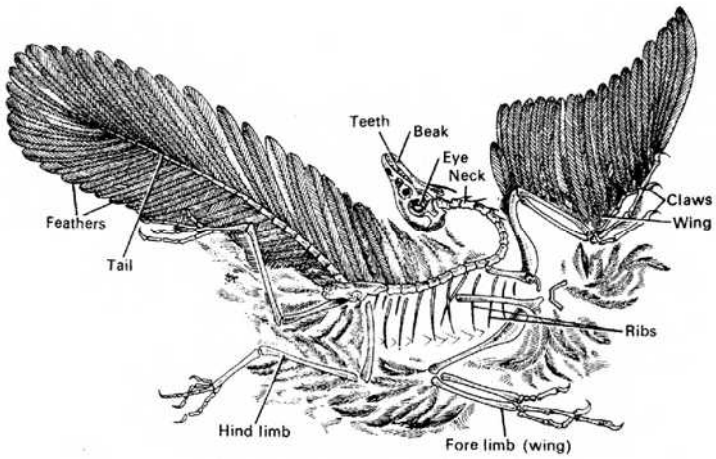
These fossils include the fossil preservation of contents of the intestine or excreta of many ancient animals including particularly the reptiles or fishes.

By studying fossils following facts about organic evolution are evident –

1. Fossils found in older rocks are of **simple type** and those found in newer rocks are of **complex types.**
2. In the beginning unicellular protozoans were formed from which multicellular animals evolved.
3. Some fossils represents connecting links between two groups
4. Angiosperms among plants and mammals among animals are highly developed and modern organism
5. By fossils, we can study the evolutionary pedigree of an animal like stages in evolution of horse, elephant and man etc.

- **Archaeopteryx –**

Fossil connective link between birds and reptiles. Fossil was discovered by **Andreas wagner** from **Bavaria** in Germany. It was found in the rocks of the **Jurassic period.**



Fossils of Archaecopteryx

- **Reptilian Characters :**

(a) Long tail is present
(b) Bones were not pneumatic.
(c) Presence of weak sternum.
(d) Presence of fee caudal vertebrae is found in Lizard.
(e) Teeth present in Jaws.

- **Avian Characters :**

(a) Presence of feathers on the body
(b) The two jaws were modified into beak
(c) The fore limbs were modified into wings
(d) The hind limbs were built in the typical avian plan.

"Age of Fossils" or "Dating of fossils" or "The clock of the Rock"

The fossils give valuable information about the history of organic evolution by giving information about the organisms which existed in the past.

This is possible only if the correct age of the fossils can be determined. Methods have been developed to find out the correct age of the fossils by determining the age of the rocks where the fossils are found.

Rocks have been found to contain certain radioactive elements which lose their radioactivity and change into other nonradioactive isotopes at a fixed rate irrespective of the environmental conditions prevalling at different times.

If the rate of this loss of radioactivity of an element is known, the relative proportions of the Quantities of radioactive and nonradioactive element in a given rock will enable us to find out the age of the rock.

This method is called **absolute dating.**

This will be illustrated with the help of four different methods.

(1) Lead method
(2) Radio-carbon method
(3) Potassium – Argon method
(4) Electron spin resonance method (ESR method)

$$\text{Potassium}^{40} \rightarrow \text{Argon}^{40}$$
$$\text{Carbon}^{14} \rightarrow \text{Nitrogen}^{14}$$
$$\text{Uranium}^{238} \rightarrow \text{Lead}^{207}$$
$$\text{Rubidium}^{87} \rightarrow \text{Strontium}^{87}$$
$$\text{Thorium}^{232} \rightarrow \text{Lead}^{206}$$

Fossils park of India –

1. Birbal sahni institute of palaeobotany, Lucknow.
2. 50 million year old fossil forests preserved in mandla district Madhya Pradesh.
3. 100 million year old fossil forest in rajmahal hills Bihar.
4. 260 milllion year old Coal forming forest in Orissa.

Important living fossils

1. *Peripatus* (Arthropoda)	2. *Limulus* (Arthropoda)
2. *Nautilus* (Mollusca)	4. *Neopilina* (Mollusca)
5. *Lingula* (Brachiopoda)	6. *Latimeria* (Coelacanth fish)
7. *Sphenodon* (Reptilia)	8. *Didelphis* (Opossum)

Geological Time Scale – Firstly given by Giovanni Avduina.

Chronological order of the history of organic evolution, which is presented in the form of geological time scale.

This time scale includes the history of earth itself ever since it was formed to formation of its crust from lava of ancient volcanic eruptions.

The period between the origin of gaseous clould (4.6 billion years ago) from which the earth was formed and the formation of earth's crust is called **Azoic Era** (era of no life).

The remaining period (about 4.0 billion years) is divided in to five Eras namely –

1. Archaeozoic 2. Proterozoic 3. Palaeozoic 4. Mesozoic
5. Coenozoic

The Archaeozoic Era had "**invisible life**" and the remaining four era had "**visible life**" **(Phanerozoic).** Archaeozoic and proterozoic eras are also grouped together as Precambrian because the first part of palaeozoic is Cambrian.

The three eras namely palaeozoic, mesozoic and coenozoic, each is further divided into smaller time spans called **Period** and the periods of coenzoic era are each further subdivided into **Epochs.**

It is also believed that each era of earth's history started with a **revolution or cataclysm** and ended with yet another revoluation.

These revolutions meant intense geological disturbances that occurred on earth, so that most of the pre-existing organisms perished in each revolution and the few remaining ones evolved into new and varied organisms.

The first great revolution is believed to have occurred between archaeozoic and proterozoic eras.

The second great revolution between proterozoic and palaeozoic eras.
Applachian revolution between palaeozoic and Mesozoic eras.
Finally the rocky mountain revolution between Mesozoic and coenozoic eras.

GEOLOGICAL TIME SCALE					
Era	**Period**	**Epochs**	**Duration**	**Animals sequence**	**Plant sequence (vegetation)**
COENOZOIC (AGE OF MAMMALS)	**QUATER-NARY**	Holocence of recent (Age of man)	Continuing Till date	Mental age, supremacy of man	Increase of herbaceous Plants evolution of monocots
		Pleistocene	7.0 lakh years	**Human appear, Appearance of social life of man** decline of giant mammals	Increase of herbs and grasses
	TERTEORY	Pliocene	1.32 crore years	**Apelike ancestor of human appeared**	Evolution of herbaceous plants
		Miocence (Golden age of Mammals)	1.1 crore years	Mammals at height of evolution evolution of man like apes and other mammals, like sheep, goat, dogs, elephant.	Land or terrestrial plants evolved.
		Oligocene	1.9 crore years	**Anthropoid apes evolved** from monkeys, crocodiles	Rise of monocots.
		Eocene	1.2 crore years	Evolution of diversified placentals, ancestors of hoofed carnivores marine mammals, and birds	Beginning of grassy plants flowering plants spread into forests.
		Palaeoene	8.0 lakh years	Evolution of insectivorous smaller mammals, carnivorous mammals.	Forests of angiosperm
				ROCKY MOUNTAIN REVOLUTION	
MESOZOIC (AGE OF PEPTILES)	**CRETACE-OUS**		7.1 crore years	**Extinction of dinosaurs and primitive birds. First modern birds appeared.** Primitive placental mammals like insectivorous shrews originated	Beginning the evolution of dicots. **Angiosperms appeared**
	JURASSIC		5.4 to 5.9 crore years	Giant reptiles like **dinosaurs were at peak, evolutionof toothed birds like Archaeopteryx**, marsupials evolved from prototherians.	Evolution of gymnosperins was at peak
	TRIASSIC		3.5 crore years	**Origin of first** oviparous **prototheria mammals, dinosaurs, flying reptiles.**	Forests of Conifers, cycades and other gymnosperms.
				APPLICATION REVOLUTION	
PALAEOZOIC	**PERMIAN**		5 crore years	extinction of trilobites, **origin of mammal like reptiles**	Among gymnosperms Evolution of comifer trees.
	CARBONI FEROUS		6.5 crore years	**Abundance of sharks, bony fishes** and **lung fishes. Appearance of first amphibians**	Ancestral gymnosperms & furns dominated bryophytes originated **Origin of first seed plant.**
	DEVONIAN (age of fishes)		5 crore years	**Origin** and evolution of **sharks, bony fishes** and **lung fishes. Appearance of first amphibians**	Giant clubmoss.
	SILURIAN		3 to 4 crore years	Evolution of arthropods, insects, jawless primitive fishes evolved.	Celophytes and land ferns were in large number. Origin of vascular plants.
	ORDO VICIAN		6 to 7 crore years	**Origin of jawless. fishes in fresh water.** Abundance of giant molluscs branchiopods, and trilobites Echinoderms. First vertebrates.	Plants reached fresh water. Marine plants abundant.
	CAMB RIAN		7 crore years	**Trilobites** and brachiopds were **dominant.** Echinodesms were also present. No life on land.	Marine bactes colonial, multicelluler filamentous algae evolved in occans.
				SECOND GREAT GEOLOGICAL REVOLUTION	
PROTE ROZOIC			1.93 billion years	Invertebrates like protozoa, coelenterate, sponges annelida and mollusca evolved.	Single celled bacteria and blue green algae evolved in sea .
ARCHAEO ZOIC			1.5 billion years	**Origin of life** in sea from organic materials **Prokaryotes (monera)** and **Eukaryotes** (Protista) evolved and diversified	Prokaryotic from of life formed **blue green algae originated.**
AZOIC			1.0 billion years	**No life. Only chemical evolution** took place.	

2. Morphological and Anatomical Evidences –

Different animals and plants show dissimilarities in their structure but in some characters they show similarities. These similarities are of two types.

1. Homology 2. Analogy

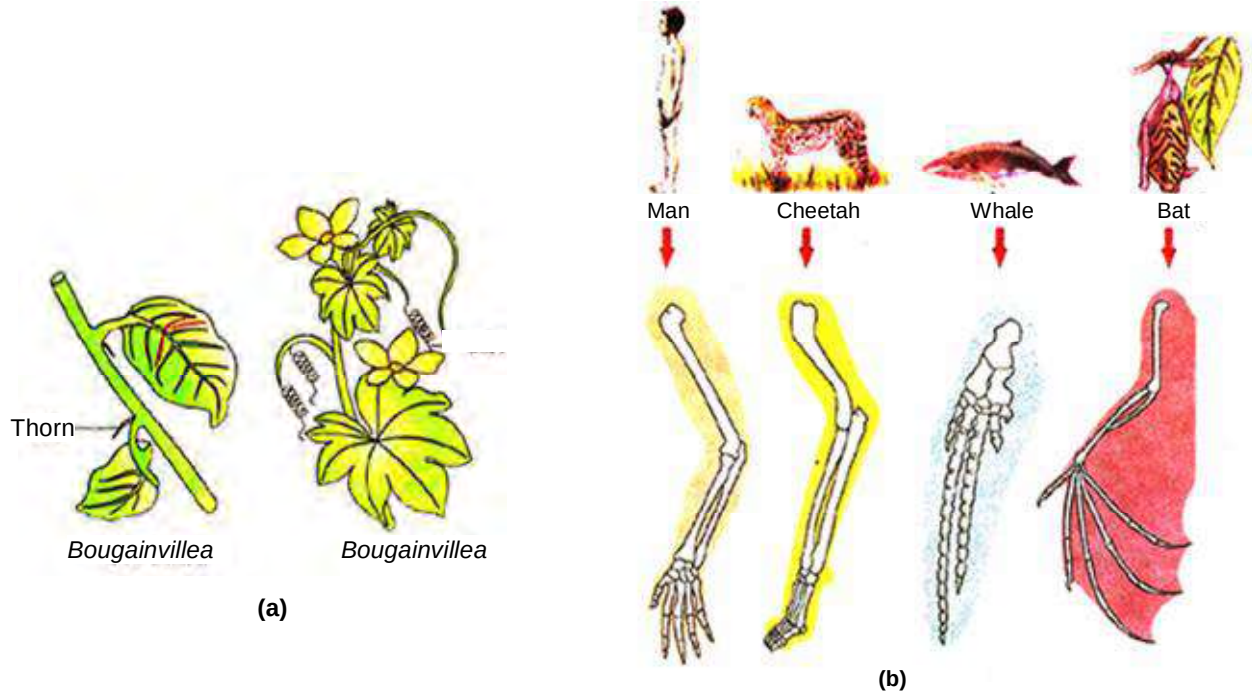
1. Homology –

The similarity based on common origin, similar basic plan of organization and embryonic development is called **homology.**

Similarity in appearance and function is not necessary.

The organs which have common origin, embryonic development and same basic structure but perform different functions are called **Homolgous organ. Homologous term given by Richard Owen.**

Examples of Homologous organs –



Example of homolgous organs in (a) Plants and (b) Animals

(i) Forelimbs of mammals –

	Horse	Bat	Whale	Seal	Man
Appearence	Foot	wings	Paddle	Flipper	Hard
Function	Running	Flying	Swimming	Swimming	Holding

In their fore limbs similar bones are present like – **humerus, radius, ulna, carplas, metacarpals and phalanges.**

(ii) Legs of invertebrates –

Cockroach	Honey bee
Walking	Collecting of pollens

But in both segmented legs are present are segments are same like **coxa, Trochanter, Femur, tibia, 1-5 jointed tarsus.**

(iii) Mouth parts of insects

Cockroach	Honey Bee	Mosquito
Biting and chewing	Chewing and lapping	Piercing and sucking

In each of these insects the mouth parts comprise **labrum, mandibles and maxillae.**

(iv) **Homology** is also seen in the skeleton, heart, blood vessels and excretory system of different vertebrates.

(v) **Thorn of Bougainvillea and tendril of cucurbita (Modification of axillary bud).**

(vi) Wings of sparrow and pectoral fins of fish.

(vii) Hind limb of mammals.

(viii) Potato & ginger.

(ix) Radish & Carrot

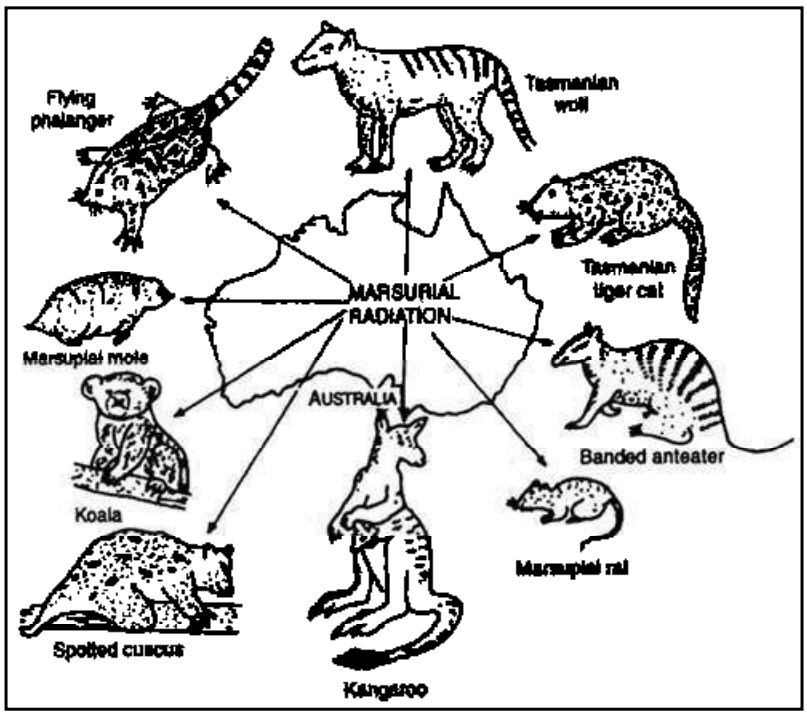
(x) Homology is also seen amongst the molecule. This is called **molecular homology.** For example the proteins found in the blood of man and apes are similar.

(xi) Testes in male and Ovaries in female develop from same embryonic tissue.

(xii) Pectoral fin of fish and flipper of seal.

(xiii) Flipper of penguin (bird) and dolphin (mammal)

Divergent evolution (adaptive divergence/adaption radiation)



Homology found in different animals indicate their evolution from common ancestors.

Species which have diverged after origin from common ancestor giving rise to new species adapted to new habitats and ways of life is called **adaptive radiation,** exhibit large number of homologous organs.

Homology shows **Divergent evolution.**

For Example Adaptive radiation gave rise to a varity of marsupials in Australia.

2. Analogy –

It is similarity in organs based on similar function.

Organs which have different origin and dissimilar fundamental structure but have similar function are called **Analogous organs.**

Examples of Analogous organs –

(i) Wings of bat & birds are analogous to wings of insects.

(ii) Pelvic fins of fish, flipper of seal

(iii) Sting of bee and scorpion.

(iv) Phylloclade of Ruscus and leaf

(v) Chloragogen cell of pheretima and liver of vertebrate

(vi) Hands of man and trunk of elephant
(vii) Potato and sweet potato.
(viii) Eyes of Octopus and eyes of mammals (different in their retinal position).
(ix) Dog fish and whale.

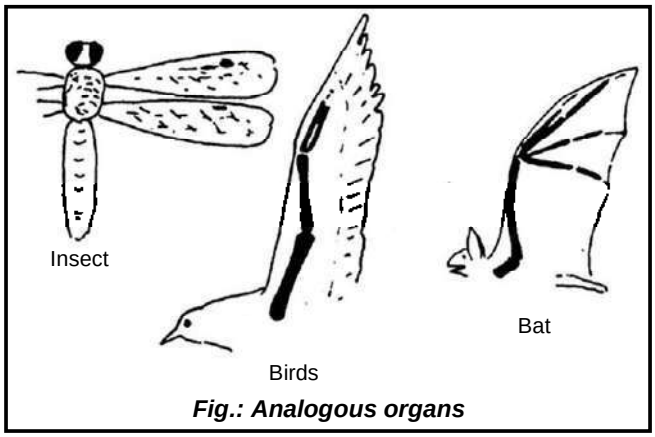


Fig.: Analogous organs

Convergent evolution (adaptive convergence/parallel evolution)

Development of similar adaptive functional structures in unrelated groups of organisms is called **convergent evolution.**

For Example : Some of the marsupials of Australia resemble equivalent placental mammals that live in similar habitats of other continents.

When adaptive convergence is found in closely related species, it is called **parallel evolution.**

Analogous organs do not show common ancestory but they show evolution.

Mole

Anteater

Marsupial mole

Numbat (anteater)

Mouse

Lemur

Marsupial mouse

Spotted cuscus

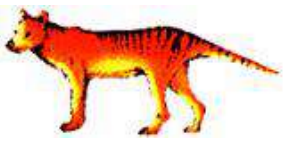
Flying squirrel

Bobcat

Flying phalanger

Tasmanian tiger cat

Wolf



Tasmanian wolf

Picture showing convergent evolution of Australian Marsupials and placental mammals

3. Evidences from vestigial organs –

The organs which are present in reduced form and donot perform any function in the body but correspond to the fully develop functional organs of related animals are called vestigial organs.

They are remanants of organs which were complete and functional in their ancestors.

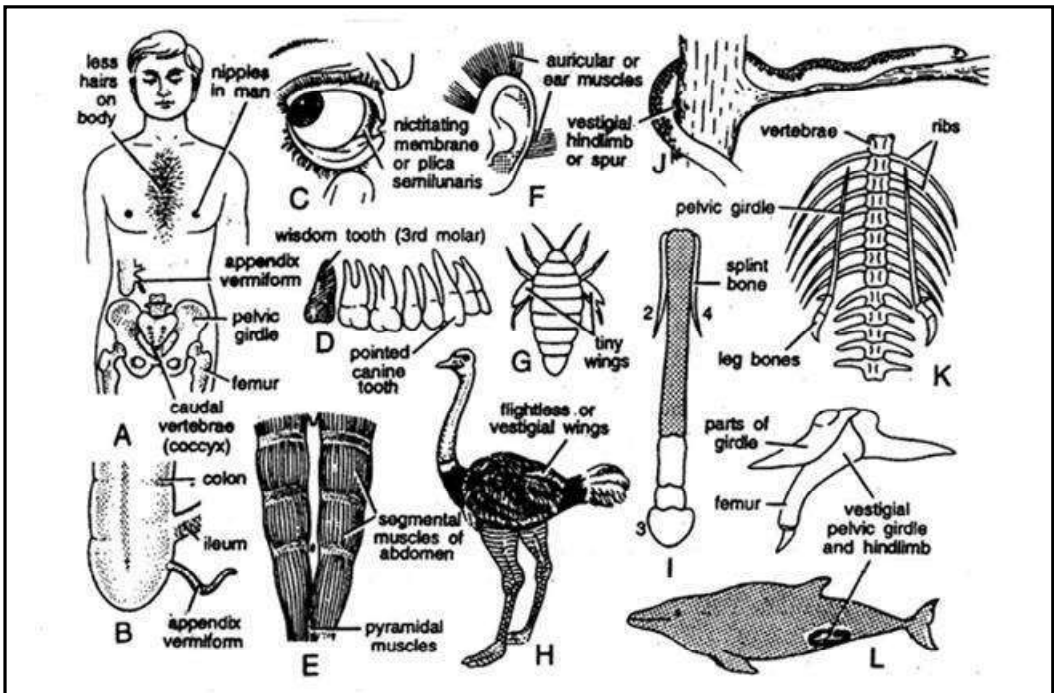
Vestigial organs in Human body –

Human body possess about 180 vestigial organs

eg.
a. nictitating membrane
b. muscles of pinna (auricular muscles)
c. vermiform appendix
d. coccyx
e. canine teeth
f. third molars (wisdom teeth)
g. segmental muscles of abdomen
h. caecum
i. body hairs
j. nipples in male
k. ear pinna

Vestigial organs in other animals –

- Hind limb and pelvic girdle of python
- wings of flightless birds such as ostrich, Emu, Kiwi, Dodo, Reha etc. (Dodo recentely extinct)
- Eyes of deep sea fishes
- splint bones in feet of horse [2nd and 4th finger]
- external ear in whale
- rudiment of reptilian jaw apparatus.
- Hindlimb and pelvic girdle of whale.



3. Vestigial organs. A—In man (i) Less body hair, (ii) Nipples in male, (iii) Coccyx, B—Vermiform ndix, C—Nictitating membrane, D—Wisdom teeth, E–Abdomen muscles, F—Muscles of pinna, G—Wings in le moth, H—Wings of Ostrich, I—Toes in forelimb of horse, J, K—Hind limbs and pelvic girdle of python, Hindlimbs and pelvic girdle of whale.

Vestigial organs in plants –

Scale leaves of Ruscus and various underground steams.

Vestigial organs are example of lamrckism (Theory of inheritance of acquired character)

4. Evidences from connecting links –

Some animals and plants possess characters of two separate groups. One being primitive and the other is advanced group.

These species as bridge between two taxonomic groups such organism are called **connecting** link. They provide good example of organic evolution of common ancestory.

(i) **Virus :** between living and non living

(ii) **Euglena :** Between plants and animals

(iii) **Proterospongia :** Between protozoa and porifera

(iv) **Neopilina :** Between mollusca and annelida

(v) **Peripatus :** Between Annelida and arthropoda

(vi) **Archaeopteryx :** Between reptiles and birds

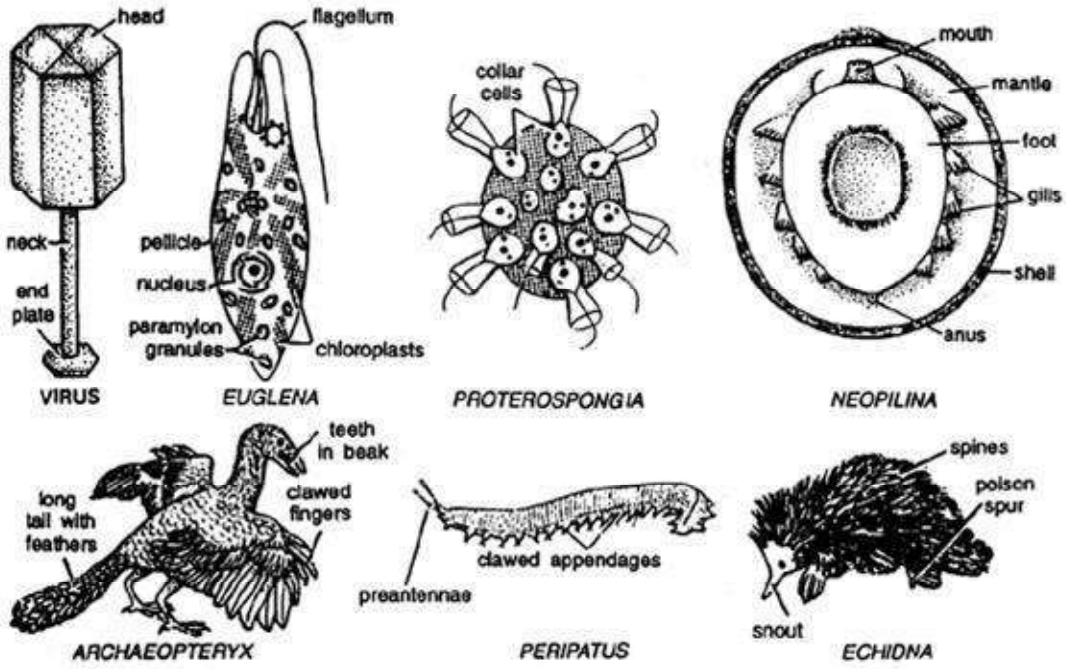
(vii) **Balanoglossus :** Between nonchordates and chordates

(viii) **Chimera :** Between cartilaginous fish and Boney fish

(ix) **Lung fish (Protopterus) :** Between fishes and amphibia

(x) **Platypus :** Between reptiles and mammals

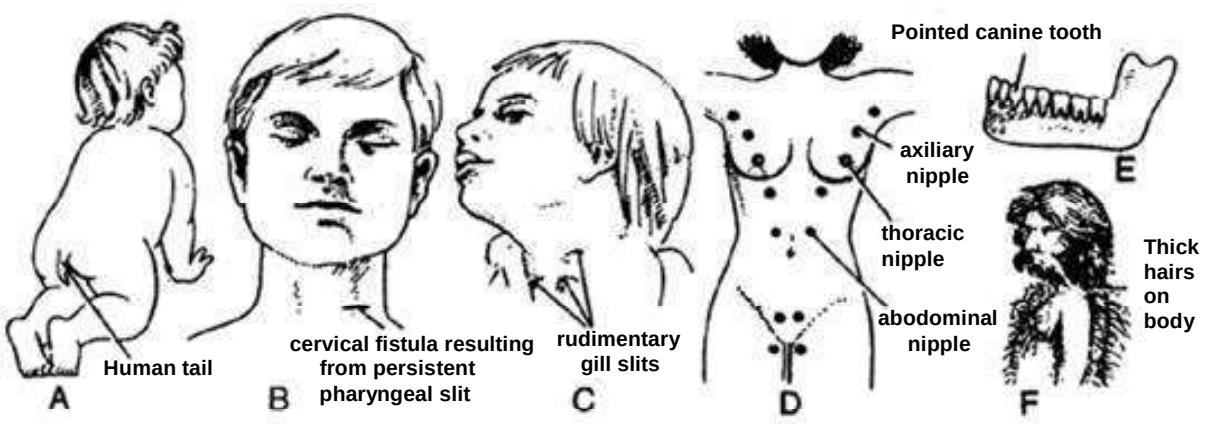
(xi) **Echidina :** Between reptiles and mammals.



5. Evidences from Atavism (Reversion) –

Sometimes in some individuals such characters suddenly appears which were supposed to be present in their ancestors but were lost during the course of development.

This phenomenon is known as **atavism or reversion.** Atavism proves that animals developing atavistic structure have evolved from such ancestors in which these structures were fully developed.



Some human atavistic characters. A–Human baby with tail, B,C–Cervical fistula or rudimentary gill-slits, D–Additional nipples, E–Pointed canine tooth, F–Thick hair on body.

Examples :

1. ***Human baby with tail***
2. ***Cervical fistula*** *– in some human babies an aperture is present on neck behind the ear called as cervical fistula. It represents pharyngeal gill slits which were present in aquatic vertebrate ancestors.*
3. ***Long and pointed canine teeth represented carnivorous ancestors.***
4. ***Large and thick body hair reflect our relationship with apes.***
5. ***Extra nipples (more than two)***

6. Evidence from physiology and biochemistry –

Different organism show similarities in physiology and biochemistry. Some clear examples are –

1. **Protoplasm :** Structure and chemical composition of protoplasm is same from protozoa to mammalia.
2. **Enzymes :** Enzymes perform same function in all animals like **Trypsin** digest protein from amoeba to man. **Amylase** digest starch from porifera to mammalia.
3. **Blood :** Chordates show almost same composition of blood.
4. **ATP :** This energy rich molecule is formed for biological oxidation in all animals.
5. **Hormones :** Secreted in different vertebrates performs same function.
6. **Hereditary material :** Hereditary material is DNA is all organism and its basic structure is same in all animals.
7. **Cytochrome C** is a respiration protein situated in the mitochondria of all organism. In this protein from 78-88 A.A. are identical in all organism, which show common ancestory.

Physiology and biochemistry thus prove that all animals have evolved from some common ancestor.

7. Evidences from bio geographical distribution –

The study of geographical distribution of animal and plant species in different parts of earth is called **Biogeography.**

Different animal species occurring in an area are called **Fauna** and those of plants are called **Flora.**

On the basis of fauna and flora **Alfred Russel Wallace** divided the whole world into six major biogeographical regions called **realms.**

Nearctic : North America fro Mexixan highlands to Arctic islands and Greenland.

Palaearctic : Europe, North Asia up to Himalayas and North Africa up to Sahara desert.

Neotropical : Central and South Amerial, Mexican lowlands and West Indies.

Oriental : Asia, South of Himalayas; India, Ceylon, Malay, Peninsula, Sumatra, Bornea, Java Celebes and Philippines.

Ethiopian : South Africa from Sahara Desert, Madagascar and Adjacent islands.

Fig.: Zoogeographicl realms

Australian : Austrialia, Tasmania, New Guinea, New Zealand and Oceanic islands of the pacific. It is believed that millions of years ago all the continents were present in the form of a single land mass called **Pangaea.**

Later on due to varies geological changes, these continents drifted fro one another.

As these continents moved away, they got separated from each other by the seas. As these continents had different environmental conditions so plants and animals evolved there were of different varieties. **(New species).**

Palaearctic and oriental realms are separated by high Himalayan Mountains.

CBSE 94

1. **Prototheria –**

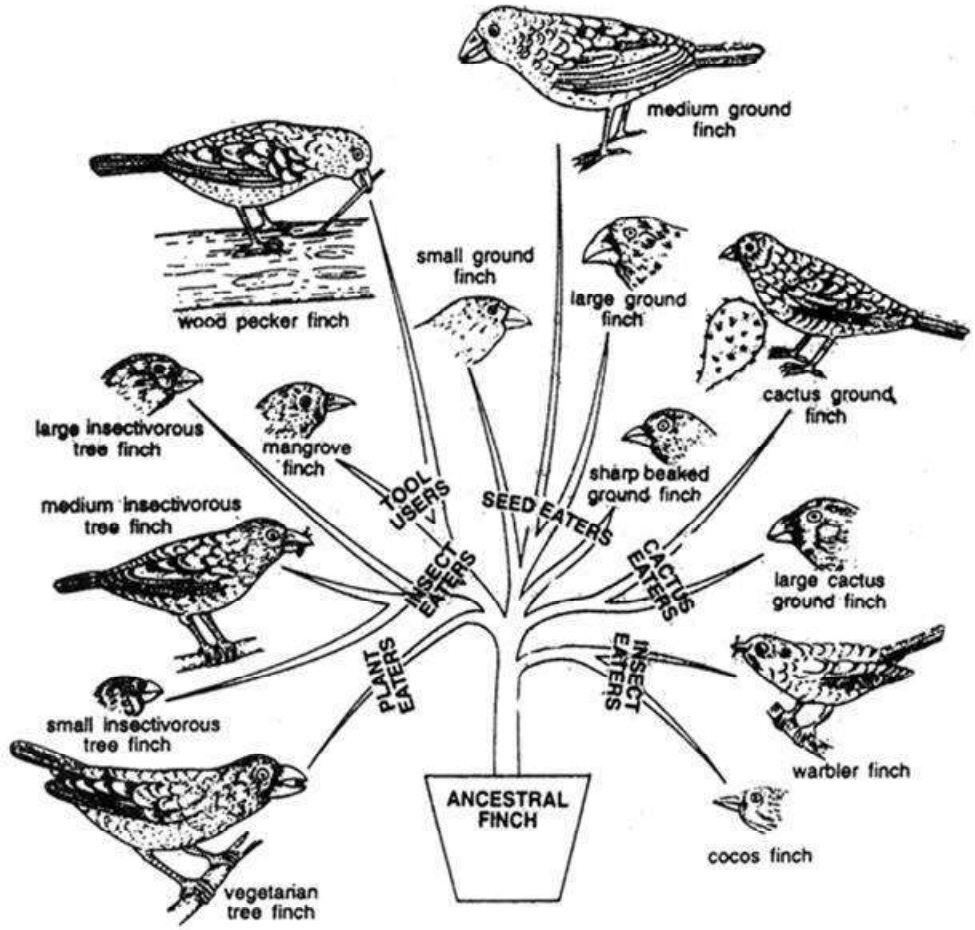
   This is sub class of mammalian, which includes egg laying mammals like **Platypus** and **Echidna** found in Australia.

   After the evolution of prototherians from reptiles Australia got seperated from mainland of Asia.

   Later on Eutherian mammals evolved in Asia, Due to their carnivorous nature they destroyed prototherians and metatherians from Asia.

   So these groups became extinct on the mainland but they survived in Australia due to absence of Eutherians.

   Today eutherians are also found in Australia **(they were later transported by man).**
2. **Marsupialia –** The subclass of class mammalian includes kangaroos and Opossum which are found only in Australia.
3. **Darwin's finches –** Darwin studied Fauna and Flora of Galapagos island situated near south America (consisted 22 islands). Here he saw 22 types of finches (birds) .



Darwin's finches

A related species of these birds were also present in South American continent.

Probably some member of this species migrated to Galapagos island where these birds evolved into different species as a result of adaptation to environment.

These birds are now known as **Darwin's Finches.**

Darwin described that a particular species is evolved in a particular area, progenies of this species migrate to different geographical areas and are gradually adapted to changing environmental conditions.

These adaptations gradually give rise to new species as a result of isolation.

Special Point :

- ***Darwin's finches are also an example of adaptive radiation (different shape of beak and claws due to their habitat)***
- ***Darwin's finches are example of allopatric speciation.***

4. Elephants and lions are mainly found in Africa and India.

5. Giraffe, Zebra and hippopotamus are found only in Africa.

6. Main land of human evolution in Africa.

Important Point :

Palaeontological and Biogeographical evidences are considered as best evidences in support of organic evolution.

8. Evidences from Embryology –

Baer's Law : An organism show its ancestor stages in embryonic development. In embryonic stage general characters appear first then specialized characters appear.

Muller : First to propose '**Recapitulation theory**'.

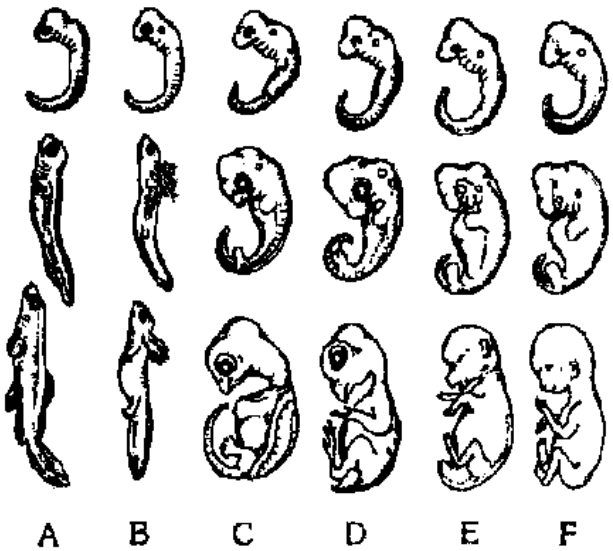
- According to it **'ontogeny recapitulate phylogeny'** it means any organism show its ancestral adult stages during its embryonic development.
  It shows that all organism evolved from a common ancestor.
- Ernest Haeckel explained it in detail and gave the name '**Biogenetic law**'

Examples : -

(a) The Zygotes from which the development of all metazoan bodies starts, are single-celled and quite comparable with the Bodies of simple protozoans.
This indicates the origin of **Metazoans from Protozoan Ancestors.**

(b) The early stages of Embryonic development, Viz. Morula, Blastula and gastrula are Basically similar in all metazoans, indicating a **Monophyletic Origin** of the latter.

(c) The Phylogenetically earliest metazoans i.e., the sponges and cnidarians, have retained early gastrula like double – layered (Diploblastic) structure of Body of Metazoans.



Comparison of stages in the development of vertebrate embryos. A. Fish, B. Salamander, C. Tortoise, D. Chick, E. Calf, F. Human

(d) In fishes, the young individual, developing from gastrula, is almost-like the adult, but the tadpole larvae of Amphibians bear more resemblance to the young once of fishes than to their own Adults. This indicates **Origin** of **Amphibians from fishes.**

(e) Even after gastrulation in the vertebrates, the early postgastrula stages are quite similar in members of all the different classes, Viz, fishes, amphibians, reptiles, birds and mammals.
The differentiation of class characters appear in later stages, moreover, the embryo of phylogenetically higher vertebrates pass through the adult stages of lower vertebrates before finally attaining the characters of their respective classes.
This proves that **All Vertebrates** have evolved from common fish like Ancestors and also that both Birds and mammals have evolved from reptiles.

(f) When the heart develops in the embryos of Amphibians, reptiles, Birds and Mammals, it is 2-chambered same as in the embryos and Adults of fishes. In later stages of Embryonic development in Amphibians, reptiles, the heart become, 3-chambered. In Birds and Mammals the heart is 4-chambered in the last embryonic stages to continue as such in the Adults.

(g) Modern Scientists have discovered "Biochemical recapitulation" also.
For example, fishes mainly excrete Ammonia. Adult Amphibians Excrete urea, but their tadpoles excrete Ammonia like the fishes.

Birds excrete uric acid, but their embryos excrete first Ammonia and then urea during earlier stages.

(i) In embryonic stage birds showed tooth buds for some time, which became extinct later. It show that birds evolved from toothed reptile like ancestors.

9. Evidences from Taxonomy –

Plants and Animals show a great diversity of form. They also show some similarities among themselves. It is on account of these differences and resemblances that the taxonomists have been to arrange the living things in to smaller and larger groups.

This the taxonomists have recognized that there are about 250,000 different kinds of plants. These different kinds are called species.

The members of each species recognized by their close resemblance to one another, their differences being of a minor type.

Amongst species also there are differences and resemblance of varying degree. Some species resemble one another more closely than they resemble others and form a closely related group.

Similarly, there are other groups of closely resembling species.

The members of each group resemble each other more closely than they resemble the members of other groups.

Each such group of species is called a genus. Genera also show different degrees of resemblances amongst themselves.

Those that resembles one another more closely than others are placed in a large group called a family.

Families are grouped in to larger units called orders, orders into classes and classes in to Phyla.

Evolution has a ready explanation for this system of grouping or classifying plants and animals in groups indicates relationship.

Special points : -

1. The aquatic mammals [eg. **Dolphins, Whales, Seals, Porpoises** etc.] don't have gill slits-**because their adaptation to aquatic life is secondary.**
2. In Acacia tree well developed compound leaves are found. But seedling has simple leaves like those found in all stages of development of its ancesters. This provide a good example of –

   Recapitulation
3. Modern day Oaks of southern United State of America retain their foliage throughout the year where as the oaks of northern United States are **deciduous** and shed their leaves during water. The southern species, on the basis of this character of leaves are considered to be more primitive than the northern oaks. However, the seedling of northern species are generally seen to retain their leaves during winter. This provide a good example of – **Recapitulation**.
4. **Evolutionary trend :** The continuous change of a character within an evolving lineage is termed as **evolutionary trend.**
5. Archaeopteryx is a connecting link between reptiles and birds.
6. Correct order of age is Paleozoic $\rightarrow$ Mesozoic $\rightarrow$ Coenozoic.
7. The scientist to propose recapitulation theory was "Haeckel".
8. Evolution is history and development of race along with variations.

9. Homologous organs are similar origin with similar or dissimilar functions.
10. Vastigeal organ of python is “Hind limbs”.
11. Process of evolution is **continuous**.
12. Haeckal’s biogenetic law or recapitulation theory states that life history of an animal reflects evolutionary history of the same.
13. “Golden age of Dinosaurs”/Age of reptiles was “Mesozoic”.
14. Humming birds and Hawk illustrate adaptive radiation.
15. Birds and mammals evolved during Jurassic.
16. Mammals are believed to have evolved from reptiles in “Triassic”.
17. Parallelism is adaptive convergence of closely related groups.
18. Some homogoies organ are “Paddle of whale”, front legs of horse and arms of humans/legs of duck, hind limbs of kangaroo.
19. Analogous organs are different origin but similar functions.
20. Upper strata younger and lower older will be true in sedimentary rocks.
21. Vermiform appedix, wisdom teeth, body hair are the vestigial organs in humans.
22. Palaeozoic era is the era of fishes.
23. Pinna muscles is a vestigial organ in humans.
24. Examples of homologous organs are wings of pigeon and arms of humans.
25. Coccyx is a vestigial organ of human body.
26. Haeckel’s recapitulation theory states “Ontogeny repeats phylogeny”.
27. Fossilisation is animals buried by natural process.
28. Homologous and analogous, homologous and vestigial organs analogous and vestigial organs are a set of evolution.
29. Dinosaurs were dominant during **Jurassic**.
30. Wings of birds and wings of butter fly are analogous.
31. Angiosperm flourished during **Coenozoic**.
32. Mammoth (Animal) has become extinct recently.
33. Body hair is a vestigial organ in human body.
34. Fossil reptile having mammalian traits was “Pelycosaurus”.
35. Origin of first mammals occurred 220 million years.
36. Basic principle of embryonic development were pronouced by “Van Bear”.
37. Age of mammals and birds is coenozoic.
38. Dinosaurs disappeared during “Cretaceous”.
39. Fossil x is older than fossil y because fossil x was found in deeper sedimentation.
40. Carboniferous period of coal deposition was 300 million years ago.
41. Fossils indicate the evolution of **“Horse”**.
42. Fossils are not indicate the evolution of monkey, man and dinosaurs etc.

43. Biogenetic law was pronouced by **"Van bear and haekel"**.
44. Dinosaurs were dominant in Mesozoic.
45. Existence of coal/pteroleum can be known from study of **"Palaeobotny"**.
46. Fossils are dated by **"Radioactive carbon content"**.
47. The earliest fossil from in the phylogeny of horse is **"Eohippus"**.
48. Fossil remains of Archaeopteryx indicates that reptiles given rise to birds during jurassic.
49. Palaenontology provides direct and solid evidence in favour of organic evolution through ages.
50. Study of the fossils comes under "Palaeontology".
51. By "Allen's law" animals of cold countries have shorter ears.
52. Mammals occur on land, air and water. It is adaptive radiation Not adaptation.
53. Wings of mosquito, Bat and bird show evolution called "Convergent".
54. Presence of gill slits in the embryos of all vertebrates supports the theory of "Recapitulation".
55. Birbal sahni was the famous palaeotologist/palaeobotanist of India.
56. Two geographical regions separated by high mountains are palaerctic and oriental.
57. Organisms present at different places without any traces in between show "Discontinous distribution".
58. Nictitating membrane is a vestigial organ in human.
59. Branch of botany dealing with distribution of plants is **"Phytogengraphy"**.
60. In azoic era had life not originated.
61. Birbal sahni institute of palaebotany is located in Lucknow.
62. Phylogeny is evolutionary history.
63. Exsitence of marsupials in australia and newzealand proves continental drift and geological period.
64. Human hand, wing of bat and flipper of whale represents homologous organs.
65. The statement "nothing in biology makes sense except in the light of evolution" was given by "Dobchansky".
66. "Genetics and the origin of life" Book had wrritten by "Dobzhansky".
67. Animals of cold area have shorter and smaller extremities. This is allen's law.
68. Coal has been mainly formed by pteridophytes/pteridosperms.
69. Vestigial pelvic girdle and bone remnants of hind limbs are characteristic of "Whale".
70. Organic evolution is change in major portion of popultion.
71. Archeopteryx is a bird with teeth.
72. Darwin's friches provide evidence of evolution from "Biogeography".
73. Living organism with oldest fossil history is "Horse".
74. Adaptive similarites in animals of the same habitat consititute. "Convergent evolution".
75. Homologous organs show " Divergent evolution".
76. Identical to those of man are monkey and some lower groups certain blood groups.

THEORIES OF ORGANIC EVOLUTION

LAMARCKISM :

First theory of evolution was proposed by

Jean Bapttiste de Lamarck (17-44 - 1829)

Book : **Philosophie Zoologique (1809)**

Lamarck coined the terms – **Invertebrates, Annelida**.

The term **Biology** was given by **Lamarck & Treviranus**.

Theory of Inheritance of Acquired Character–

Basic Concept of Lamarckism–

(i) Internal Vital Forces :

Some internal forces are present in all organisms. By the presence of these forces organism have the tendency to increase the size of their organs or entire body.

(ii) Effect of environment and new needs:

Environment influences all type of organisms. Changing environment gives rise to new needs. New needs or desires produce new structures and change habit of the organism.

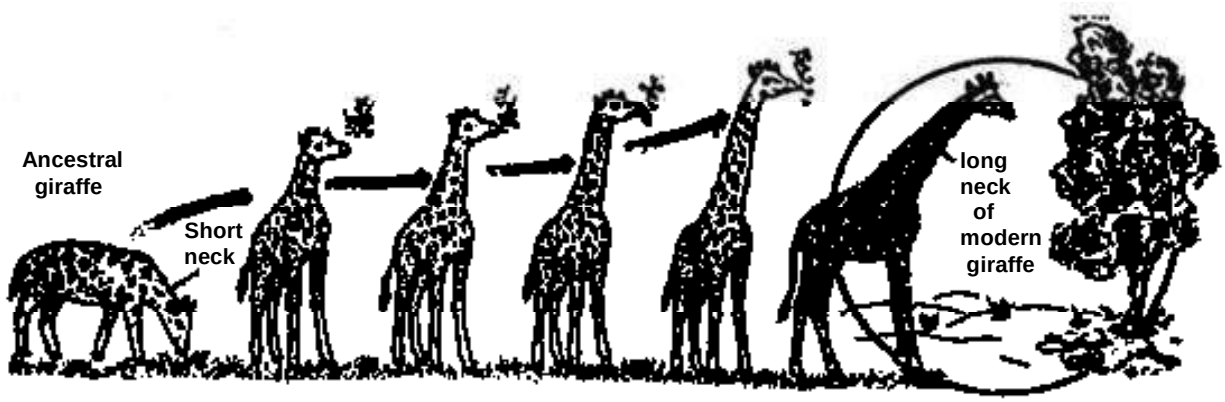
(iii) Use and disuse of organs:

If an organ is constantly used, it would be better developed whereas disuse of organ result in its degeneration.

(iv) Inheritance of acquired character:

During the life of an organism new character develop due to internal vital forces, effect of environment, new needs and use and disuse of organs.

These acquired character are inherited from one generation to another. By continuous inheritance through many generation these acquired characters tend to make new generation quite different from its Ancestors resulting in the formation of new species.



Example in support of Lamarckism :

1. Long neck and high fore limb of Giraffe.
2. Aquatic birds stretched their toes and developed web.
3. Snakes lost their legs.
4. Deers became good runners by the development of strong limbs and streamlined body.
5. Retractile claws of carnivorous animals.

Criticism of Lamarckism -

1. According to first concept organism tends to increase their size but it is not universally true.

   For Example among angiosperm the trees seem to be primitive and the shrubs, herbs and grasses have evolved from trees but the size was reduced during evolution.
2. Second concept is false. Can we sprout wings wishing to fly like birds.
3. The third concept is some what true like the well developed biceps muscles of blacksmith and less developed wings in flight less birds.

   But this concept also have many objections like the eyes of a student/reader do not increase in size and power with increasing age, the constantly beating heart maintains a constant size through generation.
4. Fourth concept is completely false because acquired characters are not inherited.

Weismann –

Weismann cut off the tails of rats for about 22 genrations but there was no reduction in the size of tail on the basis of this experiment Weismann proposed **the theory of continuity of germplasm.**

According to Weismann.

(i) Two types of matters are present in organism, **somatoplasm and germplasm.**

(ii) Sometoplasm in somatic cells and germplasm in **Germinal cell.**

(iii) Somatoplasm dies with the death of organism while germaplasm transfers into the next generation.

(iv) If any **variation** develops in germplasm, it is inherited , while if variation develop in somatoplasm it is not transmitted.

Pyane :

Pyane kept drosophila in dark up to **69 generation,** but there was no reduction in the size or sight of eyes

– Boring of ear and nose in Indians.

– Iron shoes of Chinese.

Neolamarckism-Term by Packard

Although Lamarckism remained controversial but some scientists gave the following evidences in favour of Lamarckism. The are known as **neo-lamarckians.**

According to neolamarckism environment effected the inheritance of acquired charater. According to it changing environment give rise some physical and chemical changes in organism, which effect their germplasm, and these acquired characters are definitely inherited.

1. Sumner's Experiment–

Sumner kept white rat in warn temperature resulting in elongation of body, large pinna and long tail. These features were inherited by the offspring.

2. Kammerer's Experiment–

Kammerer kept salamander in dark background. The black spots found on skin were widely spread. In lighter, background the skin became yellow with limited black spots. These character were inherited by the offspring.

3. Mac Dugal's Experiment-

Mac Dugal trained white rats to cross a tank of water following a definite route. These trained rats were mated and their offspring were again trained. It was observed that there was decrease in the number of errors by offsprings of white rats.

Difference between Lamarckism and Neo–Lamarckism

Lamarckism	*Neo–Lamarckism*
It is original theory by Lamarck.	It is a modification of the original theory of Lamarck in order to make it more suitable to modern knowledge.
The theory lays stress on internal force, appetency and use and disuse of organs.	Neo–Lamarckism does not give any importance to these factors.
It believes that changes in environment brings about a conscious reaction in animals.	The theory stresses on the direct effect of changed environment on the organisms.
According to Lamarckism the acquired characters passes on to the next generation.	Normally only those modification are transferred to next generation which influence germ cells or where somatic cells give rise to germ cells.

Special Points : -

1. **Allen's law :** The homoeothermic animals (Birds and Mammals) of colder region have shorter extremities, like pinna, toes etc., than their counter parts of warmer region.
2. **Bergman's law :** The warm blooded animals (Birds and mammals) of colder region are bigger or larger in size than their counter parts of warmer region.
3. **Cope's law :** The animals of a major adaptive group of region have a tendency of increase in size. For example, the dinosaurs formed the major adaptive group in Mesozoic era.
4. **Dollo's law :** The evolution is an irreversible process.
5. **Gause's law :** Two species with identical food habits or ecological needs can not occupy the same ecological niche for a very long time. Gause's principle was restated by Hardin (1960) as 'Competitive Exclusion Principle', which means that *complete competitors cannot co-exist*.
6. **Golger's law :** The homoeotherms of colder region, with low temperature and low humidity, have less melanin in their skin.
7. **Hardy-Weinberg's law :** This law was proposed in 1908 by G.H.Hardy, a British mathematician, and W.Weinberg, a German physician, and is related to the **Population genetics.** It states that :
   'If a population is at equalibrium then the gene frequency and the genotype frequency will remain constant generation after generation.'

- A population is said to be at equilibrium when there is :
  1. No Mutation
  2. No Natural or Artificial selection
  3. No Gene flow
  4. No Genetic drift

- This also means that sexual reproduction alone cannot bring a change in allele frequency. This law is applicable when above changes do not occur, hence no evolution takes place. (Such conditions can never be achieved in nature).
- The mathematical expression to calculate allele frequency can be given as

$$\boxed{p + q = 1}$$

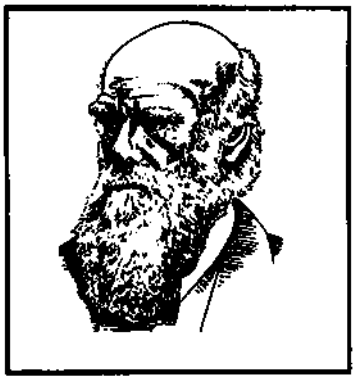
Where 'p' represents the frequency of dominant allele and 'q' represents the frequency of recessive allele. The binomial expression of Hardy Weinberg's law, to calculate genotype frequency is

$$\boxed{p^2 + 2pq + q^2 = 1}$$

Where p^2 = homozygous dominant (genotype) individuals, pq = heterozygous (genotype) individuals, and q^2 = homozygous recessive (genotype) individuals.

DARWINISM

Charles Robert Drawin was born on 12th feb. 1809 in England. Darwin traveled by **H.M.S. Beagle.**



The ship left on Dec. 27, 1831 and returned on Oct. 2, 1836. He travelled South America, **South Africa, Australia and Galapagos Islands.** Darwin was influenced by two books.

"Principles of population" of Malthus.

"Principles of Geology" of Charls Lyell.

Alfred Russel Wallace :

He travelled South eastern Asia and South America. The idea of natural selection striked in his mind. Wallace wrote an essay and sent it to Darwin. **"On the tendency of varieties to indefinitely from original type"**.

There was striking similarity between the view of Darwin and **Wallace.**

Wallance's chart : Wallace presented a chart to explain main points of theory of Darwin.

"Darwinism" or "The theory of Natural Selection" was proposed by both Charles Darwin and A.R. Wallace. This theory was later on explained by Darwin in his book **'On the origin of species by the means of Natural Selection' (1859).**

S. No.	Facts	Consequences (Conclusions)
1	(i) Enormous rate of reproduction among animals (ii) Constant number of animals of a species	Struggle for existence
2	(i) Struggle for existence (ii) Heritable variations	Suvival of the fittest or natural selection
3	(i) Survival of the fittest (ii) Continuous environmental changes	Continuous natural selection leading to evolution of new species

The main features of theory of Natural Selection are as follows –

(1) Over production : (High rate of Reproduction)

All organisms have capability to produce enormous number of offspring, organisms multiply in geometric ratio.

e.g. – Plants produce thousands of seeds.

– Insects lay hundreds of egg

– One pair elephant gives rise to about six offspring and if all survived in 750 year a single pair would produce about 19 million elephant. Thus some organisms produce more offspring and other produce fewer offspring This is called **differential reproduction.**

(2) Struggle for existence :

Every individual competes with other of the same and other species for basic necessities like. Space, shelther and food. It is called struggle for existence and it continues for the whole life from zygote stage to its natural death.

The struggle for existence is of three types –

(i) Intra-specific struggle : It is competition between the individuals of same species for same needs like food, shelter and breeding **(most acqute type of struggle).**

(ii) Inter-specific struggle : It is the struggle between the individuals of different species for food and shelter.

(iii) Environmental struggle : This struggle is between the organism and their environment. All organism struggle with cold, heat, wind, rain drought and flood etc.

(3) Variations and heredity :

Exept identical twins no two individuals are similar and their requirements are also not same. It mean there are differences among the individuals. These differences are called **variations.** Due to variations some individuals would be better adjusted towards the surroundings than the others.

According to Darwin the variations are continuous and those which are helpful in the adaptation of an organism towards its surroundings would be passed on to the next generation, while the others will disappear.

(4) Suvival of the fittest or natural selection :

The original idea of survival of fittest was proposed by Herbert Spencer.

According to Darwin most suitable and fit individuals are successful in struggle for existence. The individuals with most favourable adaptations are able to lead most successful life and are able to win over their mating partners. Darwin called I Sexual Selection.

In the struggle for existence only those members survive which posses useful variations means nature selects fit individuals. This was called Natural Selection. Fitness is the end result of the ability to adapt and get selected by nature.

(5) Origin of New Species :

Darwin explained that variations appearing due to environmental changes are transmitted to the next generation. So offspring become different from ancestors. In nest generation process of Natural selection repeats so after many generation a new species is formed.

Criticism of Darwinism –

1. Darwin does not explain the development of vestigial organs.
2. This theory has no satisfactory explanation for the cause, origin and inheritance of variation.
3. Darwin is unable to explain why in a population only a few individuals develop useful variation and others have harmful variations.
4. Criticism of Darwinism was based on sexual selection. Why only female selects the male for mating why not vice versa.
5. Darwin was unable to differentiate somatic and germinal variations.
6. This theory was unable to explain over-specialization of some organs like tusk of elephants, antelers of deer.
7. This theory only explain the survival of fittest but unable to explain **arrival of fittest**.
8. The main drawback of Darwinism was lack of the knowledge of **heredity**

Theory of pangenesis

According to this theory all organs of an individual produce Pangenes, which are minute particles carrying information about the organs.

The pangenes traveling through the blood stream will ultimately reach the gametes, so that each gamete will have pangenes for each of the different organs.

After zygote formation, the pangenes tend to form the same organs from which these pangenes were produced.

	L1 – short neck in ancestral stage of giraffe. Neck was stretched and used to feed on leaves of tall trees.	D1 – In ancestors of giraffe different length of neck was inheritable.	
	L2 – Neck in offsprings increased, this was also stretched and used to feed on leaves of tall trees.	D2 – As a result of struggle for existence giraffes with longer neck were better adapted. Due to natural selection offsprings with long neck increased in number, while those with short neck gradually disappeared.	
	L3 – Neck in the offsprings of gifaffe continued to increase in next generations resulting in the evolution of long neck in modern giraffe.	D3 – Due to above reasons giraffes with only longer neck survived.	

Difference between Darwinism and Neo–Darwinism

Darwinism (Natural Selection)	*Neo–Darwinism*
1. It is the original theory given by Charles Darwin (1859) to explain the origin of new species.	**1.** Neo–Darwin is a modification of the original theory of Darwin to remove its short–comings.
2. According to this theory accumulation of continuous variations causes changes in individuals to form new species.	**2.** Instead of continuos variations, mutations are believed to help form new species.
3. It believes in the selection of individuals on the basis of accumulation of variation.	**3.** Variations accumulate in the gene pool and not in the individuals.
4. Darwinism does not believe in isolation.	**4.** Neo–Darwinism incorporates isolation as an essential component of evolution.
5. It can explain the origin of new characters.	**5.** The theory can explain the occurrence of unchanged forms over millions of years.
6. Darwinism cannot explain the persistence of certain forms in the unchanged condition.	**6.** Normally only those modification are transferred to next generation which influence germ cells or where somatic cells give rise to germ cells.

NEODARWINISM :

NeoDarwinism is a modified form of Darwinism along with recent researches of **Weismann, Mendel, Devries, Huxley, Gates, Stabbins** ets. They performed many experiments to remove the objections against Darwin's theory.

The salient features of neodarwinism are as follows–

1. **Rapid multiplication :** All organism multiply in geometrical ratio.
2. **Limited food and space :** Food and space are limited.
3. **Struggle for existence :** It is of three types. Intraspecific, Interspecific and environmental.
4. **Genetic Variations :** They are inheritable variation which can occur due to the following reasons.
   - **(a) Mutation :** They are **discontinuous variations** which develop due to permanent changes in genotype. Mutations are of three types–
   - – **Genomatic mutations :** Change in number of chromosome.
   - – **Chromosomal Aberrations :** Changes in number of chromosome.
   - – **Gene Mutation :** Change in nucleotide.
   - **(b) Gene recombination :** They are new combination of genes which are usually caused by **crossing over.**
   - **(c) Hybridisation and gene migration :** It is crossing of organisms which are genetically different in one or more traits.
   - **(d) Genetic drift :** It is the elimination or addition of the genes of certain chartain characters when some animals in population migrate or dies or immigrate. It changes the gene frequency of remain population. Genetic drift operates only in **small population.**

     (Changes in frequency of genes in a gene pool is called **drift.)**

Founder Effect : Gene pool is the sum total of all the genes found in a population. Change in the frequency of gene in a gene pool is called genetic drift. Genetic drift always operates in small population. By genetic drift often the phenotype of this small population quickly become different from the parental population and some time form a new sp. Such an effect is called Founder Effect.

Bottleneck Effect : Death of several members of population due to natural calamities (Earthquake , Storm, Flood) also leads to genetic drift. The original size of population is then restored by mating among the survivor. The new population may lack the genes of certain. This may produce a new species after some time. The loss of a section of population by death an after sometime a new species is formed that effect is known as Bottleneck effect.

5. Natural Selection :

If differential reproduction (some individuals produce more, some only few and still others none) Continuous for many generations, genes of the individuals which produce more offspring will become predominant in the gene pool of the population. Thus natural selection occurs through differential reproduction in successive generations.

6. Isolation :

Isolation is a segregation of populations by some barriers which prevent interbreeding. The reproductive isolation between the populations due to certain barriers leads to the formation of **new species.**

Example of Natural Selection –

(1) Industrial Melanism :

This phenomenon was studied by **Barnard kettlewell.**

(a) (b)

Figure showing white – winged moth and dark – winged mouth (melanised) on a tree trunk (a) In unpolluted area (b) In polluted area

Before industrial revolution, the dull grey forms of prepared moth-**Biston betularia** – were dominant; the **Carbonaria** form (Black) was rare because it was susceptible to predation by birds. The reason was that it was **conspicuously** visible while resting on tree trunks.

The industrial revolution, resulted in large scale smoke which got deposited on tree trunks tuning them Black. Now grey varieties became susceptible – the black forms flourished. Replacement of coal by oil and Electricity reduced production of black moth so the frequency of grey moths increased again.

(2) Drug resistance :

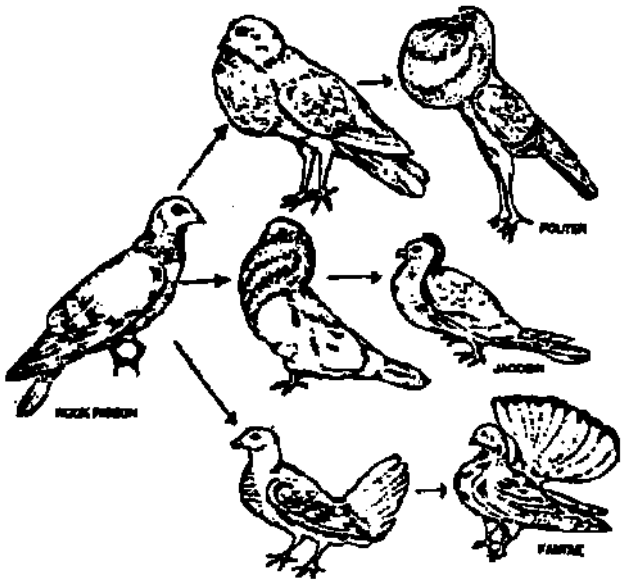
The drugs which eliminate pathogens become ineffective in the course of time because those individuals of pathogenic species which can tolerate them, survive, flourish to produce tolerant population.

(3) Sickle cell Anaemia and Malaria :

Individuals homozygous for sickle cell Anaemia die at an early age. In heterozygous individuals, the cells containing abnormal haemoglobin **Sickle** shaped. In fact, When an RBC becomes sickle-shaped, it kills Malarial parasite effectively so that these individual area able to cope with malaria infection much better than normal persons. The processs of natural selection thus maintains the abnormal form of haemoglobin along with the normal form in a region where Malaria is common.

(4) Malaria and G-6-PD deficiency :

Glucose 6- Phosphate dehydrogenase deficiency is a common abnormality in Negroids. Haemoglobin gets denatured and is deposited on cell membrane. **The disease is called favism.** In these RBC, the malarial parasite cannot complete It's cycle. Such persons get protection from Malaria.



Artificial Selection –

Man has been taking the advantage of genetic variations for improving the qualities of **domesticated plants and animals.** He selects the individuals with desired characters and separates them from those which do not have such characters. The selected individuals are interbred. This process is termed as **Artificial Selection**. This process is man made. If it is represented for many generations it produces a new breed with desired characters. By artificial selection animal breeders are able to produce improved varieties of domestic animals like **dogs, horse, pigeons,, poultry, cow, goats, sheep** and **pigs** from their wild ancestors. Similarly the plan breeders have obtained improved varieties of useful plants like wheat, rice, sugarcane, cotton, pulses vegetables fruits etc.

Artificial Selection is similar to natural selection except that the role of nature is taken over by man and the character selected are of human use.

Special points :

- The breeders have successfully produced the toy-like Shetland pony, the Dane dog, the sleek Arabian race horse by selection.
- Many crop plants like broccoli, kale cabbage, Cauliflower, Brussels sprouts and kohirabi have been produced through selective breeding.
- The various breeds of fowl ranging from the ceremonial cocks **(the Japanese onago-dori)** to the **broiler. leghorns** are all derived from a single jungle fowl **Gallus gallus.**

Reproductive Isolation –

Reproductive isolation is the prevention of inter breeding between the population of two different or closely related species.

It maintains the characters of the species but can lead to the origin of new species.

The mechanism the characters of the species but can lead to the origin of new species.

The mechanism of reproductive isolation is explained by **Stebbins** in his book **'Process of Organic Evolution'.**

Two main subtypes of reproductive isolation are–

1. **Premating or prezytotic isolation :**

   Prevent matting or formation of zygote.

   (1) Ecological isolation : Two species live in different habitats and do not meet. (One may be living in fresh water and the other in the sea).

   (2) Temporal isolation : Breeding seasons or flowering time may be different in the two species.

   (3) Behavioural isolation : The males of one animal species are unable to recognize the females of another species as potential mates.

   (4) Machanical isolation : The structural differences in genitalia of individuals belongings to different animal species interfere with mating.

   (5) Gametic isolation : The sperms and ova of different species of animals are unable to fuse. In plants, the pollen coming from a different species may be rejected by the stigma.

2. **Postzygotic Isolation :** A hybrid zygote is formed but it may not develop into a viable fertile adult.

   (1) Hybrid inviability : Hybrid zygotes fail to develop. In plants, embryos arising from interspecific crosses abort.

   (2) Hybrid sterlity : Hybrid adults do not produce functional gametes. (Mules and henny are common example) in mammals. Several hybrid ornamental plants are sterile.

   Exception :

   – Africal lioness + Asian tiger = tigon
     (panthera leo) (Panthera tigris)
   – Male lion + Female tiger = Liger
   – Mallard duck + pintail duck
   – Polar bear + Alaskan brown bear
   – Platy fish + Swordtail fish

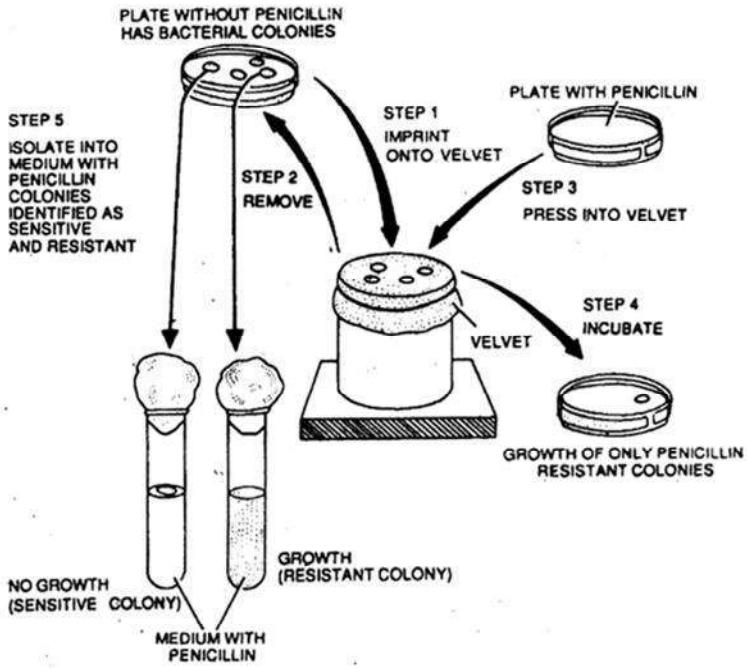
3. **Hybrid breakdown :** Sometime inter specific mating produce a hybrid, which give rise to next hybrid by back cross but they have reduced vigour or fertility or both.

GENETIC BASIS OF ADAPTATIONS :

Joshua Lederberg & Esther Lederberg shown genetic basis of adaptations by experimenting on bacteria. This experiment is known as Ledeberg's Replica plate experiment.

1. Lederberg cultured the bacterial cells on agar plate.
   Many bacterial colonies or groups grew on this agar plate.
   In this every colony is formed by the division of bacterial cells.
   Therefore its all cells were of same genetic structure.
   This type of group of cells is known as **clone.**
   This multi colony agar plate is known as **master plate.**

2. On this master plate one sterile velvet plate was pressed slightly so that some bacteria got stuck on velvet plate. In this way this becomes **replica of master plate.**



3. Now efforts of preparing replica had been made on those agar plates whose agar contains an antibiotic penicillin. It was seen that some bacteria failed to grow on penicillin agar plate while some bacteria were able to grow and developed new colony.

   It was concluded that those bacterial colonies were penicillin resistant. These bacteria have penicillin resistant mutant gene.

   ***Lamarckian view :** Penicillin induced a change in some bacterial cells enabling them to grow in medium containing penicillin (wrong concept).

   ****According to Darwin** some bacterias were penicillin resistant in bacterial suspension. In penicillin medium normal bacteria did not survive while mutant bacterias survived, as they are adapted, and form colony.

MODERN SYNTHETIC THEORY OF ORGANIC EVOLUTION :

This theory is the result of the work of a number of scientist namely **Dobzhansky, Fisher, Haldane, Swall wright, Mayr, Stebbins.**

Stebbins discussed this theory in his book **''Process of Organic Evolution''** and Dobzhansky explained it is his book **''Genetics and the origin of species''**.

According to this theory new species can not evolved by the presence of variable genotype in a population. Two factors are also required-natural selection and reproductive isolation. Natural selection guides different population in to different adaption direction and reproductive isolation between them due to geographical barriers leads these direction to the evolution of new species.

In this theory following factors are included –

(i) Gene mutation

(ii) change in chromosome number and structure

(iii) Genetic recombination

(iv) Natural selection

(v) Reproductive isolation.

Besides these factors there are two more processes which cause evolutionary changes. These are –

(i) Migration of individuals from one population to another.

(ii) Hybridisation among species and also related genera which causes genetic variation in the population undergoing process of evolution.

Mimicry :

- It is kind of adaptation.
- The term mimicry was given by Bateson (1862)
- The resemblance of one organism to another or to any natural object for the purpose of concealments, Protection or for some other advantages like attack.
- The organism which exhibits mimicry is called a **mimic** and the organism or object which is mimicked is called as **model.**

Types of mimicry :

(1) Protective (2) Aggressive (3) Conscious

1. Protective mimicry :

It is useful for an organism to protect itself from the predator.

It is of 2 types –

(a) Concealing - The organism resembles the surrounding, so it cannot be easily detected by predators. E.g Stick insect, Leaf insect.

(b) Warning type - The organism resembles a distasteful or poisonous organism. It is also known as **batesian mimicry.**

Eg. Viceroy butterfly

2. Aggressive mimicry :

It is generally used by the predator.

It is of 2 Types –

(a) concealing : In this type the predator cannot be noticed by the prey because it matches with the surroundings involving colour or body shape or both.

Eg. Yellow spider

(b) Alluring Type : The predator attracts the prey by resembling it self to any other object.

Eg. mouth corner of African lizard resembles a flower.

3. Conscious mimicry :

Some organism behave as a dead object to protect them from predator.

Eg. **Tenebrinoid beetles** become motionless and pebble like when in danger.

Mullerian mimicry :

When two or more inedible or unpalatable species each other this type of mimicry is called mullerian mimicry. Mullerian mimicry is done by two species for increasing warning effect to predators. For example ctenuchid moth resembles a wasp, where both of them are unpalatable.

It is also a kind of protective mimicry.

Mutation Theory

Proposed by Hugo-de-vries on the basis of his experiments on a plant Oenothera lamarckiana.

Main Point of mutation theory :

1. Mutation or discontinuous variation are the raw material of evolution.
2. Mutation appears suddenly and produced their effect immediately.
3. Mutants are different from the parents and there are no intermediate stages between the two.
4. The same type of mutation can appear in several individuals of a species.
5. Mutation can appear in all direction and all mutations are inheritable.
6. useful mutations are selected by nature an lethal mutations are eliminated.
7. Mutation are recurring so that the same mutant can appear again & again so change of selection by nature are increased and new species is formed.
8. Mutation is a jerky & discontinuous process. De-vries termed single step large mutation as **saltation.**
9. Mutations are random and directionless while Darwinism variations are small and directional.

Points in favour of mutation theory :

1. Mutations are actually the source of all variations and fountain head of evolution.
2. Mutation theory can explain both progressive & retrogressive evolution.
3. A number of mutations have appeared in nature and mutations are induced which have given rise all of sudden by mutation.
4. Oenothera lamarchiana is not normal plant but a complex heterozygous plant from with chromosomal aberration

Significance :

De-vries mutation theory generally accepted because the mutation were found to be inheritable. It was later through that evolution cannot occur by mutation alone, natural selection and isolation of mutants are also necessary for evolution.

Natural Selection & Polymorphism :

A population is called polymorphic for a character if two or more distinct form are present in this population.

Ex.: ABO Blood Group :

There are 4 types of blood group are present in human being A, B, AB. and O. They are due to the presence of different genotype.

Sickle cell anemia is also an example of polymorphism. In this disease on amino acid is changed in polypeptide chain due to change in one N_2 base. That's why the normal shape of RBC is changed into sickle shape.

The organism in which heterozygous condition is present for this characters, the RBC become sickle shaped. In this type of RBC malarial parasite can't have a normal growth that's why these individuals are resistant towards malaria.

The HbS, HbS, condition leads to the death of organism.

The organism with HbS, HbA condition are selected by nature because these are the fittest of all. The lose of HbS gene due to the death of organism having HbS, HbS is recovered & balanced by the reproduction of heterozygous condition (HbS, HbA).

This type of selection is called **balancing selection.**

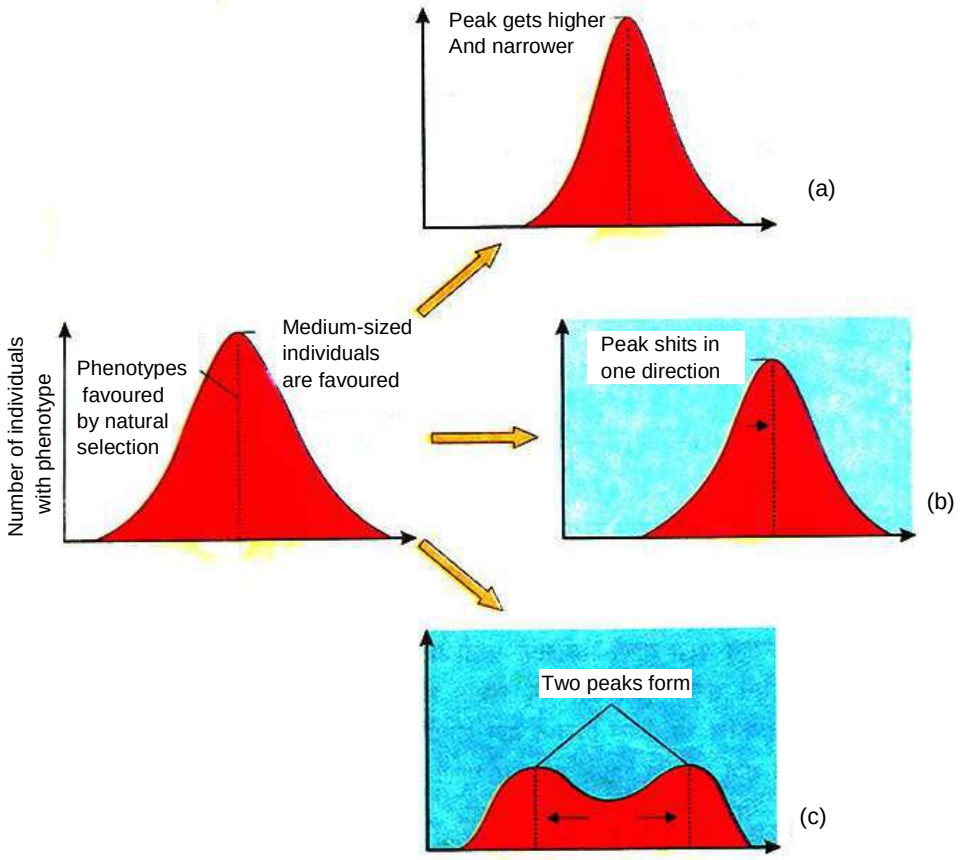
It means the preservation of genetic variability is maintained by the selection of hertozygotes which is called **'Balanced polymorphism'.**

But this kind of balancing selection is found very rarely in nature.

Difference Amongst Lamarckism, Darwinism and Mutation Theory

	Lamarckism	*Darwinism*	*Mutation Theory*
1. Vital force	The theory believes that every organism has an internal vital force that tends to increase its size upto a certain limit.	Darwinism does not believe in internal vital force.	No internal vital force is involved.
2. Conscious Reaction	Animals with well developed nervous system react consciously to any change in environments	Darwinism does not involve any conscious reaction.	No conscious reaction is believed to take part in the process of evolution.
3. Appentency	The theory considers appentency or desires on the part of animals an important force in the development of modifications.	It is not a constituent of the theory.	Appentency in not involved.
4. Use and Disuse	The organs put to more use are believed to develop more while organs not used begin to degenerate.	The theory is silent about use and disuse of organs.	The theory is silent about it.
5. Inheritance of Acquired Characters	The characters acquired by an organism during its life are believed to get transferred the next generation.	According to Darwin, all the living cells produce minute particles or pangenesis, which pass into germ cells for transmission to the offspring.	Only those variations are transferred to the offspring which originate in germ cells or in the cells which form germ cells.
6. Struggle for Existence	The theory does not clearly spell out struggle for existence in relation to high biotic potential.	Organisms produce more offspring than the available food and space so that a struggle for existence ensues amongst them.	The theory believes in the struggle for existence.
7. Origin of Variations	Variations appear in organisms in response to change in environment, conscious reaction, desire *r* use and disuse of organs.	Variations appear automatically.	Variations appear due to change in genetic make up.
8. Continuous Variations	The theory is silent about them though it believes in a continuous modification of organs in a particular direction.	It is based on the origin and selection of continuous variations.	The theory is based on discontinuous variations or mutations.
9. Natural Selection	The theory does not take into account natural selection or survival of the fittest.	Darwinism is based on natural selection or survival of the fittest.	Mutations theory believes in natural selection or survival of the fittest.
10. Progress of Evolution	Evolution is a continuous process which moves in a direction governed by environment and appentency.	Evolution is a continuous process, the direction of which is governed by nature.	Evolution is a jerky process, the direction of which is unpredictable though ultimately it is governed by nature.

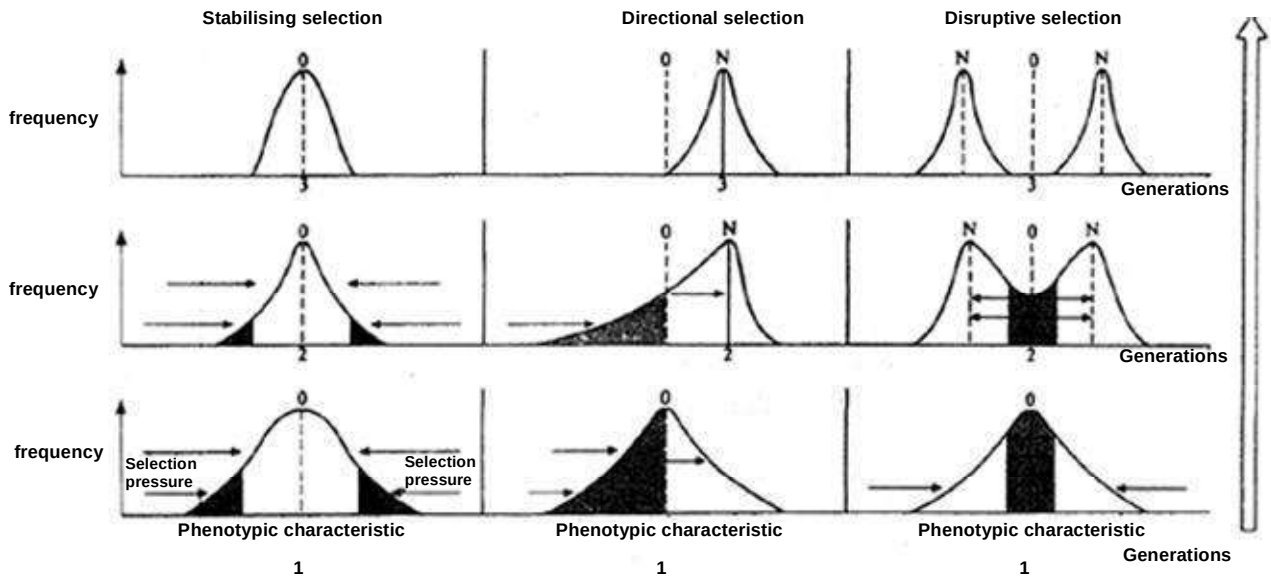
Types of Natural Selection :



Diagrammatic representation of the operation of natural selection on different on different traits : (a) Stabilising (b) Directional and (c) Disruptive

Based upon different organism – environment relationship. Following different kinds of natural selection have been recognised.

– Stabilising selection.
– Directional selection.
– Disruptive selection.



Diagrams showing the three types of selection operating within populations. 0 indicates the original coincidence between optimum and optimum environmental conditions; N indicates the new position of coincidence of optimum phenotype and optimum environmental conditions. Organisms possessing characteristics in the shaped portions of the normal distribution are at a selective disadvantage and are eliminated by selection pressure. (The number 1-3 indicate the order of generations.)

(1) Stabilising selection :

Stabilizing selection operates when phenotypic feature coincide with optimum environmental conditions and competition is not present.

It keeps a population genetically constant.

If favours the average or normal phenotypes and eliminate the extreme variants, that fall towards both ends of the bell-shaped curve of variability for the distribution of measurements of phenotypic traits.

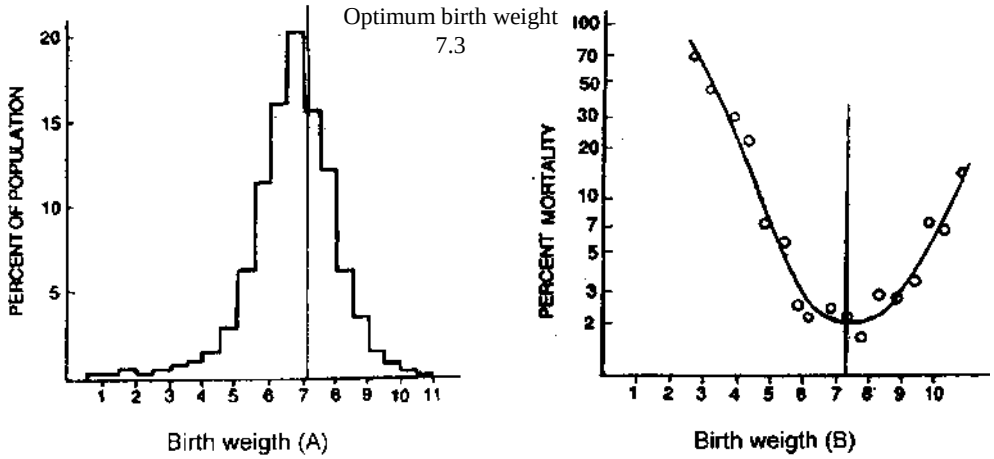
Due to continuous elimination of both extremes, the bell shaped curve tends to narrow.

Stabilising selection always operates in constant or unchanging environment.

Ex. Mortality in babies : The birth weight of human babies provides another example influenced by stabilizing selection.

The optimum birth weight favoured by stabilizing selection is 7.3 pounds.

New born infants less than 5.5 pounds and more than 10 pounds have the highest mortality rate. The curve for mortality is virtually the complement of the curve of survival.



The distribution of birth weight of human infants. A-Histogram showing the proportions of populations falling ionto various birth weight classes. B-Mortality curve in relation to birth weight of human infants

(2) Directional selection or Progressive selection :

Directional selection produce a regular change in a population in respect to certain traits.

This form of selection operates in response to gradual changes in environmental condition.

It favour individuals that change in response to the environmental change and become best adapted to new environmental condition. If favour the phenotype which is non average or extreme and then pushes the phenotype of the population in that direction.

Directional selection removes more individuals from one end of the normal curve of variability distribution and adds towards the other end and alters the mean value of the trait in the population in a particular direction.

So the mean moves in one direction. Directional selection operates when environment is changing in one direction.

Ex. (1) Biston betularia

(2) Resistance of insects to DDT.

(3) Disruptive selection :

This is probably the rerest form of selection but can be very important in bringing about evolutionary change.

Fluctuating conditions within an environment, say associated with season and climate may favour the presence of more than one phenotype in a population.

Selection pressure acting from within the population as a result increased competition may push the phenotype away from the population mean towards the extremes of the population.

This can split a population into two subpopulation.

If the gene flow between the subpopulation is prevented, each population may give rise to a new species. In some cases this form of selection can give rise to the appearance of different phenotype within a population, known as polymorphism.

Eg. Shell pattern in limpets : Shell patterns of limpets (marine mollusca) present a continuous, ranging from pure white to dark tan. These are either attached to white goose neck barnacles or to tan-coloured rocks. The white or light-coloured limpets camouflaged withy white barnacles and tanned ones were protected on the tan-coloured rocks. Limpets of intermediate shell patterns, being conspicuous are preyed by predatory shore birds, resulting in distruptive selection.

SPECIES

1. **Biological species concept :** species is a sexually interbreeding group of individuals separated from other species by the absence of genetic exchange.

   Member of a species are capable of breeding with one another and produce living, fertile offspring but are unable to breed with members of other species normally.

   Sibling species : Species which are morphologically similar but do not interbreed normally, are known as sibling species.

   Eg. **Drosophila pseudoobscura** & **Drosophila ersimillis.**

2. **Evolutionary species concept :** Proposed by **George Gaylord simpson.**

   Biological sp. Concept explained only sexually reproducing animals.

   Animals with asexual reproduction can not be explained like-prokaryotes, some protista, some fungi which kept in same sp. On the basis of same morphology & same biochemistry.

According to evolutionary sp. Concept species is defined on the basis of differences which are not base on sexual reproduction.

Supporter of this theory gave more importance to evolutionary isolation as compare to sexual isolation.

According to this concept a species is a lineage (an ancestor descendant sequence of population) which evolved separately from other species and have its own evolutionary role and tendencies.

This concept also include evolution. In this concept morphological, genetic, behavioural and ecological differences are include. But this concept is also not completely true.

3. **Typological concept :** According to this concept a fix pattern of characters is present in the species of every living organism and all the members of the species maximum resemblance with this pattern. **[The most acceptable concept].**

   According to this concept species are of 2 types :

   (A) Monotypic Sp. In the formation of this type of species main ancestor species do not divide in to small groups and modify into a new species. So the no. of species are not increased.

   (B) Polytypic. : In the formation of this type of species the main ancestor sp. Divided into two or more groups and each groups form a new species. So the no. of species will increased.

SPECIATION

Formation of one or more new species from an existing species is called **speciation.** Speciation are to 2 types.

1. **Divergent speciation :** Origin of one or more new species from an ancestor species is called **divergent speciation**.

   In this type of speciation ancestor sp. also continuous to exits with new species.

   In this type of speciation no. of species are increased.

   Demes : Local population of a particular area is called **demes.**

   The members of two different demes of same sp. Can interbreed normally.

   Race : Races are small groups of a species which are geographically isolated and have some genetical difference, which are controlled by genes.

   Divergent speciation are of two types –

(1) Allopatric Speciation : When a species split into two or more geographically isolated population and these population finally form a new species.

This mode of speciation is called allopatric speciation and these sp. are known as allopartic species.

Ex. : Finches of Darwin are example of **Allopatric speciation.**

(2) Sympatric species : In this type of speciation a sub population becomes reproductively isolated from its partental population.

Sympatric speciation is the formation of species without geographical isolation and these sp. are known as sympatric species.

Mainly present in plants due to polyploidy.

2. **Transformation speciation :** in this type of speciation an ancestor species change into a new sp. with time. In this process no. of species is not increased.

   Transformation speciation are of two types –

(1) Phyletic Evolution : When an ancestor sp. changed in to a new species by gradual change in thousand of years.

E.g. Eohippus → Mesohippus → Merychippus → Pliohippus → equus

(2) Quantum Species : In this process suddenly major changes appears in ancestor species and ancestor species immediately changed into new sp. No. connective links are present in this type of speciation. It is caused by major mutation.

Special point :

- **Micro evolution : -** Micro evolution is the occurrence of small-scale changes in gene frequencies in a population, over a few generations.

  It occurs at or below the species level. It often cause the formation of new subspecies.

  These changes may be due to several process-Natural selection, gene flow. mutation, recombination, genetic drift etc.

  eg. Formation of clines.

- **Micro evolution : -** Macro evolution is the evolution, which results is the production of new adaptive types through a process of population fragmentation and genetic divergence.

  It is the occurrence of large-scale changes in gene frequencies in a population, over a geological time period (consisting of lots of micro evolution).

  Macro evolution operates above the species level and results in the establishment of new genera, families and order.

  The changed in the organization occurs due to accumulation of large mutation (macro mutation).

  Macro evolution is the actually adaptive divergence.

  The divergent evolution of different reptilian group from initial reptile ancestor is example of macro evolution.

- **Mega evolution : -** The origin and evolution if new types of biological organization as a result of general adaptation from its predecessor resulting in the formation of new classes, phylum.

  Mega evolutionary changes are rare and have occurred only a few times in the evolutionary history of living beings.

  Ex. Origin of Amphibia from fishes, origin of reptiles from amphibian, origin of bird and mammal from reptile.

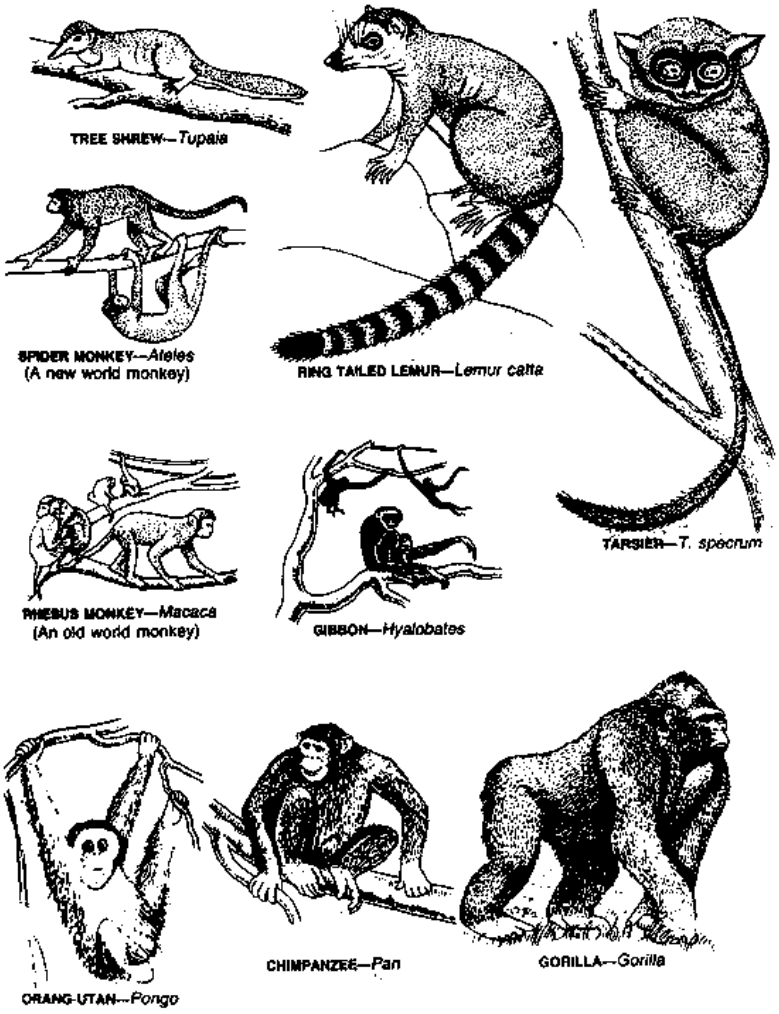
- **Anagenesis : -** It is the evolution of species involving a change in gene frequency in an antire population. It is also known as phyletic change. Anagenesis may also be reffered to as phyletic species or gradual species.

- **Cladogenesis : -** It is an evolutionary splitting event in which each branch and it's smaller branches form a ' clade' an evolutionary mechanism and a process of adaptive evolution that leads to the development of a greater variety of sister organism.

HUMAN EVOLUTION

Classification of **Man** : -

Phylum	-	Chordata
Subphylum	-	Vertebrata
Class	-	Mammalia
Subclass	-	Eutheria
Order	-	Primates
Suborder	-	Anthropoidea
Super family	-	Hominoidae
Family	-	Hominideae
Genus	-	Homo
Species	-	Sapiens



The primates include **Prosimians** (Lemurs, tarsiers and related forms) and **Anthropoids** (Monkeys, apes and Human). They are descended from small rodent like or insectivorous mammals that evolved about 80 million years ago.

- Carolus Linnaeus called human as **Homo sapiens wiseman.**
- Huxley explained origin of man in his book **The man's place in nature'.**
- Darwin explained ancestory of man in his book **'The descent of man'.**
- Human is a member of order primates of calls mammalia.
- Primates originates 80-100 million years ago in palaeocene epoch of coenozoic era.
- Primates originated from elephant shrews but they were not **real primates.**

Elephant Shrews : -

- Originated in late Mesozoic era means Cretaceous Period.
- They were not real primates because
  1. In their retina, only rods were present (cones absent).
  2. Nails absent and claws present
  3. Long snout
  4. V-shaped Jaw.
  5. By nature insectivorous.
  6. Two pairs mammary glands are present.

Tree Shrews : -

They were first real primates originated in **Palaeocene epoch.**

1. Both rods and cones are present in their retina.

2. Claws absent and nails presents on digits.
3. Shorter snout.
4. V-shaped jaw.
5. By nature insectivorous
6. Two pairs mammary glands are present.

- **Order primates divided into 2 sub orders.**

(A) Prosimians : -

Lemur - Evolved in Medagaskar — 3
Loris - Evolved in China — 2 **Closest relation to human**
Tarsiers - Evolved in Indonesia — 1

They are prosimian ancestors of human,

(B) Anthropoids : - Monkeys
Apes
Human

Monkeys : - 2 types

(1) Old world monkeys : - Rhesus (Macaca), Baboon (Old world = **Africa. Asia**)

(i) Tail short or long, non prehensile tail.
(ii) Narrow flat nose with downward direction of nostril.
(iii) U-shaped Jaw.
(iv) Dental formula same as human $\frac{2123}{2123} = 32$
(v) Menstruation cycle is present in female.

(2) New world monkeys : - spider monkey, marmosets (New world = **South & Middle America**)

(i) Long, prehensile tail
(ii) Protruding nose with upward direction of nostril
(iii) U-shaped jaw
(iv) Dental formula $\frac{2133}{2133} = 36$
(v) Menstruation cycle absent but estrous cycle is present.

So, Old world monkeys are more closer to human.

Apes : - 4 types

1. Chimpanzee → 400 c.c.
2. Gorilla → 500 c.c.
3. Oranguttan → 400 c.c.

Family - **Pongideae**

4. Gibbon → 100 c.c. — Family - **Hyalobatideae**

Human - Hominideae Family

Similarities between man and apes : -

(1) Tail absent
(2) Erect posture
(3) Grasping hands

(4) Hairs are present on body

(5) Larger head, more cranial capacity

(6) More intelligent than other animals

(7) Facial muscles are present for expression of surprise, pleasure.

(8) Menstruation cycle is present in female of both

(9) Blood group of AB series are present in both.

(10) Composition of Hb is same in both. Only one amino acid is different in human and goriall.

(11) **Chromosomal similarities : -**

(i) No. of chromosomes are approximately same in man and apes.

Apes = 48

Man = 46

(ii) DNA contents and DNA matching is same in both. This similarity is

100% with Chimpanzee

94% with Gibbon

88% with Rhesus monkey

(iii) Banding pattern of chromosome is same in both.

Banding pattern of ch. no. 3, 6 of human and chimpanzee is 100% similar.

Human Chromosomes

Somatic cells of human contain 46 chromosomes (44 Autosomes and 2-sex chromosomes).

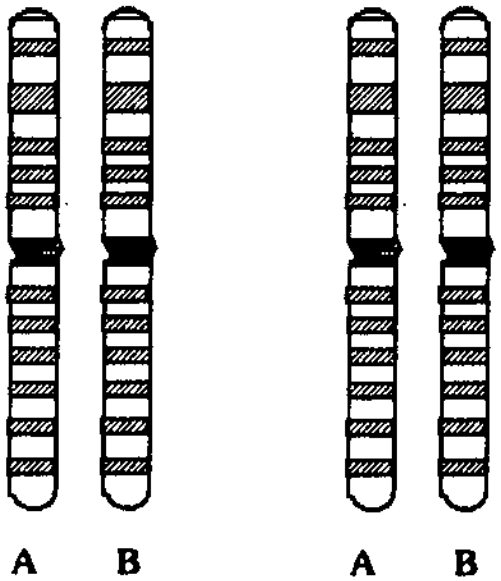
Human chromosomes are usually obtained by culturing certain types of white blood from the peripheral blood.

They can be treated with specific stains to produce characteristic bands along the length of each chromosome. The pattern of Banding so obtained is unique for each of chromosomes.

Banding techniques enable the identification of individual chromosomes and their parts.

The diploid number of chromosomes in Gorilla, chimpanzee and Oranguttan is 48.

Comparisons have been made between banded chromosomes of man and those of the great apes.



Diagrammatic representation and comparision of the banding Pattern in 3rd and 6th chromosomes of man (A) and chimpanzee (B)

The total amount of DNA in human diploid cells and that of the great apes are dissimilar.

Similarity in the fine structural organization of the chromosomes is understood only in terms of a common origin for man and chimpanzee.

All human races have the same chromosome number and gross morphology.

Differences : -

Apes	Human
1. Semi erect posture	1. Complete erect posture
2. Shorter neck and embedded.	2. Long and erect neck
3. Thick growth of hairs on complete body	3. Only on certain body part
4. Less cranial capacity (650 c.c.)	4. More cranial capacity (1300-1600 c.c.)
5. Less intelligent	5. More intelligent
6. Forelimbs longer than hind limbs	6. Forelims are shorter than hindlimb
7. 'U' shaped jaw	7. Semi circular jaw
8. Chin absent	8. Chin present
9. Thumb is parallel to palm	9. Thumb is opposable
10. Elongated pelvic girdle	10. Broad pelvic girdle
11. Less hair on body	11. More hairs on body

Human evolution :

(1) Propliopithecus : Origin & evolution in Oligocene epoch so called as Oligocene apes. Evolution about 30-35 million years ago.

(2) Agyptopithecus : Origin and evolution in late Oligocene and Miocene epoch so called as Miocene apes.

(3) Proconsul : - Its fossils were discovered by Leakey from East Africa near Victoria lake in Kenya from Miocene rocks. It walked on its four legs (considered as common ancestor of man and apes).

(4) Dryopithecus : - Evolution ≈ 15-20 million years ago.

- Direct ancestor of modern day apes.
- They were forest dwellers spending most of the time one the trees.
- Origin & evolution in **Miocene epoch.**
- Semi erect posture
- Quadra pedal locomotion, forlimbs longer than hind limbs.
- Thick growth of hair
- U shaped jaws
- Teeth larger and sharper
- By nature vegetarian, fruit eater

(5) Ramapithecus
(6) Shivapithecus } Fossils discovered by Lewis from Shivalik hills in India.

(7) Kenyapithecus]– Fossils discovered from **Kenya** by **Leakey.**

- Origin and evolution in **Pliocene epoch.**
- They are considered as ancestors of human but in characteristics same as Dryopithecus, but spending most of the time on the land.

(8) Australopithecus :- Prof. Raymond dart discovered a fossil of skull of 5-6 year old baby from the old Pliocene rocks of Tuang region (S. Africa). He named it Tuang baby, later on he renamed it **A. africanus.**

- About 3-2 million years ago it lived in East African grasslands.
- Evedences shows they hunted with stone.
- It was an apeman because it have many characters of man and apes so it is also considered as **connecting link between apes and man.**

Apes like characters :

- Less cranial capacity – 600 c.c.
- Thick growth of hair on body
- Jaw U shaped and prognathous.
- Teeth larger and sharper.
- Eyebrow present over eyes

Man like characters :

- Complete erect posture **(first man who stood erect)**
- Forelimb shorter than hindlimbs.
- **Bipedal locomotion (first man)**
- Dental formula same as human.
- Vertebral column with distinct lumber curve.
- Some other varities of Australopithecus were also discovered by some other scientist.
- A. boisei [zinjanthropus] by leakey from East Africa [Tanzania]
- A. afaransis [Lucy] by Donald Johanson from Ethiopea.

Prehistoric man : -

A number of other species of Homo appeared and became extinct from time on the evolutionary sense before the origin of homosapiens. These extinct species are called **prehistoric species of man.**

(1) Homo habilis : - The Tool maker man or Handy man.

- First human being like
- Its fossils were discovered by **Dr. Leakey** from 2 million years old rocks in Africa
- Lived in caves
- Cranial capacity - 650 – 800 c.c.
- Complete erect posture
- **Chin absent, dental formula same as human.**
- Jaw 'U' Shaped (Prognathous)
- **First man who made tools of stones for hunting animals.**
- By nature omnivorous, also show cannibalism

(2) Homo erectus : - direct ancestor of homo sapiens

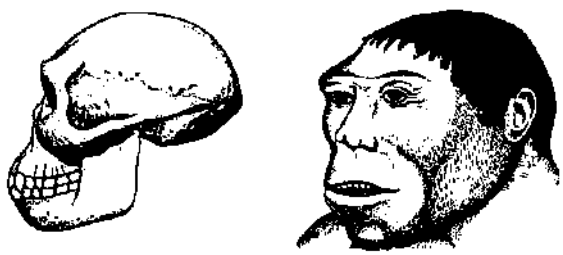
- Java man
- Peking man
- Heidelberg man (Branch from main line of Human evolution)

A. JAVA MAN :

Homo erectus erectus name given by **Mayer.**

or **Pithecanthropus erectus** given by **Dubois.**

- Fossil obtain from central java by **Eugene Dubois.**
- Lived in caves
- They used Tools of bones and stones
- Cranial capacity – 800 – 1000 c.c.
- **First man who used fire for hunting, protection and cooking**



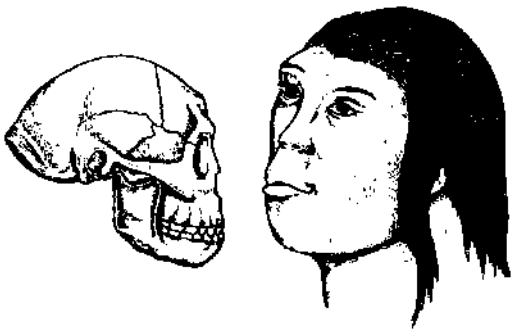
Java man

- Origin and evolution, 1.5 – 2million years ago.
- Chin absent, Jaw Prognathous
- Complete erect posture
- Complete erect posture
- Omnivorous, cannibalism have also found.
- **It is also known as erect ape man**

B. PEKING MAN : -

Homo erectus pekinensis name given by **Mayer**

Sinanthropus erectus name was given by **Davidson Black**.



Peking man

- **W.C. Pai** discovered the fossil of peking man from China.
- Origin & evolution before 6 lakh years
- Lived in caves
- Cranial capacity - 850 - 1300 c.c.
- Complete erect posture
- Chin absent, Jaw Prognathous
- Used sharp **chisel shaped tools** of stones, bones for cutting and killing animals.
- Omnivorous, cannibalism has been also found
- Used fire for cooking meat and for protection.

C. HEIDELBERG MAN : -

A fossil of lower jaw obtain from **Heidelberg in germany** it was discovered by **Ottoschotensack.**

- Mandible was large, tooth raw rounded
- Cranial capacity – 1300 c.c.
- Origin & evolution – in Pleistocene epoch. It is believed that this species was evolved as a branch from main line of evolution and got extinct after some time

(3) Homo sapiens : -

- Neanderthal man
- Cromagnon man - Direct ancestor of modern man
- Homo sapiens sapiens - **Modern man (Man of today)**

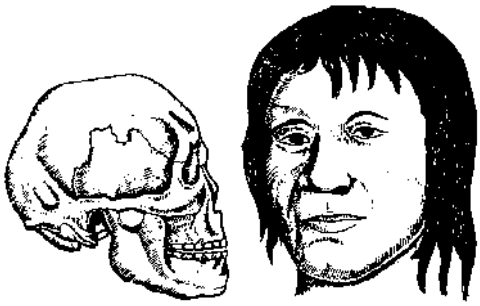
(i) Neanderthal man : - Homo sapiens neanderthalensis

Neanderthal man

- Origin & evolution before 40,000 – 1 lakh years
- Fossils were discovered by **C. fulhrott from Neanderthal velly of Germany.**
- They live in huts.
- Cranial capacity 1300 – 1600 c.c **(same as H. sapiens sapiens) Average** (1400 c.c.)
- Complete erect posture
- Semicircular jaw, Orthognathous
- Ceremonial burial of dead body
- Woar cloths of animals skin
- Less developed chin.
- Speech centre developed

– By nature – omnivorous.
– **First man believed in "immortality of soul"**

(ii) Cromagnon man : - Homo sapiens fossils



Cromagnon man

– Origin and evolution **10,000 - 50,000 years ago.**
– Fossils discovered by **Mac gregor from Cromagnon rocks of France**
– Lived in caves
– Cranial capacity - 1650 c.c. **(maximum)**
– Complete erect posture
– Larger forehead, well developed speech centre
– Semi circular jaw, well developed chin, orthognathous jaw.
– Woar cloth of animal skin.
– **This man was hunter and used domesticated dogs in hunting, so domestication of animals started by cromagnon man.**
– **They also painted beautiful painting on cave walls**
– **The cromagnon man is regarded as the direct ancestor of modern man.**
– By nature **carnivorous.**

(iii) Homo sapiens sapiens (Modern man) : - Man of today

– Origin and Distributed in whole world 10-100 thousand years ago.
– Cranial capacity - 1300 - 1600 c.c.
(Same as Neanderthal man)
– Complete erect body posture
– Semi circular jaw, orthognathous
– Well developed chin, well developed speech centre
– Smaller forehead, front eyes
– Less hairs on body as compared to fossil man
– By nature omnivorous.
– It is believed that modern man evolved in Africa, later its members to westwards, eastwards and south wards
– **Agriculture was also started by them.**

Special Point :

The course of cultural evolution is divided in to three age.

Palaeolithic – Age of tools of stones and bones.

Mesolithic – Age of animals husbandry, language, reading, writing.

Neolithic

(i) Bronze age – Age of agriculture, knowledge and use of clothes.

(ii) Iron age – Present age is also known as Iran age.

Man of future : - homo sapiens futuralis

– **Dr. Shapiro** named man of future as Homo futuralis
– Taller and hairless body
– Tomb like head and larger brain.
– With no fifth finger

Special Point : -

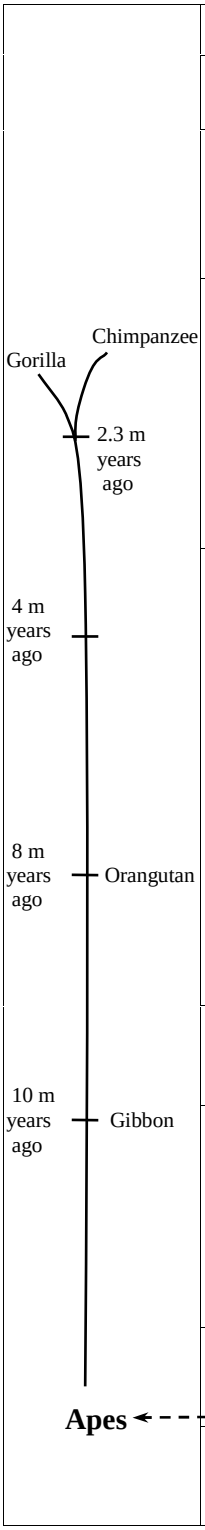
(1) **Anthropology :-** Study of evolutionary history of man.

(2) **Ethology : -** Study of animal babbits and behaviour.

(3) **Hylobates hoolock :-** (The Gibbon) is the only ape found in India (forests of Assam)

(4) **Races of human - 4 types - Caucasoid, Negroid, Mongoloid, Australoid.**

(5) **Hobit : -** Recently **Rechard Roberts** scientist discovered a **18,000 years** old fossil of a lady form **flors island situated near Australia.** He gave name it to **Hobit/Dwarf man/Homo florasiansis.**



Geological time scale	Name of fossil & cranial capacity	Distribution and Characteristics
Holocene (Epoch)	***Homo sapiens sapiens*** **(Modern man)** Cr. Cap. ~ 1500 cc.	Appeared about 10,000 years ago in central Asia.
Late Pleistocene	*Homo sapiens fossilis* (Cro-Magnon Man) Cr.Cap. 1450-1700cc	Discovered from Cro-Magnon valley (France), and later from Czech & Israel. 1st **Chin-man**, used bows and arrows. Had aesthetic sense and was a sculptor, artist and painter. He made articulated language and existed ~34,000 years ago. *Most recent or closest ancestor of present-day-man.
Late Pleistocene	***Homo sapiens neanderthelensis*** **(Neanderthal Man) Cr.Cap. ~1450 cc**	It was the 1st fossil man to be discovered (in 1856). It is the best known pre-historic man. Discovered from Neanderthal valley (Germany), so called Neanderthal man. It was a true man with Cranial capacity equal to that of Modern man. Distributed in Eurasia and Africa, and existed about 0.5 million years ago. He believed in 'Immortality of soul' and did *Ceremonial burial of the dead ones for the first time*, and was God-fearing man. He built huts and used animal hides as clothing. The well developed speech centre indicates that these could communicate with each other.
Middle Pleistocene	***Homo erectus*** Cr. Cap. 800 - 1200 cc.	**1. Java Man** (*Pithecanthropus erectus*) Discovered from Java (Asia), but distributed in Eurasia and Africa. Earlier named *H. erectus erectus*. Fossile described by **Eugene Dubois**. Use fire for the first time (?) Its cranial capacity was ~900cc. **2. Peking man** (*Sinanthropus pekinensis*) Discovered from China but distributed in Eurasia and Africa. Fossil described by **Davidson Black W.C. Pei.** Used fire for cooking. Its cranial capacity was ~1100cc. **3. Atlantic man** (*H. erectus mauritanicus*) Discovered from Algeria (in rocks near Ternifier) and commonly called Ternifier man. Its cranial capacity was ~1000 cc. All members of *Homo erectus* were migratory and existed ~1.7 million years ago.
Early Pleistocene	***Homo habilis*** **(Handy man)** Cr. Cap. ~600 - 700 cc.	Discovered from East Africa by Mrs. and Dr. Leakey. *1st tool maker* man, or nut-cracker man who made tools from stones. It existed about 2 million years ago and marked the beginning of human phase.
Early Pleistocene	***Australopithecus*** Cr. Cap. 350 - 450 cc. ***Ramapithecus*** Cr. Cap. 350 cc.	1st bipedal 'man' (walked erect) Omnivorous, and used bones for hunting. Discovered from Africa by **Raymond Dart**. Described from a child skull, discovered from Tuang valley. Commonly called **Tuang baby**, W.T. 1500 (male), Lucy (female) or **'African Ape man'**. Considered to be a pre-man or ape man, a *connecting link between man and apes*. It existed about 3-5 million years ago.
Late Pliocene		Discovered from Shivalik hills in H.P. (India), by **Dr. Lewis**. It was more ape-like than human-like. It was herbivorous. It existed about 15 million years ago.
Miocene (epoch)	***Dryopithecus*** Cr. Cap. - ~300 cc.	Common ancestor of apes and man. Discovered from Lake Victoria (Africa) by Mrs. and Dr. Leakey. It is also known as **Proconsul**. It appeared about 24 million years ago (24 × 10 years).

Fig. Progressive evolution of modern man through primitive apes, ape man and prehistoric man.

BRIEF REVIEW

Ancestory line of Human

↓

Propliopithecus

↓

Agyptopithecus

↓

Proconsul

↓

Dryopithecus

↓→ apes

Ramapithecus

Shivapithecus + Kenyapithecus

↓

Australopithecus

↓

Homohabilis

↓→ Homoheidelberg (extinct)

Homoerectus (Java man → peking man)

↓→ Homo Neanderthalensis

Cromagion man

↓

Homo sapiens sapiens

- Tree shrews were first real primates.
- Old world monkeys are more closer to human as compared to new world monkeys.
- Chimpanzee is closest ape to human.
- Australopithecus firstly show bipedal locomotion.
- Homohabilis is also known as handy man or the tool maker man.
- Java man firstly used fire.
- W.C. Pai discovered the fossils of Peking man from China.
- Neanderthal man was first man who believed in 'immortality of soul.'
- Cromagnon man was a painter and regarded s the direct ancestor of modern man.
- Homosapiens sapiens is the man of today.

Evolution of Horse –

Evolution of horse was described by **C.marsh.**

The primitive fossil of the horse was found in North America named **Eohippus.**

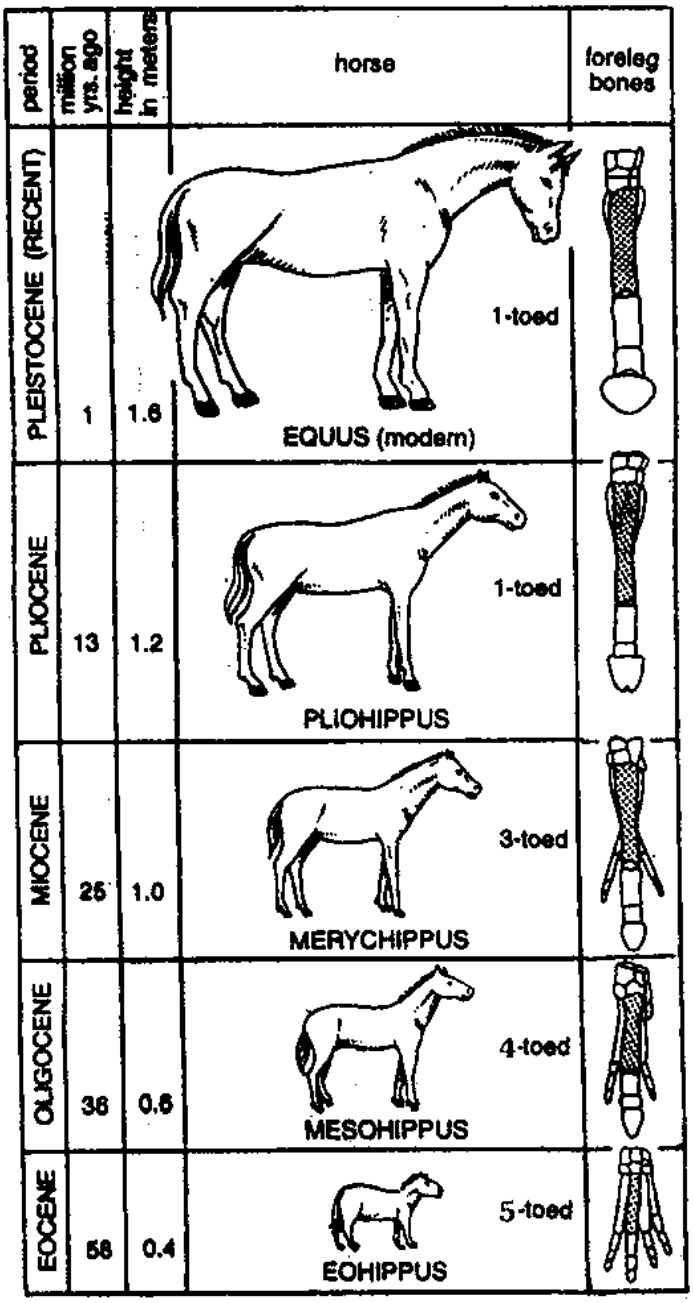
Changes during evolution of horse are as follows –

1. Increase in body height
2. Increase in the length of neck

3. Development of high crown on the surface of teeth and formation of cement.
4. There is gradual increase in the length of legs.
5. Number of toes or fingers in legs have reduced in modern horse. Only middle toe touches the ground, other toes reduced gradually.
6. Legs become more powerful for fast running
7. As new species were formed, previous ones becomes extinct.
8. Enlargement of brain size.

Fossils of important Ancestors of horse

1. **Eohippus or Hyracotherium –**
   It evolved in **Eocene** Epoch.
   It's size was like a **fox.**
   (**Orohippus :** It evolved in middle Eocene epoch.)
2. **Mesohippus –**
   It evolved from eohippus during **Oligocene** epoch.
   It's size was like a **sheep.**
   (**Miohippus :** In the late oigocene Mesohippus was replaced by another slightly advanced horse like form named miohippus. It was much like mesohippus in a appearance but some what large in size)
   (**Parachippus :** It evolved in early miocene).
3. **Merychippus –**
   It evolved in middle and upper miocene epoch. It's size was like a **donkey.**
4. **Pliohippus –**
   This horse evolved during **pliocene** epoch. It was of the size of modern pony.
5. **Equus –**
   This is modern horse which evolved from pliohippus during **pleistocene** epoch (height 60-64 inches).



EXERCISE - 1

Q.1 Who first proved that herdity is controlled by nucleus not by cytoplasm -
(1) Hershay and chase
(2) Strassburger
(3) Hammerling (4) Mendel

Q.2 Mendelism is genetics of -
(1) Haploids (2) Diploids
(3) Prokaryotes (4) All the above

Q.3 Which technique is used by Mendel for hybridisation -
(1) Emasculation (2) Bagging
(3) Protoplast fusion (4) 1 & 2 both

Q.4 The word ''Genetics'' coined by -
(1) Mendel (2) Johannsen
(3) Bateson (4) morgan

Q.5 Dihybrid plants form how many types of pollen grains -
(1) One (2) Two
(3) Four (4) Eight

Q.6 When flowers are unisexual then emasculation is done in -
(1) Female (2) male
(3) 1 & 2 both (4) None of these

Q.7 How many plants are dihybrid in F_2 generation of dihybrid cross -
(1) One (2) Two
(3) Four (4) Sixteen

Q.8 Mendel's conclusion first published in -
(1) Journal of plants breeding
(2) journal of genetics & plant breeding
(3) Nature forschender verein
(4) None

Q.9 When a plant have two alleles of contrasting characters it is called -
(1) Homozygous (2) Dioecious
(3) Heterozygous (4) Monoeious

Q.10 Phenotypic ratio 3:1 proves -
(1) Dominance
(2) Segregation
(3) Crossing-over
(4) Indepenent assortment

Q.11 What is the ratio of one pair of contrasting characters in F_2 of a dihybrid cross -
(1) 5:3 (2) 3:1
(3) 9:3:3:1 (4) 1:2:2:4:1:2:1:2:1

Q.12 What is ratio of homozygous and heterozygous individuals in F_2 of a monohybrid cross -
(1) 1:1 (2) 3:1
(3) 2:1 (4) 1:2

Q.13 What is ratio of homozygous plants for both dominant characters in F_2 of a dihybrid cross-
(1) 1/16 (2) 3/16
(3) 4/16 (4) 9/16

Q.14 Which is Mendelian ratio -
(1) 3:1 (2) 1:2:1
(3) 1:1 (4) 4:9:3:3:1

Q.15 Which of the following is significance of dominance -
(1) Organisms with dominant genes are more vital
(2) Harmful mutations are not expresed due to dominant gene
(3) Heterosis is due to dominant gene
(4) All the above

Q.16 An offspring of two homozygous parents differing from one another by alleles at only one gene locus is known as -
(1) Back cross (2) Monohybrid
(3) Dihybrid (4) Trihybrid

Q.17 From a single ear of con, a farmer planted 200 kernels which produced 140 tall & 40 short plants. The genotypes of these of springs are most likely -
(1) TT, Tt & tt (2) TT & tt
(3) TT & Tt (4) Tt & tt

Q.18 A useful process for determining whether an individual is homozygous or heterozygous is-
(1) Cross-breeding (2) Self fertilization
(3) Back-crossing (4) Test cross

Q.19 Genetic recombinations occur through -
(1) Mitosis & Fertilisation
(2) Mitosis & Meiosis
(3) Meiosis & Fertilisation
(4) None of the above

Q.20 Disease resistant verienties can be produced by -

(1) Crossing a plant with wild veriety

(2) Treating with colchicine

(3) Crossing with hormones

(4) Treating with low temperature

Q.21 Heterozygous tall plants were crossed with dwarf plants. What will be the ratio of dwarf plants in the progeny -

(1) 50% (2) 25%

(3) 75% (4) 100%

Q.22 A pure tall plant can be differentiated from a hybrid tall plant -

(1) By measuring length of plant

(2) By spraying gibberalins

(3) If all plants are tall after self-pollination

(4) If all plants are dwarf after self-pollination

Q.23 Which of the following is the unit of inheritance-

(1) Phenotype (2) Genotype

(3) Gene (4) None of these

Q.24 If the cell of an organism heterozygous for two pairs of genes represented by Aa,Bb, undergoes meiosis, then the possible genotypic combination of gametes will be -

(1) AB, Ab, aB, ab (2) AB, ab

(3) Aa, Bb (4) A, a, B, b

Q.25 Allele is the -

(1) Alternate triat of gene pair

(2) Total number of genes for a trait

(3) Total number of chromosomes of a haploid set

(4) Total number of genes present on a chromosome

Q.26 Sex linkage first observed by -

(1) Bateson (2) Corrense

(3) Morgan (4) Muller

Q.27 Types of genotypes in F_2 generation of dihybrid cross -

(1) 4 (2) 16

(3) 8 (4) 9

Q.28 A character which is expressed in a hybrid is called -

(1) Dominant (2) Recessive

(3) Co-dominant (4) Epistatic

Q.29 Cross AABb X aaBb yields AaBB : AaBb : Aabb : aabb of spring in the ratio of -

(1) 0:3:1:1 (2) 1:2:1:0

(3) 1:1:1:1 (4) 1:2:1:1

Q.30 Genetic constitution of an individual is represented by -

(1) Genome (2) Genotype

(3) Phenotype (4) Karyotype

Q.31 Genes do not occur in pairs in -

(1) Zygote (2) Somatic cell

(3) Endosperm cell (4) Gametes

Q.32 ''Like begets like'' an important and universal phenomenon of life, is due to -

(1) Eugenics (2) Inheritance

(3) dominance (4) Crossing-over

Q.33 The genes for same trait present on non-homologous chromosomes are -

(1) Alleles (2) Linked genes

(3) Multiple alleles (4) None of these

Q.34 Genotype-phenotype concept was first produced by -

(1) Bateson (2) Johannsen

(3) Sutton & Boveri (4) Punnet

Q.35 How many types of gametes are expected from the organism with genotype AABBCC-

(1) One (2) Two

(3) Four (4) Eight

Q.36 One of the following did not constitute the seven contrasting pairs of characters noticed by mendel -

(1) Height of the plants

(2) Shape of the leaves

(3) Shape of pod

(4) Colour of pod

Q.37 The scientist who worked on garden pea before mendel was -

(1) Goss (2) Kolreuter

(3) Bateson (4) Maupertius

Q.38 The plant which made Hugo-de vries famous is -

(1) Antirrhinum majas

(2) Lathyrus odoratus

(3) Oenathera lamarckina

(4) Pisum sativum

Q.39 If 3^n is the theoretically possible number of different genotypes (when n = the number of chromosome pairs with each carrying one pairs of heterozygous alleles). the different genotypes produced by pea plant is -

(1) 3^{10} (2) 3^{12}

(3) 3^{14} (4) 3^7

Q.40

		Male gametes			
Female gametes	?	AB	Ab	aB	ab
		AaBB	AaBb	aaBB	aaBb

In the Punnet square given above, the genotype of the female parents and male parents respecticley -

(1) AABB, AaBb (2) AaBB, AaBb

(3) aaBB, AaBb (4) AAbb, AaBb

Q.41 A trihybrid cross is made between two plants with genotyes A/a B/b C/c how many offspring of such cross will have a genotype a/a b/b c/c -

(1) 1/64 (2) 1/4 (3) 1/16 (4) 1/32

Q.42 How is the arrangement of Mendel's selected seven characters on four chromosomes -

(1) One in ch. no 1.4 in ch. no 4, one in ch. no. 5 and one in ch. no 7

(2) 2 in ch. no. 1,3 in ch. no. 4, one in ch. no. 5 and one in ch. no. 7

(3) 3 in ch. no. 1,1 in ch. no. 4,2 in ch. no 5 and one in ch. no.7

(4) 2 in ch. no. 1,3 in ch. no. 4, 1 in ch. no. 5 and 1 in ch. no. 7

Q.43 Out of three characters on chromosome no. 4, two characters indicate linkage and not mentioned by Mendel. These characters were -

(1) Pod form - stem length

(2) Pod form - pod position

(3) Pod form - pod colour

(4) Pod position - stem length

Q.44 Mrs. verma has a autosomal gene pair 'Bb' and she contain x-linked gene 'd' What is the percentage of gamete which contain 'bd' genes-

(1) 1/2 or 50% (2) 1/4 or 25%

(3) 3/4 or 75% (4) 1 or 100%

Q.45 When two different genotypes produce the same phenotype due to environmental difference, then each one is known as -

(1) Phenotype

(2) Phenocopy

(3) Progeny

(4) Independent offspring

Q.46 The Punnett square shown below represents the pattern of inheritance in dihybrid cross when yellow (Y) is dominant over white (y) and round (R) is dominant over wrinkled (r) seeds -

	YR	Yr	yR	yr
YR	F	J	N	R
Yr	G	K	O	S
yR	H	L	P	T
yr	I	M	Q	U

A plant of type 'H' will produce seeds with the genotype identical to seeds produced by the plants of -

(1) Type M (2) Type J

(3) Type P (4) Type N

Q.47 1:1:1:1 ratio shows -

(1) Monohybrid cross

(2) Dihybrid cross

(3) Back cross

(4) Dihybrid test cross

Q.48 If a heterozygous tall plant is crossed with a homozygous dwarf plant then what shall be the percentage of dwarf in offspring -

(1) 25% (2) 100%

(3) 75% (4) 50%

Q.49 If a homozygous tall plant is crossed with a dwarf plant, what shall be the ratio of plants in offsprings -

(1) All heterozygous tall

(2) Two tall & Two dwarf

(3) 1:2:1

(4) All homozygous dwarf

Q.50 In a plant gene 'A' is responsible for tallness and its recesive allele 'a' for dwarfness and 'B' is responsible for red colour it's recessive allele 'b' for white flower colour. A tall and red flowered plant with genotype AaBb crossed with dwarf and red flowered (aaBb). What is the percentage of dwarf-white flowered offspring of above cross -

(1) 50% (2) 6.25%

(3) 12.5% (4) 50%

Q.51 In rabbit black skin (B) is dominant over brown skin (b) and short (S) is dominant over long hair (s). If homozygous black-short haired male is crossed with homozygous brown-long haired female. All F_1 -offspring are heterozygous black-short haired. F_1 male crossed with F_1 -female. In F_2 generation what is the percentage of homozygous black-short haired off spring -

(1) 50% (2) 12.5%

(3) 6.25% (4) 18.75%

ANSWER KEY

EXERCISE- 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	2	4	3	3	4	3	3	3	2	2	1	1	1	2	2	1	4	3	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	3	3	1	1	3	4	1	2	2	4	2	4	2	1	2	1	3	4	3
Ques.	41	42	43	44	45	46	47	48	49	50	51									
Ans.	1	4	1	1	2	4	4	4	1	3	3									

EXERCISE- 2

Q.1 With increasing age the linkage becomes-

(1) Strong (2) Weak

(3) Terminates (4)Remains unchange

Q.2 Coupling and Repulsion theory produced by-

(1) Morgan (2) Bateson

(3) Muller (4) De vries

Q.3 In which type of inheritance the result are affected by reciprocal cross-

(1) Nuclear (2) Cytoplasmic

(3) Blending (4) All the above

Q.4 If there were only parental combinatios in F_2 of a dihybrid cross then mendel might have dicovered -

(1) Independant assortment

(2) Atavism

(3) Linkage

(4) Repulsion

Q.5 Plants similar to mother plant can be obtained from -

(1) Seeds (2) Stem cutting

(3) Both of these (4) None of these

Q.6 Linkage discovered in Drosophila by -

(1) Bateson (2) Morgan

(3) Muller (4) Correns

Q.7 Mendelian dihybrid and dihybrid with linkage are respectively realated with how many chromosomes -

(1) 1 pair & 2 pair (2) 2 pair & 1 pair

(3) 2 pair & 2 pair (4) 1 pair & 1 pair

Q.8 Incomplete dominance occurs in -

(1) Mirabilis (2) Antirrhinum

(3) Andulasion fowl (4) All of the above

Q.9 A dihybrid plant with incomplete linkage on test cross may prduce how many types of plants -

(1) 2 (2) 4

(3) 8 (4) 1

Q.10 How many linkage group are there in nucleoid of becteria -

(1) One (2) Two

(3) Four (4) None

Q.11 Which cross yields red, white & pink flowers variety of dog flower -

(1) RR X Rr (2) Rr X RR

(3) Rr X Rr (4) Rr X rr

Q.12 What shall be ratio in offspring when a roan cow is crosed with a white bull -

(1) 1:2:1 (2) 3:1

(3) 1:1 (4) All roan

Q.13 If distance between gene on chromosome is more, then gene shows -

(1) Weak linkage (2) Strong linkage

(3) Less crossing (4) 1 & 3 both

Q.14 Linked gene shows -

(1) Always parental combination

(2) Sometimes new combinations

(3) Always new combination

(4) New combination more

Q.15 The number of linkage groups in a cell having 10 pairs of chromosomes are -

(1) 5 (2) 10

(3) 15 (4) 20

Q.16 Cytology + genetics were marged into ''Cytogenetics'' by one of flowing -

(1) Bateson (2) Punnet

(3) Morgen (4) Muller

Q.17 Phenotypic ratio in codominance -

(1) 1:2:1 (2) 3:1

(3) 2:1 (4) 2:1:3

Q.18 Which of the following is exception to Mendel's laws -

(1) Linkage

(2) Incomplete dominance

(3) Co-dominance

(4) All of the above

Q.19 The association of parental characters combinations in the offsprings of a dihybrid is excess to non-parental combination is said to be due to -

(1) Co-dominance

(2) Blending inheritance

(3) Linkage

(4) Duplicate genes

Q.20 Complete linkage is found in -

(1) Birds

(2) Snakes

(3) Female-Drosophila

(4) Male-Drosophila

Q.21 A phenomenon which works opposite to the linkage is -

(1) Independent assortment

(2) Crossing-over

(3) Segregation

(4) Mutation

Q.22 The scientist who first discovered cytoplasmic inheritance was -

(1) Correns (2) Rhoades

(3) Mendel (4) Morgan

Q.23 Shell coiling in Limnaea (Snail) is an example of -

(1) Maternal inheritance

(2) Biparental inheritance

(3) Predetermination

(4) Dauermodification

Q.24 Kappa particles were discovered by -

(1) Correns (2) Sonneborn

(3) Rhoades (4) Bycott et.al.

Q.25 Kappa particles make an animal killer when thier number in an individual is -

(1) 6 (2) 60

(3) 400 (4) 150

Q.26 The killer chemical secreted by kappa particles is -

(1) Secretin (2) Paramecin

(3) Plasmon (4) Poky

Q.27 Which is not an example of cytoplasmic inheritance -

(1) Female sterility in maize

(2) Sigma particle inheritance

(3) Kappa particle inheritance

(4) Plastid inheritance

Q.28 Cytoplasmic male sterility is passed down-

(1) Throgh bacteriophages

(2) Paternally

(3) Maternally

(4) Biparentally

Q.29 The two eukaryotic organelles responsible for cytoplasmic inheritance are -

(1) Lysosome & Mitocondria

(2) Chloroplasts & Lysosomes

(3) Mitochondria & chloroplasts

(4) Mitochondria & Golgi-complex

Q.30 In a dihybrid cross, when one pair of alleles show incomplete dominance, genotypic ratio comes to -

(1) 3 : 6 : 3 : 1 : 2 : 1

(2) 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1

(3) 9 : 3 : 3 : 1

(4) 1 : 2 : 1

Q.31 Which of the following is the example of codominance -

(1) $Hb^A\ Hb^A, l^A\ l^B$ (2) $Hb^s\ Hb^s, l^A\ l^B$

(3) $Hb^A\ Hb^s, l^A\ l^B$ (4) $Hb^s\ Hb^s, l^A\ l^A$

Q.32 Cross over value (COV) of gene A and B is 5% while COV of genes B and C is 15% the possible sequence of three genes on chromosome is -

(1) A-B-C (2) C-A-B

(3) B-C-A (4) Both (1) & (2)

Q.33 A test cross of F_1 files + a/+b produced the following offspring

++/ab = 9

ab/ab = 9

+b/ab = 41

a+/ab = 41

What will be distance between linked gene-

(1) 82 cm. (2) 18 cm. (cis)

(3) 20 cm. (4) 18 cm. (trans)

Q.34 Which of the following conditions represent a case of co-dominant genes -

(1) A gene expresses itself, suppressing the phenotypic effect of its alleles

(2) Genes that are similar in phenotypic effect when present separately, but when together interact to produce a different trait

(3) Allele, both of which interact to product a trait, which may resemble either of the parental type.

(4) Alleles, each of which produces an independent effect in heterozgous condition.

Q.35 A sinistral shelled female snail having Dd genotype cross with dextral shelled male having dd genotype. What type of shell will be present in the progeny -

(1) All dextral

(2) All sinistral

(3) 50% dextral, 50% sinistral

(4) None

Q.36 In female Drosophila the linked gene exhibit recombination during meiosis of gamete formation, but such a recombination does not occur during the formation of sperm in male Drosophila -

(1) Male Drosophila is sterile

(2) Male Drosophila is parthenogentic male

(3) No crossing over occur in male Drosophila

(4) Male Drosophila is haploid

Q.37 Hypertrichosis is -

(1) Holandric character

(2) X-Linked character

(3) Diagenic character

(4) Sex-influened character

Q.38 Organisms with two or more than two types of genotypes in their tissues are called -

(1) Wobble (2) Heterozygous

(3) Heterosis (4) Chimera

Q.39 Products of somatic hybridisation are -

(1) Hybridoma (2) Hybrid-vigour

(3) Heterosis (4) Super-hybrids

Q.40 In which of the following the inheritance takes place only by male -

(1) Nuclear

(2) Cytoplasmic

(3) co-dominance

(4) Holandric inheritance

Q.41 Which of the following is not a sex linked characters -

(1) Haemophilia (2) Colour bindness

(3) Hypertrichosis (4) Baldness

Q.42 A gene located on Y-chromosome and therefore, transmitted from father to son is known as -

(1) Supplementry gene

(2) Complementry gene

(3) Duplicate gene

(4) Holandric gene

Q.43 The condition in which only one allele of a pair is present is known as -

(1) Homozygous

(2) Heterozgous

(3) Hemizygous

(4) Incomplete dominance

Q.44 Colourblindness is a -

(1) Sex limited character

(2) Sex linked character

(3) Sex influenced character

(4) None

Q.45 What is the effect of sexual reproduction -

(1) Offspring is weak

(2) Offspring is like the parent

(3) Offspring is more vigorous

(4) Offspring is diseased

Q.46 Blue eye colour in human is recessive to brown eye coloue. The expected children of a marriage between a blue eyed woman and a brown eyed man who had a blue eyed mother will be -

(1) All black eyed (2) All blue eyed

(3) All brown eyed

(4) One blue eyed and one brown eyed

Q.47 Baldness in man is a -
(1) Autosomal chracter
(2) Sex linked character
(3) Sex influenced character
(4) 1 and 2 both

Q.48 A colourblind man marries a daughter of colourblind father, then in the offspring -
(1) All sons are colourblind
(2) All daughters are colourblind
(3) Half sons are colourblind
(4) No daughter is colourblind

Q.49 A woman with normal vision marries a man with normal vision and gives birth to a colourblind son. Her husband dies and the marries a colourblind man. what is the probability of her children having the abnormality -
(1) 50% colourblind sons + 50% colourblind daughters
(2) All sons colourblind & daughter carrier
(3) All daughter colourblind & sons normal
(4) 50% sons colourblind and all daughters normal

Q.50 A hybrid is generally more vigours than either of the parents, this is due to -
(1) Homozgosity
(2) Heterozygosity
(3) Superior gens in hybrid
(4) Mixing of cytoplasm

Q.51 Albinism is determined by a recessive gene in man the pressence of albinism in 50% children born to a couple proves that -
(1) Both parents are heterozygous for albinism
(2) Father is homozygous normal and mother is heterozygous
(3) Father is homozygous for albinism but mother is heterozygous
(4) Both are homozygous

Q.52 Epistatic gene differs from dominant gene in-
(1) Epistatic gene in non-allelic
(2) Epistatic gene never express it self independently
(3) Epistatic and hypostatic genes are present at different loci
(4) All the above

Q.53 A dihybrid ratio of 1:4:6:4:1 is obtained instead of 9:3:3:1 This is an example of -
(1) Complementary gene
(2) Supplementary gene
(3) Polygenic inheritance
(4) Incomplete dominance

Q.54 A gene that shows it's effect on more than one character is -
(1) Polygene (2) Pleotropic gene
(3) Multifactor gene (4) Multiple gene

Q.55 In multiple allele system a gamete prossesses-
(1) Two alleles (2) Three alleles
(3) One allele (4) Several alleles

Q.56 An example of the quantitative trait in man is-
(1) Hair colour (2) Colour of eye
(3) Skin colour (4) Shape of nose

Q.57 Polygenic inheritance was first noted by -
(1) Devenport (2) Galton
(3) Mendel (4) Kolreuter

Q.58 A single recessive trial which can express its effect should occur on -
(1) Any autosome
(2) Any-chromosome
(3) X-chromosome of male
(4) X-chromosome of male

Q.59 Sex-linked chracters are generally -
(1) Lethal (2) Recessive
(3) Dominant (4) Not inherited

Q.60 The technique of the production of monoclonal antibodies was initially developed by -
(1) Stewards & skoog
(2) Lister & Koch
(3) Arber & Haberlandt
(4) Kohler & milstern

Q.61 In a lymphocyte - myeloma type of hybridoma the antibody forming ability is derived from -
(1) Myelomas only
(2) Lymphocytes only
(3) Partly from lymphocyte and partly from myelomas
(4) Myelomas to greater extent and lymphocytes to a lesser extent

Q.62 If dominant C and P genes are essential for the development of purple colour in sweet pea flowers, what would be the ratio of white and purple colour in a cross between CcPpxCcpp-

(1) 5 : 3 (2) 9 : 7

(3) 2 : 6 (4) 6 : 2

Q.63 Blood grouping in humans is controlled by -

(1) 4 alleles in which 1^A is dominant

(2) 3 alleles in which 1^A and I^B are dominant

(3) 2 alleles in which none is domainant

(4) 3 alleles in which 1^A is recessive

Q.64 In Drosophila crossing over occurs in female but not in male. Gene A and B are 10 map unit apart on chromosome. A female Drosophila with genotype $\frac{AB}{ab}$. and male Drosophila with genotype $\frac{AB}{ab}$. How many type of gametes are produced by female and male Drosophila respectivel -

(1) 4 types : 2 type

(2) 2 types : 2 types

(3) 4 types : 4 type

(4) 4 types : one types

Q.65 In polygenic inheritance triat which controlled by three pairs of genes. Two individuals which are heterozygous for three alleles, Crossed each other. Such type of cross produced phenotypic ratio in what ratio-

(1) 1 : 2 : 1 (2) 9 : 3 : 3 : 1

(3) 1 : 4 : 6 : 4 : 1

(4) 1 : 6 : 15 : 20 : 15 : 6 : 1

Q.66 In jersey hog, the coat colour is dependant on two pairs of alleles, R and r or S and s. Any genotype containing at least one R-gene and at least one S-gene result in red coat colour. The double recessive genotype results in white coat colour. All other genotypes results in sandy coat colour. If one hog with genotype ''RrSs'' mated with another hog will be prduced by above cross-

(1) 9 red : 6-sandy : 1 white

(2) 9 red : 3-sandy : 4 white

(3) 12 red : 3-sandy : 1 white

(4) 1 red : 2-sandy : 1 white

Q.67 Multiple alleles are present -

(1) In different chromosomes

(2) At different loci on chromosome

(3) At the same locus on homologous chromosomes

(4) At the non homologous chromosomes

Q.68 A scientist performed the gene mapping experiments in maize. He mapped the genes on chromosomes on the basis of % crossing over between different genes. One map unit corresponds to one% crossing over or recombination. The genes showing more than 50% recombination were not supposed to be linked on same chromosome. In crossing over studies on maize, scientist observed the following % crossing over between genes A, B,C,D- between. A and D 10% between A and D 10% between genes A and B 5% and between genes C and B 8% On the basis of above observation find out the correct sequecne of genes A, B, C and D on chromosmes -

(1) BCDA (2) ABCD

(3) BACD (4) DACB

Q.69 In a cross between individuals homozygous for (a, b) and wild type (++) In this cross 700 out of 1000 individuals were of parental type. Then the distacne between a and b is-

(1) 70 map unit (2) 35 map unit

(3) 30 map unit (4) 15 map unit

Q.70 In maize coloured endosperm (C) is dominant over colourless (c) and full endosperm (R) is dominant over shrunken (r). When a dihybrid of F_1 generation was test crossed it produced four phenotype in the following percentage -

Coloured and Full = 45%

Coloured - Shrunken = 5%

Colourless - Full = 4%

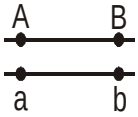
Colourless - Shrunken = 46%

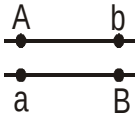
From these data what would be distacne between the two allelic genes -

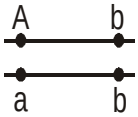
(1) 48 unit (2) 9 unit

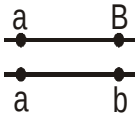
(3) 4 unit (4) 12 unit

Q.71 Which of the following show linkage group in coupling phase -

(1) 

(2) 

(3) 

(4) 

Q.72 In a family, father has a blood group 'A' and mother has a blood group 'B'. Their children show 50% probility for a blood group 'AB' idicating that -

(1) Father is heterozygous

(2) Mother is heterozygous

(3) Either of parent is heterozgous

(4) Mother is homozygous

Q.73 In a plant three dominant independently assorting gene A. B and C are essential for production of purple pigment. If any of the genes or all three genes are present in recessive condition then flower is colourless

Raw material $\xrightarrow{A}$ X $\xrightarrow{B}$ Y $\xrightarrow{C}$ Z pigment

A purple plant with genotype AABBCC crossed with a colourless plant with genotype aabbcc gives purple F_1 hybrid. On selfing of F_1 - what proportion of coloured offspring in F_2 -

(1) $\frac{27}{64}$ (2) $\frac{1}{64}$

(3) $\frac{9}{64}$ (4) $\frac{37}{64}$

Q.74 When a red grain veriety of wheat is crossed with another white grain variety a F_1 - hybrid is produced. On selfing of this F_1 hybrid, how many offsprings of F_2 -generation resemble phenotypically to it's parents (let grain colour of wheat controlled by three gene pairs)

(1) 2/16 (2) 20/64

(3) 15/64 (4) 2/64

Q.75 Epistasis differs from dominance because-

(1) In epistasis one gene pair mask the expression of another pair of genes

(2) Epistasis is an allelic interaction

(3) Many genes collectively controls a particular phenotype

(4) One gene pair independendenly controls a particuar phenotype

Q.76 In a plant flower colour is the example of polygenic trait and controlled by one gene pair. How many plants show parental phenotype in F_2 generation -

(1) $\frac{2}{16}$ (2) $\frac{2}{4}$

(3) $\frac{2}{64}$ (4) $\frac{2}{256}$

Q.77 In Drosophila several alleles exhibit same phenotype for eg. W^{+s},W^{+c},W^{+g} exhibit eye colour these alleles are called -

(1) Psudoalleles (2) Iso alleles

(3) Multiple alleles (4) All of above

Q.78 (a) Pleiotropic genes have multiple phenotypic effect

(b) Muliple alleles exhibit same phenotypic expression.

(c) Polygenes exhibit continous variation

(1) Statement (a), (b) and (c) are correct

(2) Statement (a), (c) correct and (b) is incorrect

(3) Statement (a), (b) and (c) are incorrect

(4) Statement (a) and (c) are correct and (a) is incorrect

Q.79 Which is not correctly matched :

(1) Agrobacterium $\Rightarrow$Ti-plasmid

(2) Cosmid $\Rightarrow$Vector DNA

(3) Rhizobium $\Rightarrow$ Asymbiotic N_2 -fixer

(4) Albinism $\Rightarrow$ Autosomal recessive gene

Q.80 In Drosophila a set of homeiotic genes which controls body plan at the time of organ differentiaion known as -

(1) TATA-box (2) Homeobox

(3) Pribnow box (4) All the above

Q.81 The longer the chromosome of an orgasnism, the more genetic variability its gets from -

(1) Independent assortment

(2) Linkage

(3) Crossing over (4) Mutation

Q.82 Which statement is incorrect about linkage-

(1) It helps in maintaining the valuable traits of new varieties

(2) It helps in forming new recombinants

(3) Knowledge of linkage helps the breeder to combine all desirable traits in a single variety

(4) It helps in locating genes on chromosome

Q.83 The concept of sudden genetic change which breeds true in an organism is visualized as:-

(1) Natural selection

(2) Inheritance of acquired characters

(3) Mutation

(4) Independent assortment

Q.84 Term 'sport' was used for the sudden appearance of heritable trait by-

(1) Morgan (2) Muller

(3) Darwin (4) De Vries

Q.85 Who coined the term mutation

(1) Morgan (2) Darwin

(3) Stadler (4) De Vries

Q.86 True mutation was first discovered by-

(1) Muller (2) Morgan

(3) Stadler (4) De Vries

Q.87 Mutation is-

(1) An abrupt or discontinuous change which is inherited

(2) A factor for plant growth

(3) A change which affects parents only and is never inherited

(4) A change which affects the offspring of F_2 generation

Q.88 Mostly mutations are-

(1) Heritable (2) Non-heritable

(3) Harmful (4) Benefical

Q.89 Abrupt and distinct changes in the structure of a gene is called-

(1) Point mutation (2) Forward mutation

(3) Backward mutation

(4) Chromosomal aberration

Q.90 Micromutations involve changes in-

(1) Satellite region of the chromosomes

(2) Mini-chromosomes

(3) Microsomes (4) Single gene

Q.91 The change of chromosomal parts between non homologous pairs of chromosome

(1) Crossing over/Transduction

(2) Translocation

(3) Inversion (4) Transition

Q.92 Which of the following can be called a mutation-

(1) The halfing of the chromosome number at meiosis

(2) The doubling of the chromosome after syngamy

(3) The possession of an additional chromosome

(4) All the above

Q.93 Mutation causes normally-

(1) Small changes (2) Negligible changes

(3) Large changes (4) No change

Q.94 Mutations are generally-

(1) Dominant (2) Recessive

(3) Codominant

(4) Incompeletely dominant

Q.95 The first mutant reported by Morgan on Drosophila was-

(1) Red eyed male (2) Red eyed female

(3) White eyed male (4) White eyed female

Q.96 The earliest record of point mutation is -

(1) Short legged sheep by Sneth Wright

(2) White eyed male Drosophila by Morgan

(3) Autotrophic mutants of Neurospora by Beadle and Tatum

(4) Mutants of Escherichia coli discovered by Joshua Lederberg

Q.97 Short-legged variety of sheep is an example of-
(1) Recessive germinal mutation
(2) Dominant germinal mutation
(3) Recessive somatic mutation
(4) Dominant somatic mutation

Q.98 Genetic mutations occur in -
(1) DNA
(2) RNA
(3) Protein
(4) RNA & protein both

Q.99 Which of the following undergoes change in mutation -
(1) Chromosome
(2) Structure of gene
(3) Sequence of gene
(4) Any of the above

Q.100 The locus of mutation is -
(1) Gene (2) Chromosome
(3) Centromere (4) Nucleus

Q.101 Gene mutation is caused -
(1) Due to reproduction
(2) Due to linkage
(3) Due to change in sequence of N_2 base
(4) Due to changes in sequence of genes in DNA

Q.102 The natural rate of mutation is -
(1) 1 × 10-10 (2) 1 × 10-6
(3) 1 × 105 (4) 1 × 1010

Q.103 Mutagenic nature of X-ray and UV-radiations was discovered by -
(1) Beadle and Tatum
(2) Madam Curie
(3) Muller (4) Hardy & Weinberg

Q.104 The title " Artificial transmutation by X-rays" was published by-
(1) Morgan (2) Muller
(3) Stadler (4) DeVries

Q.105 H.J. Muller received Noble Prize for-
(1) Discovering linked genes
(2) Discovering the mutations induced by X-rays
(3) His studies on the genetics of Drosophila
(4) Proving that DNA was a genetic material

Q.106 X-rays generally cause-
(1) Polyploidy
(2) Frame shift mutations
(3) Chromosomal aberrations
(4) Paramutations

Q.107 α & β rays do not cause mutations in human beings because:-
(1) They are non ionizing
(2) They do not react with DNA
(3) They do not penetrate through skin
(4) They are not un-natural

Q.108 Which of the following causes mutation (not polyploidy)
(1) Crossing-over (2) NaCl
(3) Colchicine (4) γ-rays

Q.109 Non-ionizing radiations commonly used for inducing mutations in organisms are
(1) UV-rays (2) Beta-rays
(3) X-rays (4) Gamma-rays

Q.110 The best mutagen for micro-organisms is-
(1) X-rays (2) UV-rays
(3) γ-rays (4) α-rays

Q.111 The sites in the gene at which the mutations occur with unusually high frequency are referred to as-
(1) Recons (2) Palindromes
(3) Hot spots (4) Mutons

Q.112 The smallest unit of genetic material which upon mutation produce a phenotypic effect is
(1) Sexual reproduction
(2) Meiosis
(3) Mutation
(4) Independent assortment

Q.113 Ultimate source of genetic variations is (OR) the process which provides raw material for evolution is
(1) Sexual reproduction
(2) Meiosis
(3) Mutation
(4) Independent assortment

Q.114 Continuous variations are due to
(1) Chromosomal aberrations
(2) Polyploidy
(3) Mutations (4) Crossing over

Q.115 Genetic mutation occurs in-
(1) DNA (2) RNA
(3) Chromosome (4) All

Q.116 To be evolutionary successful the mutation must occur in (OR) important mutations occur in-
(1) Somatoplasm
(2) Germplasm
(3) Karyolymph/Zygote
(4) Ergastoplasm

Q.117 Chemical mutagens are far more hazardous than radiations because
(1) The exposure to chemicals is more prevalent
(2) The organism possess protection for radiation but no protection for chemicals
(3) The chemically induced mutations are move deleterious
(4) The chemicals are synthetics

Q.118 Mutations involving a single base substitution are induced by
(1) Infra red rays
(2) Ultrasonic vibrations
(3) Violet rays
(4) X-rays

Q.119 Triticum durum is
(1) 8n (2) 4n
(3) 6n (4) 8n

Q.120 X-rays cause mutations by
(1) Breading spindle fibers
(2) Rupturing nuclear envelope
(3) Changing chromosome morphology
(4) Inhibiting chtokinesis

Q.121 Mutagens which are effective on replication DNA only are-
(1) Base analogues and Acridines
(2) Alkylating agents
(3) HNO_2
(4) α and β rays

Q.122 Which of the following is the most effective chemical mutagen which induce mutations
(1) Caffeine
(2) Guanine
(3) Methane
(4) Carbon-tetra-sulphide

Q.123 Which of the following agents cause mutation through deamination
(1) 2-Aminopurine
(2) 5-Bromo uracil & X-rays
(3) HNO_2 & UV
(4) Alkyl sulphonates & N_2 mustards

Q.124 The antibiotic commonly used in inducing the mutations in cytoplasmic genes is
(1) Tetramycin (2) Streptomycin
(3) Tetracycline (4) Cyclosporin

Q.125 Streptomycin, kenamycin & neomycin binds to smaller sub-unit of prokaryotic ribosomes and cuase-
(1) Inhibition of protein syntheis
(2) Mis reading of the genetic code
(3) Inhibition of translation
(4) Hydrolysis of peptide bonds

Q.126 Mutagenic effect of X-rays was discovered by-
(1) Muller (2) Luria
(3) Morgan (4) De Vires

Q.127 Most mutagens have more adverse effects on
(1) Diploids (2) Triploids
(3) Tetraploids (4) Haploids

Q.128 Induced mutations are very common in
(1) Lentils
(2) Millets
(3) Cereals
(4) Vegetatively propagated plants

Q.129 On which of the following crops, mutations studies havemore intensively been done.
(1) Wheat (2) Millets
(3) Legumes (4) Tube crops

Q.130 Which of the popular variety of wheat has been developed by mutation
(1) Triticale (2) Kalyan Sona
(3) Sonalika (4) Sharbati sonora

Q.131 A favourite material for the study of mutagenesis at the molecular level is-
(1) TMV
(2) E.coli
(3) Drosophila
(4) Isolated protoplasts of Arabiodopsis thaliana

Q.132 Haploids are preferred over diploids for mutation studies because:-

(1) Recessive mutation is expressed in F_1

(2) Recessive mutation is expressed in F_2

(3) Dominant phenotype is expressed

(4) Dominant phenotype is suppressed

Q.133 Type of gene mutation which involves replacement of purine with pyrimidine or vice vice versa (OR) The substitution of one type of base with another type of base is

(1) Transduction (2) Transversion

(3) Translocation (4) Transcription

Q.134 Replacement of a purine N_2 base with another purine base (OR) Replacement of a pyrimidine N2 base with another pyrimidine is termed as-

(1) Transition (2) Transversion

(3) Translocation (4) Transcription

Q.135 Mutations induced by 5-Bromo uracil are-

(1) Transversional mutations

(2) Transitional mutations

(3) Frame shift mutations

(4) Backward mutations

Q.136 A point mutation which involves change of A G, C T, C G and T A in DNA are:-

(1) Transition, Transition, Transversion Transversion

(2) Transition, Transversion, Transition transversion

(3) Transversion, Transition, Transversion, Transition

(4) None of the above

Q.137 Base substitution caused by base analogues is:

(1) Transition

(2) Transvesion

(3) Complementation

(4) None

Q.138 The minimum requirement for mutation is-

(1) Change of triplet codon

(2) Change in single nucleotide

(3) Change in whole DNA

(4) Change in single strand of DNA

Q.139 A segment of DNA has a base sequence: AAG, GAG, GAC, CAA, CCA-, Which one of the following sequence represents a frame shift mutation.

(1) AAG, GAG, GAC, CAA, CCA-

(2) AAG, AGG, ACC, AAC, CAA-

(3) ACG, GAG, GAC, CAG, CCA-

(4) AAG, GCG, GAC, CAG, CCA-

Q.140 If the DNA-codons are ATGATGATG and a cytosine base is inserted at the beginning which of the following would be the result-

(1) A non sense mutation

(2) CA, TGA, TGA, TG

(3) CAT, GAT, GAT, G

(4) C, ATG, ATG, ATG

Q.141 Which of the mutagen causes frame shift mutation

(1) 2 Aminopurine (2) Proflavine

(3) 5 Bromouracil

(4) Methane sulphonates

Q.142 Mutations are-

(1) Always useful (2) Mostly useful

(3) Never useful (4) Rarely useful

Q.143 If a mutation is not visible in successive generations it is called as a-

(1) Deletion (2) Dominant mutation

(3) Recessive mutation

(4) Segregation

Q.144 Which of the following is most difficult to detect-

(1) Auxotrophic mutation

(2) Lethal mutation

(3) Recessive non-lethal mutation

(4) Dominant mutation

Q.145 What is an auxotroph-

(1) A plant that responds by bending towards then sun

(2) A mutant (organism) which has lost its ability to synthesize one or more essential compounds

(3) An organism that depends on another organism for meeting its nutritional requirements

(4) A plant that is able to synthesize its own carbohydrates

Q.146 Recessive mutations are not lost from a gene pool, This is known as-

(1) Survival of the dominant

(2) Survival of the recessive

(3) Hardy-Weinberg's law

(4) Darwin's gene mutation law

Q.147 Blood cancer is known as-

(1) Leukemia (2) Thrombosis

(3) Haemophilia (4) Haemolysis

Q.148 When the mutation at one locus is neutralized by the mutation at another locus of same or different chromosome it is termed:-

(1) Gibberish mutation

(2) Backward mutation

(3) Crossing over

(4) Neutral mutation

Q.149 Mutation theory was proposed by-

(1) Hugo De Vries (2) J. G. Mendel

(3) Lamarck (4) Kolreuter

Q.150 Lethal mutations were first detected by-

(1) Morgan (2) Muller

(3) De Vries (4) Bateson

Q.151 Deamination of adenine and guanine by HNO_2 and UV rays produces-

(1) Cytosine and uracil

(2) Xanthine and hyproxanthine

(3) Hypoxanthine and xanthine

(4) Xanthine and uracil

Q.152 Who performed the popular "Replica Plating Experiment"-

(1) Nirenberg and Kornberg

(2) Kornberg and Lederberg

(3) Joshua Lederberg & Esther lederberg

(4) Holley, Khorana & Mathi

Q.153 Which of the following substance was used as a screening agent in Replica Plating Experiment-

(1) Vitamin B_{12}

(2) Cofactors & Streptomycin

(3) Amino acid Lysine

(4) Antibiotic streptonmycin

Q.154 Sickle cell anaemia is an example of-

(1) Frame shift mutation

(2) Point mutation

(3) Segmental mutation

(4) Gibberish mutation

Q.155 The most striking example of frame shift mutation was found in a disease called-

(1) Sickle cell anaemia

(2) Colour blindness

(3) Laesh-Nyhn Syndrome

(4) Thallesemia

Q.156 Thallesemia is an example of-

(1) Point mutation

(2) Frame-shift mutation

(3) Translocation and transition

(4) Transversion

Q.157 Change in sequence of nucleotide in DNA is called as-

(1) Mutagen (2) Mutation

(3) Recombination (4) Translation

Q.158 In a random mating population in equilibrium, which of the following brings about a change in gene frequency in a non-directional manner

(1) Mutation (2) Random drift

(3) Selection (4) Migration

Q.159 In a mutational event, when adenine is replaced by guanine, it is a case of -

(1) Transcription (2) Transition

(3) Transversion

(4) Frameshift mutation

Q.160 The most likely reason for the development of resistance against pesticides in insects damaging a crop a -

(1) Genetic recombination

(2) Directed mutation

(3) Acquired heritable changes

(4) Random mutations

Q.161 A nutritionally wild type organism, which does not require any additional growth supplement in known as -

(1) Holotype (2) Auxotroph

(3) Prototroph (4) Phenotype

Q.162 Using imprints from a plate from complete medium and carrying bacterial colonies, you can selected streptomycin resistant mutants and prove that such mutations do not originate as adaptation. These imprints need to be used -

(1) One plates with and without streptomycin

(2) Only on plates with streptomycin

(3) On plates with minimal medium

(4) Only on plates without streptomycin

Q.163 Which of the following in generally used for induced mutagenesis in crop plants -

(1) Gamma rays (from cobalt 60)

(2) Alpha particles

(3) X-rays

(4) UV (260 nm)

Q.164 There are two opposing views about origin of modern man. According to one view Homo erectus in Asia were the ancestors of modern man. A study of variation of DNA however suggested African origin of modern man. What kind of observation of DNA variation could suggest this -

(1) Greater variation in Asia thatn in Africa

(2) Similar variation in Africa and Asia

(3) Variation only in Asia and no variation in Africa

(4) Greater variation in Africa than Asia

Q.165 De Vries gave his mutation theory on organic evolution while working on -

(1) Oenothera lamarckiana

(2) Frosophila melanogaster

(3) Pisum sativum

(4) Althea rosea

Q.166 Cri-du-chat syndrome in humans is caused by the

(1) Fertilization of an XX egg by a normal Y-bearing sperm

(2) Loss of half of the short arm of chromosome 5

(3) Loss of half of the long arm of chromosme 5

(4) Trisomy of 21st chromosome

Q.167 Tricticle, the first man-made cereal crop, has been obtained by crossing wheat with -

(1) Rye (2) Pearl millet

(3) Sugarcane (4) Barley

Q.168 Sickle cell anemia has not been eliminated from the African population because -

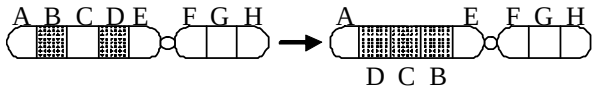
(1) It is controlled by recessive genes

(2) It is not a fatal disease

(3) It provided immunity against malaria

(4) It is controlled by dominant genes

Q.169 Given below is the representation of a kind of chromosomal mutation :



What is the kind of mutation represented

(1) Deletion (2) Duplication

(3) Inversion

(4) Reciprocal translocation

Q.170 Potato and sweet potato -

(1) Have edible parts which are homologous organs

(2) Have edible parts which are analogous organs

(3) Have been introduced in India from the same place

(4) Are two species of the same genus

Q.171 The "cri-du-chat" syndrome is caused by change in chromosome structure involving-

(1) Deletion (2) Duplication

(3) Inversion (4) Translocation

Q.172 Mutations occur in :

(1) Dominant genes (2) Recessive genes

(3) Lethal genes (4) Mendel's genes

Q.173 In the hexaploid wheat, the haploid (n) and basic (x) numbers of chromosomes are :

(1) n = 7 and x = 21 (2) n = 21 and x = 21

(3) n = 21 and x = 14 (4) n = 21 and x = 7

Q.174 Chromosome with genes abcdefg becoming abedcfg is :

(1) duplication (2) deletion

(3) translocation (4) inversion

Q.175 Haploids are more suitable for mutation studies than the diploids. This is because :

(1) haploids are more abundant in nature than diploids

(2) All mutations, whether dominant or recessive are expressed in haploids

(3) Haploids are reproductively more stable than diploids

(4) Mutagens penetrate in haploids more effectively than in diploids

Q.176 Which one of the following scientist's name is correctly matched with the theory put forth by him ?

(1) de Vries - Natural selection

(2) Mendel - Theory of pangenesis

(3) Weismann - Theory of continuity of Germplasm

(4) Pasteur - Inheritance of acquired characters

ANSWER KEY

EXERCISE-2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	2	3	2	2	2	4	2	1	3	3	1	2	2	4	1	4	3	4
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	3	2	3	2	1	3	3	2	3	4	4	4	1	3	1	4	1	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	4	3	2	3	4	3	3	1	2	3	4	3	2	3	3	4	4	2	4
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	1	2	1	4	4	3	3	3	2	1	3	1	4	1	2	2	2	3	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	2	3	3	4	2	1	1	1	4	2	3	3	2	3	2	2	1	4	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	2	3	2	2	3	3	4	1	2	3	1	3	4	4	2	2	4	2	3
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	4	3	2	2	1	4	3	1	4	2	1	2	1	2	1	1	2	2	3
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	2	4	3	3	2	3	1	4	1	2	3	3	4	2	4	2	2	2	2	4
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176				
Ans.	3	2	1	1	1	2	1	3	3	2	1	4	4	4	2	3				

EXERCISE- 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Germplasm concept was proposed by : **[RPMT-93]**

(1) Mendel (2) De-vries

(3) Aristoltle (4) Weismann

Q.2 On which plant mendel had carried out his investigation :- **[RPMT-87,88]**

(1) Garden-pea (2) Wild pea

(3) Cow-pea (4) Pigeon pea

Q.3 Which of the following in non-heritable : **[AIPMT-95]**

(1) Point mutation

(2) Chromososmal mutation

(3) Gene mutation

(4) Somatic mutation

Q.4 The year 1900 AD is highly significant for geneticists due to the- **[RPMT-92,95]**

(1) Discovery of genes

(2) Principle of Linkage

(3) Mendelian rediscovery

(4) Chromosome theory of heredity

Q.5 During breeding the removal of anthers from a flower is called - **[MP PMT-95]**

(1) Anthesis (2) Pollination

(3) Emasculation (4) Vasectomy

Q.6 When a heterozygous tall pea plant of F_1 generation upon self fertilization produces tall and dwarf phenotypes it proves the principle of - **[RPMT-85,90]**

(1) Dominance

(2) Segregation

(3) Independant assortement

(4) Inheritance & purity of gametes

Q.7 Mendel formulated the law of purity of gametes on the basis of - **[RPMT-90]**

(1) Dihybrid cross (2) Monohybrid cross

(3) Back cross (4) Test cross

Q.8 Mendelian monohybrid ratio is - **[RPMT-93]**

(1) 1:2:1 (2) 3:1

(3) 9:3:1 (4) 9:3:4

Q.9 In a monohybrid cross the genotype ratio of the offspring is - **[MP PMT-96]**

(1) 3:1 (2) 1:2:1

(3) 1:1:1:1 (4) 4:0

Q.10 A cross between AaBB X aa BB yieldds a genotypic ratio of - **[AIPMT-90]**

(1) 1 AaBB: 1 aaBB

(2) 1 AaBB: 3 aaBB

(3) 3AaBB : 1 aa BB

(4) All AaBb

Q.11 In monohybrid cross what is the ratio of homozygous dominant and homozygous recessive individuals in F_2-generation - **[RPMT-89-92-93-96]**

(1) 1: 2:1 (2) 2:1/1:2

(3) 3:1/1:3 (4) 1:1

Q.12 Back cross is a cross between -**[RPMT-87]**

(1) $F_1 \times F_1$ (2) $F_1 \times$ Recessive

(3) $F_1 \times$ Dominant (4) $F_1 \times$ any parent

Q.13 The cross between recessive to it's hybrid or it's F_1 plant is called - **[RPMT-92,93,96]**

(1) Back cross (2) Test cross

(3) Monohybrid cross (4) Dihybrid cross

Q.14 What is the genotypic and phenotypic ratio of monohybrid test cross - **[RPMT-86]**

(1) 1:1 (2) 1:2

(3) 3:1 (4) 1:2:1

Q.15 What is the ratio of a progeny of cross between F_1 heterozygous and recessive - **[RPMT-87]**

(1) 3:1 (2) 1:2:1

(3) 1:1 (4) 2:1

Q.16 Dihybrid cross proves the law of - **[AIPMT-92]**

(1) Segregation

(2) Purity of gametes

(3) Dominance

(4) Independent assortment

Q.17 How many types & in what ratio the gametes are produced by a dihybrid heterozygous - **[AIPMT-92]**

(1) 4 types in the ratio of 9:3:3:1

(2) 2 types in the ratio of 3:1

(3) 3 types in the ratio of 1:2:1

(4) 4 types in the ratio of 1:1:1:1

Q.18 How many gametes are produced in F_1 generation of a trihybrid - **[MP PMT-88]**

(1) 3 (2) 4

(3) 8 (4) 16

Q.19 Which genotype represents a true dihybrid condition - **[AIPMT-91]**

(1) tt rr (2) Tt rr

(3) Tt Rt (4) TT Rt

Q.20 Mendel enunciated how many principles of inheritance - **[MP PMT-95]**

(1) One (2) Two

(3) Three (4) Four

Q.21 Mendelian ratio 9:3:3:1 is due to-**[RPMT-95]**

(1) Law of segregation

(2) Law of purity of gemetes

(3) Law of independent assortment

(4) Law of unit characters

Q.22 In a cross between a pure tall plant with green pod & a pure short plant with yellow pod. How many short plants are produced in F_2 generation out of 16 - **[AIPMT-94]**

(1) 1 (2) 3

(3) 4 (4) 9

Q.23 In a dihybrid cross between AABB and aabb the ratio of AABB, AABb, aaBb, aabb in F_2 generation is - **[AIPMT-92-94]**

(1) 9:3:3:1 (2) 1:1:1:1

(3) 1:2:2:1 (4) 1:1:2:2

Q.24 Branch of biology dealing with heredity and variation is called - **[MP PMT-98]**

(1) Palaentolozy (2) Evolution

(3) Genetics (4) Ecolozy

Q.25 A dihybrid ratio is - **[MP PMT-98]**

(1) 1:1:1:1 (2) 3:1

(3) 9:3:3:1 (4) 9:5:1:1

Q.26 AABbCc genotype forms how many types of gametes - **[AIPMT-98]**

(1) 4 (2) 8

(3) 2 (4) 6

Q.27 Who rediscovered the results of mendel's experiments - **[RPMT-97]**

(1) Devries, Tschemark, corrents

(2) Devries, Tschemark, Morgan

(3) Tschemark, Morgan, correns

(4) Tschemark, Bateson, Punnet

Q.28 Crossing AABB & aabb, the ratio of AaBb would be in F_2 generation - **[RPMT-97]**

(1) 1/16 (2) 2/16

(3) 8/16 (4) 4/16

Q.29 On crossing Black & while flowered plants the ratio of Black and white flowered plants in F_2 gen.was 120:40, then on selfing the heterozygous Black flowered plants, the offsprings would be - **[RPMT-97]**

(1) 144:48 (2) 40:60

(3) 52:48 (4) 84:16

Q.30 In mendel's experiments, colour of seed coat, nature of flower, position of flower, colour of pod, height of stem, are called - **[RPMT-97]**

(1) Alleles (2) Genotype

(3) Phenotype (4) All of the above

Q.31 120 Plants are produced on crossing pure red and pure white flowered pea plants, these ratio is- **[RPMT-96]**

(1) 90 Red : 30 White

(2) 30 Red : 90 White

(3) 60 Red : 60 White

(4) All Red

Q.32 According to Mendel's law of segregation the ratio of F_2 generation is - **[RPMT-96]**

(1) 1:2:1 (2) 3:1

(3) 1:1 (4) 2:1

Q.33 Mendel worked in - **[CPMT-80]**

(1) 17^{th} century (2) 18^{th} century

(3) 19^{th} century (4) 20^{th} century

Q.34 Pea plants were more suitable than cattle for Mendel's experiment because - **[CPMT-88]**

(1) There were no breeding records of cattles

(2) Pea plants can be self-fertilised

(3) Cattle are not easy to mantain

(4) All pea plants have 2X chromosomes and fewer gentetic traits

Q.35 An individal with two identical members of a pair of genetic factros is called -**[CPMT-81]**

(1) Heteromorphic (2) Heterozygote

(3) Homomorphic (4) Homozygote

Q.36 Two allelic genes are located on - **[AFMC-84]**

(1) The same chromosome

(2) Two homologous chromosomes

(3) Two-non-homologous chromosomes

(4) Any two chromossomes

Q.37 The percentage of ab gametes produced by Aa Bb parent will be - **[AIIMS-88]**

(1) 12.5 (2) 25

(3) 50 (4) 75

Q.38 Gregor Mendel was born in - **[CPMT-93]**

(1) Britain (2) Austria

(3) Russia (4) America

Q.39 Mendel's principles are related to - **[CPMT-95]**

(1) Evolution (2) Reproduction

(3) Variantions (4) Heredity

Q.40 Different forms of a gene are called - **[MP PMT-94]**

(1) Heterozygotes

(2) Alleles

(3) Complementary genes

(4) Supplementary genes

Q.41 How many character of pea pod were chosen by mendel - **[MP PMT-94]**

(1) 7 (2) 2

(3) 4 (4) 3

Q.42 Mendel chose character in pea -**[CPMT-94]**

(1) Three (2) Two

(3) One (4) Seven

Q.43 Mendel's law of segregation is based on separation of alleles during - **[MP PMT-93]**

(1) Gemete formation

(2) Seed formation

(3) Pollination

(4) Embryonic development

Q.44 In a cross 45 tall & 14 dwarf plants were obtained, genotype of parents was - **[BHU-93]**

(1) TT X TT (2) TT X Tt

(3) Tt X Tt (4) TT X tt

Q.45 First geneticist was - **[AIPMT-91]**

(1) De vries (2) Mendel

(3) Darwin (4) Morgan

Q.46 An organism with two identical alleles is - **[AIPMT-93]**

(1) Dominant (2) Hybrid

(3) heterozgous (4) Homozygous

Q.47 Gametes of AaBb individual can be - **[AIIMS-91]**

(1) Aa, Bb (2) AB, ab

(3) AB,ab,aB (4) AB,Ab,aB, ab

Q.48 Mendel did not propose - **[BHU-91,MPPMT-90]**

(1) Dominance

(2) Incomplete dominance

(3) Segregation

(4) Independent assortment

Q.49 When two hybrids Ttrr & Rrtt are crossed, the phenotypic ratio of offspring shell be - **[CPMT-90]**

(1) 3:1 (2) 1:1:1:1

(3) 1:1 (4) 9:3:3:1

Q.50 Body features are - **[MP PMT-88]**

(1) Phenotype (2) Genotype

(3) Sex of individual

(4) Controlled by atmosphere

Q.51 The allele which is unable to express its effect in the presence of another is called - **[AIPMT-91]**

(1) Co-dominant (2) Supplementary

(3) Complementry (4) Recessive

Q.52 Genotype is - **[BHU-83]**

(1) Genetic composition of many organisms

(2) Genetic composition of plastids

(3) Genetic composition of germ cells

(4) Genetic composition of an individual

Q.53 When AABBcc is corossed with Aa Bb Cc then the ratio of hybrid for all the three genes is - **[AIPMT-1999]**

(1) 1/8 (2) 1/4

(3) 1/16 (4) 1/32

Q.54 According to mendelism which character is showing dominance - **[AIPMT-2000]**

(1) Terminal position of flower

(2) Green colour in seed coat

(3) Wrinkled seeds

(4) Green pod colour

Q.55 Due to the cross between TTRr x ttrr the resultant progenies showed how many percent plants would be, tall, red flowered:- **[AIPMT-2000]**

(1) 50% (2) 75%

(3) 15% (4) 100%

Q.56 lrregularity is found in Drosophila during the organ differentiation for example-inplace of wing, long legs are formed. Which gene is responsible for - **[AIPMT-2000]**

(1) Double dominant gene

(2) Homeiotic gene

(3) Complimentary gene

(4) Plastid

Q.57 Mendel obtained wrinkled seeds in pea due to deposition of sugars instead of starch. It was due to which enzyme - **[AIPMT-2001]**

(1) Amylase (2) Invertase

(3) Diastase

(4) Absence of strach branching enzyme

Q.58 A gene said to be dominant if - **[AIPMT-2002]**

(1) It express it's effect only in homozygous stage

(2) It expressed only in heterozygous condition

(3) It expressed both in homozygous and heterozygous condition

(4) It never expressed in any condition

Q.59 A plant of F_1 generation with genotype ''AABbCC'' On selfing of this plant what is the phenotypic ratio in F_2 –generation- **[AIPMT-2002]**

(1) 3 : 1

(2) 1 : 1

(3) 9 : 3 : 3 : 1

(4) 27 : 9 : 9 : 9 : 3 : 3 : 3 : 1

Q.60 Which one of the following traits of garden pea studied by Mendel, was a recessive feature - **[AIPMT-2003]**

(1) Axial flower position

(2) Green seed colour

(3) Green pod colour

(4) Round seed shape

Q.61 In a plant, red fruit (R) is dominant over yellow fruit (r) and tallness (T) is dominant over shortness (t). If a plant with RRTt genotype is crossed with a plant that is rrtt - **[AIPMT-2004]**

(1) All the offsprings will be tall with red fruit

(2) 25% will be tall with red fruit

(3) 50% will be tall with red fruit

(4) 75% will be tall with red fruit

Q.62 When a red flower homozygous pea plant is crossed with a white flower plant what colour is produced in F_1 - **[RPMT-87]**

(1) Red (2) White

(3) Pink (4) Red + white

Q.63 How many different types of gametes can be formed by F_1 progeny, resulting from the following cross, : AA BB CC x aa bb cc - **[AIIMS-2004]**

(1) 3 (2) 8

(3) 27 (4) 64

Q.64 In order to find out the different types of gametes produced by a pea plant having the genotype AaBb, it should be crossed to a plant with the genotype - **[AIPMT-2005]**

(1) AaBb (2) aabb

(3) AABB (4) aaBB

Q.65 Gene word was coined by - **[RPMT-2005]**

(1) mendel (2) Hugo-de-vires

(3) Morgan (4) Johanson

Q.66 Discoverer of incomplete dominence - **[RPMT-2005]**

(1) Von Tschermak (2) Carl correns

(3) Hugo-de-vries (4) None of the above

Q.67 Test cross is - **[RPMT-2005]**

(1) Tt × Tt (2) Tt × TT

(3) TT × TT (4) Tt × tt

Q.68 Law of independent assortment of mendel was proved by - **[RPMT-2005]**

(1) Monohybrid cross

(2) Test cross

(3) Dihybrid (4) Back cross

Q.69 Mendel does not select which chracter in his experiment - **[RPMT-2005]**

(1) Plant height (2) Plant colour

(3) Pod shape (4) Pod colour

Q.70 In Mirabilis & Antirrhinum plant the apppearence of the pink hybrid (Rr) between cross of a red (RR) and white (rr) flower parent indicates - **[RPMT-88-89-90]**

(1) Incomplete dominance

(2) Segregation

(3) Dominance (4) Heterosis

Q.71 Exception to mendel's law is found in flower colour of - **[RPMT-96]**

(1) Mirabilis (2) Sweet-pea

(3) Garden-pea (4) Beans

Q.72 RR(red) is crossed with ww (white). All Rw off springs are pink. This indicates that R-gene is - **[CPMT-76-81-85]**

(1) Hybrid

(2) Incompletely dominant

(3) Recessive

(4) Mutant

Q.73 In case of incomplete dominance the monohybrid ratio of phenotype in F_2 generation is - **[RPMT-85]**

(1) 1:2:1 (2) 3:1:1

(3) 9:3:3:1 (4) 2:3:1

Q.74 A white flowered mirabils plant rr was crossed with red coloured RR, If 120 plants are produced in F_2 generation. the result would be- **[RPMT-96]**

(1) 90 uniformly coloured & 30 white

(2) 90 Non-uniformly coloured (Pink) & 30 white

(3) 60 Non-uniformly coloured (Pink) & 60 white

(4) All coloured & No white

Q.75 When the phenotypic and genotypic ratios resemble in the F_2 generation it is an example of - **[RPMT& DPMT-85]**

(1) Independant assortment

(2) Qualitative inheritance

(3) Segregation of factors

(4) Incomplete dominance

Q.76 Which one carries extra nuclear genetic material - **[BHU-87]**

(1) Plastids (2) Ribosomes

(3) Chromosomes (4) Golgi-complex

Q.77 When certain character is inherited only through the female parent, it probably repbably represents the case of - **[AIPMT-92]**

(1) Mendelian nuclear inheritance

(2) Multiple plastid inheritance

(3) Cytoplasmic inheritance

(4) Incomplete dominace

Q.78 Cytoplasmic male sterility is inherited - **[MP-PMT-86]**

(1) Maternally

(2) Paternally

(3) Both

(4) Bacteriophage multiplication

Q.79 Mendel did not include in his laws - **[RPMT-90]**

(1) Segregation (2) Dominance

(3) Purity of gametes (4) Linkage

Q.80 If mendel has chosen to study traits determined by linked genes he would not have discovered- **[AIIMS-87]**

(1) Law of segregation

(2) Law of dominance

(3) Law of independant assortment

(4) Law of unit character

Q.81 Which law would have been violated if mendel has chosen eight character in garden-pea- **[RPMT-90, AIPMT-90-96]**

(1) Law of dominance
(2) Law of segregation
(3) Principle of independant assortment
(4) Law of purity of gametes

Q.82 Mendel had a difficulity in explaining the linked character due to - **[AIPMT-90]**

(1) Law of dominance
(2) Law of segregation
(3) Law of independant assortment
(4) All the above

Q.83 In Mirabilis jalapa when homozygous red flowered and white flowered plants are crossed, all F_1 plants have pink coloured flowers. In F_2 produced by selfing of F_1 plants, red, pink, white flowered plants would appear respectivley in the ratio of - **[MP PMT-98]**

(1) 1:1:2 (2) 2:1:1
(3) 1:0:1 (4) 1:2:1

Q.84 The main aim of plant breeding is - **[MP PMT-98]**

(1) To produce improved varieties
(2) To make soil fertile
(3) To controle pollution
(4) To become more progessive

Q.85 Plants having similar genotypes produced by plant breeding are called - **[MP PMT-98]**

(1) Clone (2) Haploid
(3) Autopolyploid (4) Genome

Q.86 If mendel might have studies 7 pairs of characters in a plant with 12 chromosomes. instesd of 14, then - **[AIPMT-98]**

(1) He could not discover independant assortment
(2) He might have not discovered linkage
(3) He might have discovered crossing-over
(4) He might have not observed dominance

Q.87 Plant, which does not obeys Mendel's laws- **[RPMT-96]**

(1) Mirabilis jalapa (2) Pisum sativum
(3) Cicer auriethinum (4) lberies amara

Q.88 The first attempt to show linkage in plants was done - **[BHU-84]**

(1) Pisum sativim (2) Lathyrus odoratus
(3) Zea mays
(4) Oenothera lamarckiana

Q.89 In case of incomplete dominance, F_2 generation has - **[BHU-95]**

(1) Genotypic ratio equal to phenotypic ratio
(2) Genotypic ratio is 3:1
(3) Phenotypic ratio is 3:1
(4) None

Q.90 Genes controlling seven traits in pea studied by mendal were actually located on - **[BHU-94]**

(1) Seven chromosomes
(2) Six chromosomes
(3) Four chromosomes
(4) Five chromosomes

Q.91 Hybridoms is - **[AIPMT-1999]**

(1) Collection of DNA from DNA
(2) Collection of RNA from DNA
(3) A fusion of tumour sex cell with non tumour sex cell
(4) A fusion of tumour somatic cell with non tumor somatic cell

Q.92 When dominant and recessive alleles express itself together it is called - **[AIPMT-2001]**

(1) Co-dominance (2) Dominance
(3) Amphidominance
(4) Pseudo dominance

Q.93 Extranclear inheritacne occurs in - **[AIPMT-2001]**

(1) Killer paramecium (2) Killer Amoeba
(3) Euglena (4) Hydra

Q.94 Nucleus of a donor embryonal cell/somatic cell is transferred to an enucleated egg cell. Then after the formation of organism, what shell be true : **[AIPMT-2002]**

(1) Organism will have extranuclear genes of the donor cell.
(2) Organism will have extra nuclear genes of recipient cell.
(3) Organism will have extra nuclear genes of both donor and recipient cell.
(4) Organism will have nuclear genes of recipient cell.

Q.95 Genes for cytoplasmic male sterility in plants are generally located in - **[AIPMT-2003]**

(1) Chloroplast genome

(2) Mitochondrial genome

(3) Nuclear genome

(4) Cytosol

Q.96 Two crosses between the same pair of genotypes or phenotypes in which the source of the gametes are reversed in one cross, is known as - **[AIPMT-2003]**

(1) Test cross (2) Reciprocal cross

(3) Dihybrid cross (4) Reverse cross

Q.97 The genes controlling the seven pea characters studied by Mendel are known to be located on how many different chromosomes - **[AIPMT-2003]**

(1) Seven (2) Six

(3) Five (4) Four

Q.98 Extranuclear inheritance is a consequence of presence of genes in - **[AIPMT-2004]**

(1) Lysosomes and ribosomes

(2) Mitochondria and chloroplasts

(3) Endoplasmic reticulum and mitochondria

(4) Ribosomes and chloroplast

Q.99 Mendel observed the certain characters did not assort independently. Later researches, found it to be due to - **[MP PMT-98]**

(1) Amitosis (2) Linkage

(3) Dominance (4) Crossing over

Q.100 The phenomenon of incomplete dominance was observed by -

(1) De vries (2) Correns

(3) Tschermak (4) None

Q.101 Genes for cytoplasmic male sterility in plants are generally located in - **[AIPMT-2005]**

(1) Nuclear genome

(2) Chloroplast genome

(3) Cytosol

(4) Mitochondrial genome

Q.102 Sickle cell anemia is - **[AIPMT-2009]**

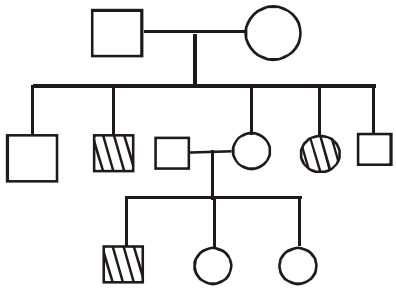
(1) Characterized by elongated sickle like RBCs with a nucleus

(2) An autosomal linked dominant trait

(3) Caused by substitution of valine by glutamic acid in the beta globin chain of haemoglobin

(4) Caused by a change in a single base pair of DNA

Q.103 Study the pedigree chart given below -



What does it show - **[AIPMT-2009]**

(1) Inheritance of a recessive sex-linked disease like haemophilia

(2) Inheritance of a sex-linked inborn error of metabolism like phenylketonuria

(3) Inheritance of a condition like phenylketonuria as an autosomal recessive trait

(4) The pedigree chart is wrong as this is not possible

Q.104 The most popularly known blood grouping is the ABO grouping. It is named ABO and not ABC, becouse ''O'' in it refers to haivng : **[AIPMT-2009]**

(1) No antigens A and B on RBCs

(2) Other antigens besides A and B on RBCs

(3) Overdominance of this type on the genes for A and B types

(4) One antibody only-either anti-A or anti-B on the RBCs

Q.105 Select the incorrect statement from the following - **[AIPMT-2009]**

(1) Baldness is a sex-limited trait

(2) Linkage is an exception to the principle of independent assortment in heredity

(3) Galactosemia is an inborn error of metabolism

(4) Small population size result in random genetic drift in a population

Q.106 Which one of the following is commonly used in transfer of foreign DNA into crop plants ? **[AIPMT-2009]**

(1) Penicillum expansum

(2) Trichoderma harzianum

(3) Meloidogyme incognita

(4) Agrobacterium tumefaciens

Q.107 The bacterium Bacillus thuringiensis is widely used in contemporary biology as - **[AIPMT-2009]**

(1) Source of industrial enzyme

(2) Indicator of water pollution

(3) Insecticide

(4) Agent for production of dairy products

Q.108 Polyethyene glycol method is used for - **[AIPMT-2009]**

(1) Energy production from sewage

(2) Gene transfer without a vector

(3) Biodiesel production

(4) Seedless fruit production

Q.109 Transgenic plants are the ones - **[AIPMT-2009]**

(1) Grown in artificial medium after hybridization in the field

(2) Production by a somatic embryo in artificial medium

(3) Generated by introducing foreign DNA in to a cell and regenerating a plant from that cell

(4) Produced after protoplast fusion in artificial medium

Q.110 What is true about Bt toxin? **[AIPMT-2009]**

(1) The connerned Bacillus has antitoxins

(2) The inactive protoxin gets converted into active form in the insect gut

(3) Bt protein exists as active toxin in the Bacillus

(4) The activated toxin enters the ovaries of the pest to sterlise it and thus prevent its multiplication

Q.111 The genetic defect-adenosine deaminase (ADA) deficiency may be cured permanently by - **[AIPMT-2009]**

(1) Enzyme replacement therapy

(2) Peridic infusion of genetically engineered lymphocytes having functional ADA cDNA

(3) Administering adenosine activators

(4) Introducing bone marrow cells producing ADA into cells at early embyonic stage

Q.112 Epistasis was discovered by - **[AIPMT-90]**

(1) Johanson (2) Shull

(3) Bateson (4) Mendel

Q.113 A normal woman whose father was albino, marries an albino man. what proportion of normal and albino are expected among their off springs - **[AIPMT-94]**

(1) All normal

(2) 2 normal : 1 Albino

(3) All albino

(4) 1 normal : 1 Albino

Q.114 What is the inheritance of colour bindness of both parents having a normal vision but mother has a recessive gene for colour blindness - **[AIPMT-90-96]**

	Son	**Daughter**
(1)	50%	Nil
(2)	100%	Nil
(3)	Nil	100%
(4)	Nil	Nil

Q.115 What would be the nature of children if a colour blind woman marries a normal man- **[AIPMT-95]**

(1) Colourblind daughter & normal sons

(2) Colourblind sons and carrier daughters

(3) Normal sons & carrier daughters

(4) Normal sons & Normal daughters

Q.116 A colourblind man marries a normal lady whose father was colour blind. If it produces two sons & two daughters. how many of them would be suffer - **[AIIMS-85,AFMS-88]**

(1) Both sons

(2) Both daughters

(3) One son & one daughter

(4) Both sons & both daughters

Q.117 Inheritance of skin colour in human beings is an example of - **[BHU-80]**

(1) Complementary gene

(2) Monogenic inheritance

(3) Polygenic inheritance

(4) Mendelian inheritance

Q.118 The phenomenon in which an allele of one gene suppresses the expression of an allele of another gene is known as - **[AIPMT-95]**

(1) Dominance (2) Inactivation

(3) Epistasis (4) Suppression

Q.119 When two independentaly assorting dominant genes interact with each other to produce perticular phenotype but when they present alone they did not produce phenotype they are called - **[AIPMT-96]**

(1) Complementary gene

(2) Supplementry gene

(3) Duplicate gene

(4) Inhibitory gene

Q.120 Polygenic genes show - **[AIPMT-96]**

(1) Identical phenotype

(2) Identical biochemistry

(3) Different phenotype

(4) Identical genotype

Q.121 AB-Blood group shows - **[AIPMT-89]**

(1) Co-dominance

(2) Complete dominance

(3) Mixed inheritance

(4) Composite inheritance

Q.122 ABO blood group is an example of - **[AIPMT-90]**

(1) Epistasis

(2) Multiple allelism

(3) Pleotropism

(4) Complementary genes

Q.123 A child is blood group is 'O' His parents blood group can not be - **[AIPMT-94]**

(1) B & O (2) A & O

(3) AB (4) A & B

Q.124 If selfing occurs in the plant having genotype RrYy, then ratio of given genotype will be- RRYY. RrYY. RRYy. RrYy **[RPMT-2006]**

(1) 1 : 2 : 2 : 4 (2) 1 : 2 : 2 : 1

(3) 1 : 1 : 1 : 1 (4) 2 : 2 : 2 : 1

Q.125 If one parent has blood group A and the other parent has blood group B. The offspring have which blood group - **[MP PMT-98]**

(1) AB (2) O

(3) BO (4) A, B, AB, O

Q.126 A colourbind daughter is born when - **[MP PMT-98]**

(1) Father is colourblind, mother is normal

(2) Mother is colourblind, father is normal

(3) Mother is carrier, father is normal

(4) Mother is carrier, father is colourblind

Q.127 The process of mating between closely related individuals is - **[AIPMT-94]**

(1) Out-breeding (2) Inbreeding

(3) Hybridisation (4) Heterosis

Q.128 Ratio 9:7 is due to - **[AMU-93]**

(1) Supplementary genes

(2) Lethal genes

(3) complementry genes

(4) Epistatic genes

Q.129 A man of A blood group marries a woman of AB blood group. which type of progeny would indicate that man is heterozygous A - **[AIPMT-93]**

(1) AB (2) A

(3) O (4) B

Q.130 A child of O blood group. has B-blood group father, the genotype of father would be - **[AIPMT-92]**

(1) I^0I^0 (2) I^BI^B

(3) I^AI^B (4) I^BI^0

Q.131 Marriages between close relatives should be avoided becouse it includes more - **[MP PMT-90]**

(1) Recessive alleles to come together

(2) Mutations

(3) Multiple births

(4) Blood group abnormalities

Q.132 What ratio is expected in off springs if father is colour blind and mother's father was colour blind - **[AIPMT-1999]**

(1) 50% daughter - colour blind

(2) All the sons are colour blind

(3) All the daughters colour blind

(4) All the sons are normal

Q.133 Independent assortment of genes does not take place when - **[AIPMT-2001]**

(1) Genes are located on homologous chromosomes

(2) Genes are linked and located on same chromosome

(3) Gnes are located on non-homologous chromosome

(4) All the above

Q.134 What is true for monoclonal antibodies - **[AIPMT-2001]**

(1) These antibodies obtained from one parent and for one antigen

(2) These obtained from different parents and for one antigen

(3) These obtained from one parents and for many antigen

(4) These obtained from many parents and for many antigen

Q.135 Ratio of complementry genes is - **[AIPMT-2001]**

(1) 9 : 3 : 4 (2) 12 : 3 : 1

(3) 9 : 3 : 3 : 4 (4) 9 : 7

Q.136 A and B genes are linked. What shall be genotype of progeny in a cross bet. AB/ab and ab/ab - **[AIPMT-2001]**

(1) AAbb and aabb (2) AaBb and aabb

(3) AABB and aabb (4) None

Q.137 Two nonallelic genes produces the new phenotype when present together but fail to do so independently then it is called - **[AIPMT-2001]**

(1) Epistatisis

(2) Polygen

(3) Non complimentry gene

(4) Complimenatry gene

Q.138 Male XX and female XY sometime occur due to - **[AIPMT-2001]**

(1) Deletion

(2) Transfer of segments in X and Y chromosomes

(3) Anneuploidy

(4) Hormonal imbalance

Q.139 Which of the following is the example of pleiotropic gene - **[AIPMT-2002]**

(1) Haemophilia

(2) Thalaessemea

(3) Sickle cell anaemia

(4) Colour blindness

Q.140 There are three genes a,b,c percentage of crossing over between a and b is 20% b and c is is 28% and a and c is 8% What is the sequence of genes on chromosome - **[AIPMT-2002]**

(1) b, a c (2) a, b, c

(3) a, c, b (4) None

Q.141 The linkage map of X-chromosome of fruitfly has 66 units, with yellow body gene (y) at one end and bodded hair (b) gene at the other end. The recombination frequecy between these two genes (y and b) should be- **[AIPMT-2003]**

(1) 60% (2) > 50%

(3) ≤ 50% (4) 100%

Q.142 Pattern baldness, moustaches and beard in human males are examples of - **[AIPMT-2003]**

(1) Sex linked traits

(2) Sex limited traits

(3) Sex differentiating traits

(4) Sex-determining

Q.143 When a cluster of genes show linkage behaviour they - **[AIPMT-2003]**

(1) Do not show a chromosome map

(2) Show recombination during meiosis

(3) Do not show independent assortment

(4) Induce cell division

Q.144 Genetic Map is one that - **[AIPMT-2003]**

(1) Establishes sites of the genes on a chromosome

(2) Establishes the various stage in gene evolution

(3) Shows the stage during the cell division

(4) Shows the distribution of various species in a region

Q.145 One of the genes present exclusively on the X-chromosome in humans is concerned with- **[AIPMT-2003]**

(1) Baldness

(2) Red green colour bindness

(3) Facial hair/Moustaches in males.

(4) Night blindness

Q.146 The recessive genes located on X-chromosome in humans are always - **[AIPMT-2004]**

(1) Expressed in females

(2) Lethal

(3) Sub-lethal

(4) Expressed in males

Q.147 Lack of independent assortment of two genes A and B in fruit fly **Drosophila** is due to - **[AIPMT-2004]**

(1) Crossing over (2) Repulsion

(3) Recombination (4) Linkage

Q.148 A normal woman, whose father was colour-blind is married to a normal man. The sons would be - **[AIPMT-2004]**

(1) All colour-blind (2) 75% colour-blind

(3) 50% colour-blind (4) All normal

Q.149 In totmto, genotype aabbcc produces 100g tomatoes and AABBCC produces 160g tomatoes. What is contribution of each polygene in the production of tomatoes -

(1) 10 g (2) 20 g

(3) 30 g (4) 40 g

Q.150 If father shows normal genotype and mother shows a carrier trait for haemophelia - **[OLYMPIAD-2004]**

(1) All the female children will be carrier

(2) A male child has 50% chances of active disease

(3) Female child has probability of 50% to active disease

(4) All the female children will be colourblind

Q.151 In a genetic cross having recessive epistais, F_2 phenotypic ratio would be - **[AIPMT-90]**

(1) 9 : 6 : 1 (2) 15 : 1

(3) 9 : 3 : 4 (4) 12 : 3 : 1

Q.152 Which of the following is not a hereditary disease - **[AIPMT-2005]**

(1) Haemophilia (2) Cretinism

(3) Cystic fibrosis (4) Thalassaemia

Q.153 A woman with normal vision, but whose father was colour blind, marries a colour blind man. Suppose that the fourth child of his couple was a boy. This boy - **[AIPMT-2005]**

(1) Must have normal colour vision

(2) May be colour blind or may be normal vision

(3) Will be partially colour blind since he is heterozygous for the colour blind mutant allele

(4) Must be colour blind

Q.154 Haemiphilia is more commonly seen in human males than in human females because- **[AIPMT-2005]**

(1) This disease is due to a Y-linked recessive mutation

(2) This disease is due to an X-linked recessive mutation

(3) This disease is due to an X-linked dominant mutation

(4) A greater proportion of girls die in infancy

Q.155 A man and a woman, who do not show any apparent signs of a certain inherted disease, have seven children (2 daughters and 5 sons). Three of the sons suffer from the given disease but none of the daughters are affected. Which of the following mode of inheritance do you suggest for this disease - **[AIPMT-2005]**

(1) Sex-limited recessive

(2) Autosomal dominant

(3) Sex-linked recessive

(4) Sex-linked dominant

Q.156 Grain colour in wheat is determined by three pairs of polygenes. Following cross AABBCC (dark colour) x aabbcc (light colour), in F_2 generation what proportion of the porgeny is linkely to resemble either parent ?

[AIIMS-2005]

(1) None (2) Less than 5 percent
(3) One third (4) Half

Q.157 The genotype of a plant showing the dominant phenotype can be determined by –

[CPMT - 2010]

(1) Test cross (2) Dihybrid cross
(3) Pedigree analysis (4) Back cross

Q.158 ABO blood groups in humans are controlled by the gene I. It has three alleles – IA, IB and i. Since there are three different alleles, six different genotypes are possible. How many phenotypes can occur – **[CPMT - 2010]**

(1) Three (2) One
(3) Four (4) Two

Q.159 Select the correct statement from the ones given below with respect to dihybrid cross –

[CPMT - 2010]

(1) Tightly linked genes on the same chromo some show higher recombinations
(2) Genes far apart on the same chromosome show very few recombinations
(3) Genes loosely linked on the same chromo some shwo similar recombinations as the tightly linked ones
(4) Tightly linked genes on the same chromo some show very few recombination

Q.160 Which one of the following palindromic base sequences in DNA can be easily cut at about the middle by some particular striction enzyme?

[CPMT - 2010]

(1) 5' _____ CG TTCG _____ 3'
3' _____ATGGTA _____5'

(2) 5'_____GATATG _____3'
3'_____CTACTA _____5'

(3) 5'_____GAATTC _____3'
3'_____CTTAAG_____5'

(4) 5'_____CACGTA_____3'
3' CTCAGT_____5'

Q.161 Hybrid breakdown is failure of

[AFMC 1997]

(1) Hybrid zygote to develop into offspring
(2) Hybrid adult to produce fertile offspring
(3) Fusion failure of ova and sperms of two species
(4) All the above

Q.162 Hexaploid wheat developed through

[AIIMS 1997]

(1) Hybridomas
(2) Chromosome doubling
(3) Hybridisation
(4) Hybridisatin and chromosome doubling

Q.163 Genetic drift in mendelian population takes place in- **[CPMT 1998]**

(1) Small population (2) Large population
(3) Oceanin population (4) Never occurs

Q.164 Industrial melanism is example of

[CPMT 1999]

(1) Natural selection (2) Mutation
(3) Racial difference (4) Predation

Q.165 Frequency of an allele in an isolated population may change due to **[CPMT 2001]**

(1) Genetic drift (2) Gene flow
(3) Mutation (4) Natural selection

Q.166 In lederberg's replica plating experiment what shall be used to obtain streptomycin resistant strain:

[CPMT 2001]

(1) Minimal medium and streptomycin
(2) Complete medium and streptomycin
(3) Only minimal medium
(4) Only complete medium

Q.167 Forecoming generations are less adaptive than their parental generation due to- **[CPMT 2001]**

(1) Natural selection (2) Mutation
(3) Genetic drift (4) Adaptation

Q.168 Some bacteria are able to grow in Streptomycin containing medium due to **[CPMT 2002]**

(1) Natural selection
(2) Induced mutation
(3) Reproductive isolation
(4) Genetic drift

Q.169 Genetic drift operates in- **[CPMT 2002]**

(1) Small isolated population
(2) Large isolated population
(3) Fast reproductive population
(4) Slow reproductive population

Q.170 Sequence of which of the following is used to know the phylogeny- **[CPMT 2002]**

(1) m-RNA (2) r-RNA

(3) t-RNA (4) DNA

Q.171 Random genetic drift in a population probably results from:- **[CPMT 2003]**

(1) Highly genetically variable individuals

(2) Interbreeding within this population

(3) Constant low mutation rate

(4) Large population size

Q.172 Industrial melanism is an example of- **[CPMT 2003]**

(1) Drug resistance

(2) Darkening of skin due to smoke from industries

(3) Protective resemblance with the surroundings

(4) Defensive adaptation of skin against ultraviolet radiations

Q.173 A class of mutation induced by addition of deletion of a nucleotide is called - **[AMU 2002]**

(1) Missense (2) Non-sense

(3) Substitution (4) Frame shift

Q.174 The number of chromosome present in the cells of the bread wheat (Triticum aestivum) suggests that it is - **[AMU 2003]**

(1) Hexaploid (2) Diploid

(3) Tetraploid (4) Pentaploid

Q.175 A gene mutation which does not result in phenotypic expression is termed -**[AMU 2004]**

(1) Nonsense mutation

(2) Silent mutation

(3) Missense mutation

(4) Frame shift mutation

Q.176 Breeding is possible between two member of - **[AMU 2005]**

(1) Genus (2) Family

(3) Order (4) Species

Q.177 In which one of the following combinations (1-4) of the number of chromosomes is the present day hexaploid wheat correctly represented **[AIIMS 2006]**

Combination	(1)	(2)	(3)	(4)
Monosomic	21	7	21	41
Haploid	28	28	7	21
Nullisomic	42	40	42	40
Trisomic	43	42	43	43

Q.178 Which of the following may be true to for RNA- **[RPMT - 96]**

(1) A = U ≠ G = C

(2) A ≠ U ≠ G ≠ C

(3) A = U = G = C

(4) Purines = Pyrimidines

Q.179 The enzyme which can cut molecules of DNA in to segments is known as - **[MP PMT-94]**

(1) DNA Polymerase (2) DNA Ligase

(3) Restriction enzyme (4) DNA Gyrase

Q.180 The genes concerned with the production of cancer are called - **[MP PMT-95]**

(1) Cancer genes (2) Carcino genes

(3) Carcinomas (4) Onco genes

Q.181 Quantity of nucleic acids in animal cells is - **[RPMT - 95]**

(1) 2% (2) 5%

(3) 10% (4) 15%

Q.182 Nucleic acids are made up of - **[RPMT - 95]**

(1) Amino acids (2) Pentose sugars

(3) Nucleosides (4) Nucleotide

Q.183 Nucleic acids are polymer of - **[RPMT - 94, 85 AIPMT 78, 81]**

(1) Nucleotides (2) Nucleosides

(3) Amino acids (4) Nitrogen bases

Q.184 Who proved DNA as genetic material- **[RPMT - 94]**

(1) Griffith (2) Bacteria

(3) PPLO (4) Hershey and chase

Q.185 Circular and double stranded DNA occurs in **[RPMT - 94]**

(1) Golgibody (2) Mitochondria

(3) Nucleus (4) Cytoplasm

Q.186 If there are 10,000 base pairs in DNA, then its length - **[RPMT - 94]**

(1) 340 nm (2) 3400 nm

(3) 34000 nm (4) 340000 nm

Q.187 Code in RNA corresponding to AGCT in DNA- **[RPMT - 94]**

(1) TACA (2) UCGA

(3) TCGA (4) AGUC

Q.188 Double helix model of DNA which was proposed by Watson and crick was of - **[RPMT - 93]**

(1) C-DNA (2) B-DNA

(3) D-DNA (4) Z-DNA

Q.189 Mitochondrial DNA is - **[RPMT - 93]**

(1) Naked (2) Circular

(3) Double stranded (4) All the above

Q.190 If there are 10,000 nitrogenous base pairs in a DNA then how many nucleotides are there - **[RPMT - 93]**

(1) 500 (2) 10,000

(3) 20,000 (4) 40,000

Q.191 The process of m RNA sythesis on a DNA is known as - **[RPMT - 92]**

(1) Translation (2) Transcription

(3) Transduction (4) ransformation

Q.192 Double helix model of DNA is proposed by - **[RPMT - 92, DElHI PMT' 92]**

(1) Watson and Crick

(2) Schleiden and schwann

(3) Singer and Nicholson

(4) Kornberg and Khurana

Q.193 Which of the following nitrogen base is not found in DNA - **[AIPMT 8; RPMT - 92]**

(1) Thymine (2) Cytosine

(3) Guanine (4) Uracil

Q.194 Back bone of structure of DNA molecule is made up of - **[RPMT - 91]**

(1) Pentose Sugar and phosphate

(2) Hexose sugar and phosphate

(3) Purine and pyrimidine

(4) Sugar and phosphate

Q.195 Which of the following is called adaptor molecule - **[RPMT - 91]**

(1) DNA (2) m-RNA

(3) t-RNA (4) RNA

Q.196 Substance common in DNA and RNA - **[RPMT - 90]**

(1) Hexose Sugar (2) Histamine

(3) Thymine (4) Phosphate groups

Q.197 Which of following base pair is wrong - **[RPMT - 88]**

(1) A-T (2) G-C

(3) A-C (4) A-U

Q.198 Which may be attached with Adenine base in RNA - **[RPMT - 88]**

(1) Guanine (2) Cytosine

(3) Uracil (4) Thymine

Q.199 Nucleotide is - **[RPMT - 88]**

(1) N_2-base, pentose sugar and phosphoric acid

(2) Nitrogen, Hexose sugar and phosphoric acid

(3) Nitrogen base, pentose sugar

(4) Nitrogen base, trioses and phosphoric acid

Q.200 DNA differs from RNA in - **[RPMT - 88]**

(1) Only Sugar

(2) Nitrogen base only

(3) Nitrogen base and sugar

(4) None

Q.201 Who propounded the theory one gene one enzyme one chemical reaction- **[BHU' - 82'83]**

(1) Watson & Crick

(2) George Beadle and Edward Tatum

(3) Abraham Trembley

(4) T.H. Morgan

Q.202 A codon in m-RNA has - **[BHU - 83]**

(1) 3-bases

(2) 2-bases

(3) 1- base

(4) Number of bases very

Q.203 Unit of nucleic acids are - **[NCERT - 76]**

(1) Phosphoric acid

(2) Nitrogenous bases

(3) Pentose Sugar

(4) Nucleotide

Q.204 Which element is not found in nitrogenous base- **[NCERT - 76]**

(1) Nitrogen (2) Hydrogen

(3) Carbon (4) Phosphorus

Q.205 The link between successive generation is provided by - **[AIPMT - 81,84]**

(1) Nucleus (2) Cytoplasm

(3) Chromosomes (4) Nucleic acid

Q.206 DNA was first discovered by - **[AIPMT - 76, 85]**

(1) Meischer (2) Robert Brown

(3) Flemming (4) Watson & Crick

Q.207 Nucleic acids are found in - **[AIPMT - 80]**

(1) Nucleus

(2) Cytoplasm

(3) Both nucleus & Cytoplasm

(4) Nucleus & ribosome

Q.208 DNA is found in - **[AIPMT' 78, 80, MP. PMT - 86]**

(1) ER & Ribosomes

(2) Mitochondria, Plastid & nucleolus

(3) Sphersome & Peroxysome

(4) Plasma membrane & lysosome

Q.209 Nucleic acids are found in - **[RPMT' 90, MP. PMT - 90]**

(1) Nucleus & nucleolus

(2) Spherosome & Plastid

(3) Mitocondria & plastid

(4) Chloroplast & Nucleosome

Q.210 The contribution of cytoplasmic DNA in the total DNA of a cell - **[DELHI PMT - 86]**

(1) 90-99% (2) 65-75%

(3) 5-15% (4) 1-5%

Q.211 DNA is not present in - **[DELHI PMT '83, RPMT' 89]**

(1) Mitochondria (2) Chloroplast

(3) Bacteriophage (4) TMV

Q.212 A nucleic acid contains thymine or methylated uracil then it should be - **[BHU' 81]**

(1) DNA

(2) RNA

(3) Either DNA or RNA

(4) RNA of bacteria

Q.213 Prokaryotic genetic system contains - **[RPMT' 85]**

(1) DNA & histones

(2) RNA & histones

(3) Either DNA or histones

(4) DNA but no histones

Q.214 DNA histone complex can be removed from chromosome by treatment with -**[JIPMER -85]**

(1) 6 M NaCl + Mg [OH]2

(2) 1 M , NaCl

(3) Mg [OH]2

(4) Non-Separable

Q.215 Genetic information is carried by the long chain molecules which are made up of- **[BANGALORE PMT' 85]**

(1) Amino acids (2) Nucleotides

(3) Chromosomes (4) Enzymes

Q.216 A N2-base together with pentose sugar and phosphate forms (or) building-block unit of nucleic acid is - **[MPPMT' 85; ALIGARH PMT' 86]**

(1) Nucleoside (2) Polypeptide

(3) Nucleotide (4) Aminoacid

Q.217 One of the characteristics of DNA is - **[DELHI PMT' 84]**

(1) Uracil (2) Deoxyribose sugar

(3) Single strandedness

(4) Ability of protein synthesis

Q.218 What replaces thymine in RNA - **[AIPMT' 81, ALLMS' 82, BHU' 85]**

(1) Guanine (2) Adenine

(3) Uracil (4) Water

Q.219 Purine bases of DNA are - **[AIPMT' 83, 89, RPMT' 92]**

(1) U & G (2) A & G

(3) A & C (4) None

Q.220 Which of the following N2 bases are pyrimidines **[RPMT' 89]**

(1) T & C (2) T & A

(3) A & C (4) G & T

Q.221 Which of the following is not a pyrimidine N_2 base - **[JIPMER' 85]**

(1) Thymine (2) Cytosine

(3) Guanine (4) Uracil

Q.222 The base sequence of nucleic acid is AGG, GGA, CGA, CCA from this it can be inferred that it is a segment of - **[RPMT' 90]**

(1) DNA (2) m-RNA

(3) t-RNA (4) Data insufficient

Q.223 Kinds of N2 bases in nucleic acids are - **[AIPMT' 81, 84, 90]**

(1) Three (2) Four

(3) Five (4) Eight

Q.224 The purine & pyrimidine pairs of complementry strands of DNA are held together by - **[AIPMT' 80]**

(1) H-bonds (2) Q-bonds

(3) C-bonds (4) N-bonds

Q.225 Which purine & pyrimidine bases are paired together by H-bonds in DNA- **[BHU' 85]**

(1) AC & GT (2) GC & AT

(3) GA & TC (4) None of the above

Q.226 Watson & crick proposed the model of DNA structure in - **[AIPMT' 85]**

(1) 1953 (2) 1943

(3) 1955 (4) 1963

Q.227 A single stranded DNA is present in - **[AIPMT 80; ALLM'86, MPPMT'90]**

(1) TMV (2) Salmonella

(3) Coliphage $\phi \times 174$ (4) Bacteria

Q.228 What is the nature of the 2 strands of a DNA duplex - **[MPPMT'90]**

(1) Identical & Complimentary

(2) Antiparallel & complimentary

(3) Dissimilar & non complimentary

(4) Antiparallel & none complimentary

Q.229 DNA Replication occurs at - **[RPMT' 85; MP PMT'85]**

(1) Go & G-1 (2) G2 -stage

(3) S-Stage (4) Mitotic phase

Q.230 RNA synthesis is controlled by - **[AIPMT-89]**

(1) Rho-factor (2) Sigma factor

(3) Endo-nuclease (4) RNA-polymerase

Q.231 Duplication of DNA is called -**[AFMC;82, 84]**

(1) Replication (2) Transduction

(3) Transcription (4) Translation

Q.232 DNA polymerase enzyme is required for the synthesis of - **[BHU 87]**

(1) DNA From DNA (2) DNA from RNA

(3) Both the above

(4) DNA from nucleosides

Q.233 Ligase enzyme is used for - **[BHU' 85]**

(1) Denaturation of DNA

(2) Spliting DNA into small bits

(3) Joining bits of DNA

(4) Digestion of lipids

Q.234 In the base sequence of one strand of DNA is GAT, TAG, CAT, GAC what shall be the sequence of its complementary stand - **[AIMPT-90; MP PMT'90]**

(1) CAT, CTG, ATC, GTA

(2) GTA, ATC, CTG, GTA

(3) ATC, GTA, CTG, GTA

(4) CTA, ATC, GTA, CTG

Q.235 In the base sequence of one starand of DNA is CAT, TAG, CAT, CAT, GAC what would be the base sequence of its complementary m-RNA- **[AFMC' 82]**

(1) GUA, GUA, CUG, AUC, CUG

(2) AUG, CUG, CUC, GUA, CUG

(3) GUA, AUC, GUA, GUA, CUG

(4) GUC, CUG, CUG CUA, CUU

Q.236 A DNA strand is directly involved in the synthesis of all the following except - **[AIIMS' 81,85]**

(1) Another DNA (2) t-RNA & m-RNA

(3) r-RNA (4) Protein

Q.237 Strongest evidence that DNA is genetic material comes from - **[AIPMT 85; MP.PMT 84]**

(1) Chromosomes contain DNA

(2) Transformation of bacterial cells

(3) DNA is present in nucleus

(4) DNA is not present in cytoplasm

Q.238 Genetic code was discovered by - **[BHU 87]**

(1) Nirenberg & Mathei

(2) Kornberg & Crick

(3) Khorana & Kornberg

(4) Gamow

Q.239 Genetic code was deciphered by chemically synthesizing the trinucleotides by - **[MP PMT 90]**

(1) Wastson & Crick (2) Beadle & Tatum

(3) Briggs & King (4) M.W. Nirenberg

Q.240 Nitrenberg synthesized an m-RNA containing 34 poly-Adenine (A-A-A-A-A-A…….) and found a polypeptide formed of 11 poly-lysine this proved that genetic code for lysine was - **[AIPMT-'90; RPMT'91]**

(1) one-adenine (2) A-A doublet
(3) A-A-A triplet (4) Many adenines

Q.241 64 Codons constitute genetic code because **[AIPMT 90]**

(1) There was 64 types of amino acid
(2) 64 types of t-RNA
(3) Genetic code is triplet
(4) There are 64 enzymes

Q.242 Degeneracy of genetic code was discovered by- **[BHU' 86]**

(1) Mc Clintock (2) Khorana
(3) Ochoa
(4) Baurnfield & Nirenberg

Q.243 Genetic code consists of - **[AIPMT' 88]**

(1) Adenine & Guanine
(2) Guanine & Cytosine
(3) Cytosine & uracil
(4) All

Q.244 Which codon gives signal for the start of polypeptide (protein) chain synthesis- **[AIIMS 86]**

(1) AUG (2) UGA
(3) GUA (4) UAG

Q.245 The function of non-sense codons is - **[AIIMS 85]**

(1) To release polypeptide chain from t-RNA
(2) To form an unspecified amino acid
(3) To terminate the massage of a gene controlled protein synthesis -
(4) To convert a sense DNA into non sense DNA

Q.246 Termination of chain growth in protein synthesis is brought about by - **[AIIMS' 83]**

(1) UUG, UGC, UCA (2) UCG, GCG, ACC
(3) UAA, UAG, UGA (4) UUG, UAG, UCG

Q.247 Genetic code determines - **[AIPMT' 83]**

(1) Structural pattern of an organism
(2) Sequence of amino acid in protein chain
(3) Variation in offsprings
(4) constancy of morphological trait

Q.248 Which of the following is employed in recombinant DNA technology - **[BHU' 87]**

(1) Plastids (2) Plasmids
(3) Ribosomes (4) Histones

Q.249 Fuelgen reaction is employed to establish the presence of - **[BHU' 83' AFMC'83'AIPMT'85]**

(1) DNA (2) RNA
(3) Protein (4) Lipids

Q.250 Chargaff 's' rule is given as - **[RPMT 1998]**

(1) Purines Pyrimidines
(2) A + G = T + C
(3) A + U = G + C
(4) A + T/G +C = Constant

Q.251 In RNA, Nucleotides are bonded by - **[RPMT 1998]**

(1) H - bonds
(2) Phospo diester bonds
(3) Ionic bonds
(4) Salt linkage

Q.252 m-RNA is attached with - **[RPMT 1997]**

(1) E.R. (2) Ribosome
(3) Nucleus (4) Lysosome

Q.253 DNA of E.COLI - **[AIPMT 1998]**

(1) ds circular (2) ss circular
(3) ds linear (4) ss linear

Q.254 Knife of DNA is - **[AIPMT 1998]**

(1) DNA ligase
(2) Restriction endonuclease
(3) Exonuclease (4) Peptidase

Q.255 Segments of DNA which can move in genome- **[AIPMT 1998]**

(1) Introns (2) Exons
(3) Transposons (4) Cistrons

Q.256 Transcription means synthesis of - **[MP PMT 1998]**

(1) DNA (2) Protein
(3) m-RNA (4) Enzyme

Q.257 A nucleoside differs from a nucleotide is not having - **[MP PMT 1998]**

(1) Phosphate (2) Sugar
(3) Phosphate & sugar (4) Nitrogen base

Q.258 Wilkins X-ray diffraction showed the diameter of the DNA helix is - **[MP PMT 1998]**

(1) 10 Å (2) 20 Å

(3) 30 Å (4) 40 Å

Q.259 DNA fingerprinting method is very useful for - **[MP PMT 1998]**

(1) DNA tests for identity & relation ships

(2) Forensic studies

(3) Polymorphism

(4) All of the above

Q.260 A sequence of three consecutive bases in a t-RNA molecule which specifically binds to a complementary codon sequence in m- RNA is known as - **[MP PMT 1998]**

(1) Triplet (2) Non - sense codon

(3) Anti codon (4) Termination codon

Q.261 Number of base pairs in human chromosomes - **[AIPMT -99]**

(1) 3×10^9 (2) 3×10^7

(3) 6×10^8 (4) 6×10^7

Q.262 Gene composed of - **[AIPMT -99]**

(1) Amino acids (2) Polynucleotide

(3) Fatty acid (4) Nitrogen bases

Q.263 Function of Nucleases - **[AIPMT - 99]**

(1) Break the polynucleotide chain by breaking the each terminal nucleotide

(2) Breaks phosphodiester bond

(3) Breaks peptide bonds

(4) Breaks ester bonds

Q.264 Molecular wight of DNA in yeast is - **[AIPMT - 99]**

(1) 2.56×10^9 (2) 0.5×10^9

(3) 7×10^7 (4) 6×10^6

Q.265 Similarity in DNA and RNA - **[AIPMT-2000]**

(1) Both are polymer of nucleotides

(2) Both have similar pyrimidine

(3) Both have similar sugar

(4) Both are genetic material

Q.266 Length of one loop of B-DNA- **[AIPMT - 2000]**

(1) 3.4 nm. (2) 0.34 nm.

(3) 20 nm. (4) 10 nm.

Q.267 ATP is - **[AIPMT - 2000]**

(1) Nucleotide (2) Nucleoside

(3) Nucleic acid (4) Vitamin

Q.268 In three dimensional view the molecule of t-RNA is - **[AIPMT - 2000]**

(1) L-shaped (2) S-shaped

(3) Y-shaped (4) E-shaped

Q.269 Which of the following is initiation codon - **[AIPMT - 2000]**

(1) UAG (2) AUC

(3) AUG (4) CCU

Q.270 Method of DNA replication in which two strands of DNA separates and synthesize new strands- **[AIPMT - 2000]**

(1) Dispersive (2) Conservative

(3) Semiconservative (4) Non conservative

Q.271 In which stage of cell cycle, DNA replication occurs- **[AIPMT - 2000]**

(1) G1 - phase (2) S - phase

(3) G2 - phase (4) M - phase

Q.272 Extranuclear DNA is found in - **[AIPMT - 2000]**

(1) Lysosome and chloroplast

(2) Chloroplast and mitochondria

(3) Mitochondria and lysosome

(4) Golgi body and E.R.

Q.273 Which one of the following triplet codes, is correctly matched with its specificity for an amino acid in protein synthesis or as start or stop codon - **[AIPMT - 2003]**

(1) UCG - Start (2) UUU - Stop

(3) UGU - Leusine (4) UAC - Tyrosine

Q.274 During translation initiation in prokaryotes, a GTP molecule is needed in - **[AIPMT - 2003]**

(1) Formation of formyl-met-tRNA

(2) Binding of 30 S subunit of ribosome with mRNA

(3) Association of 30 S-mRNA with formyl-met RNA

(4) Association of 50 S subunit of ribosome with initiation complex

Q.275 In recent years, DNA sequences (nucleotide sequence) of mt-DNA and Y chromosomes were considered for the study of human evolution because- **[AIPMT - 2003]**

(1) They are small, and therefore, easy to study

(2) They are uniparental in origin and do not take part in recombination

(3) Their structure is known in great detail

(4) They can be studied from the samples of fossil remains

Q.276 Degeneration of a genetic code is attributed to the - **[AIPMT - 2003]**

(1) First member of a codon

(2) Second member of a codon

(3) Entire codon

(4) Third member of a condon

Q.277 What would happen if in a gene encoding a polypeptide of 50 amino acids, 25th codon (UAU) is mutated to UAA- **[AIPMT - 2003]**

(1) A polypeptide of 24 amino acids will be formed

(2) Two polypeptides of 24 and 25 amino acids will be formed

(3) A polypeptides of 49 amino acids will be formed

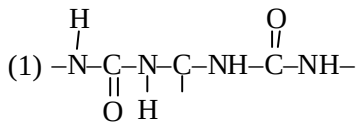
(4) A polypeptide of 25 amino acids will be formed

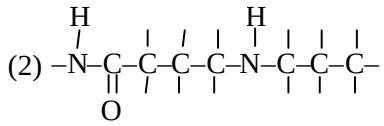
Q.278 During transcription, the DNA site at which RNA polymerase binds is called - **[AIPMT - 2003]**

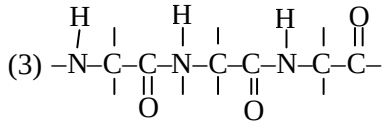
(1) Promoter (2) Regulator

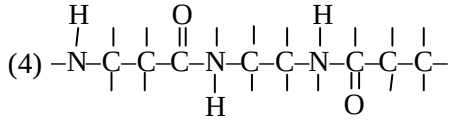
(3) Receptor (4) Enhancer

Q.279 Which of the following structures represents the peptide chain? **[AIPMT - 2004]**

(1) 

(2) 

(3) 

(4) 

Q.280 Which one of the following is a chain growth polymer ? **[AIPMT - 2004]**

(1) Starch (2) Nucleic acid

(3) Polystyrene (4) Protein

Q.281 The correct statement in respect of protein haemoglobin is that it - **[AIPMT - 2004]**

(1) functions as a catalyst for biological reactions

(2) maintains blood sugar leval

(3) acts as an oxygen carrier in the blood

(4) forms antibodies and offers resistance to diseases.

Q.282 Number of chiral carbons in β-D-(+) - glucose is - **[AIPMT - 2004]**

(1) five (2) six

(3) three (4) four

Q.283 The helical structure of proteins is stabilized by- **[AIPMT - 2004]**

(1) dipeptide bonds (2) hydrogen bonds

(3) ether bonds (4) peptide bonds

Q.284 Chemically hormones are **[AIPMT - 2004]**

(1) Biogenic amines only

(2) Proteins, steroids and biogenic amines

(3) Proteins only

(4) Steroids only

Q.285 In a mutational event, when adenine is replaced by guanine, it is case of - **[AIPMT - 2004]**

(1) Frameshift mutation

(2) Transcription

(3) Transition (4) Transversion

Q.286 In which one of the following enzymes, is copper necessarily associated as an activator ? **[AIPMT - 2004]**

(1) Carbonic anhydrase

(2) Tryptophanase

(3) Lactic dehydrogenase

(4) Tyrosinase

Q.287 During transcription, if the nucleotide sequence of the DNA strand that is being coded is ATACG, then the nucleotide sequence in the mRNA would be - **[AIPMT - 2004]**

(1) TATGC (2) TCTGG

(3) UAUGC (4) UATGC

Q.288 Which one of the following hormones is a modified amino acid ? **[AIPMT - 2004]**

(1) Epinephrine (2) Progesterone

(3) Prostaglandin (4) Estrogen

Q.289 The most abundant element present in the plants is - **[AIPMT - 2004]**

(1) Carbon (2) Nitrogen

(3) Manganese (4) Iron

Q.290 The following ratio is generally constant for a given species - **[AIPMT - 2004]**

(1) A + G /C + T (2) T + C / G + A

(3) G + C /A + T (4) A +C / T + G

Q.291 Which form of RNA has a structure resembling clover leaf ? **[AIPMT - 2004]**

(1) rRNA (2) hnRNA

(3) mRNA (4) tRNA

Q.292 After a mutation at a genetic locus the character of an organism chages due to the change in - **[AIPMT - 2004]**

(1) protein structure (2) DNA replication

(3) protein synthesis pattern

(4) RNA transcription pattern

Q.293 During replication of a bacterial chromosome DNA synthesis starts from a replication origin site and - **[AIPMT - 2004]**

(1) RNA primers are involved

(2) is facilitated by telomerase

(3) moves in one direction of the site

(4) moves in bi-directional way

Q.294 A sequence of how many nucleotide in messenger RNA makes a codon for an amino acid ? **[AIPMT - 2004]**

(1) Three (2) Four

(3) One (4) Two

Q.295 Which one of the following pairs is correctly matched with regard to the codon and the amino acid coded by it - **[AIIMS - 2004]**

(1) UUU-Valine (2) AAA-Lysine

(3) AUG-Cysteine (4) CCC-Alanine

Q.296 DNA is present in - **[AIIMS - 2004]**

(1) Chromosomes and dictyosome

(2) Chloroplast and lysosomes

(3) Mitochondria and chloroplasts

(4) Mitochondria and endoplasmic reticulum.

Q.297 Which of the following is the simplest amino acid- **[AIPMT - 2005]**

(1) Alanine (2) Asparagine

(3) Glycine (4) Tyrosine

Q.298 Enzymes, vitamins and hormones can be classified into a single category of biological chemicals, because all of these - **[AIPMT - 2005]**

(1) Are exclusively synthesized in the body of a living organism as at present

(2) Enhance oxidative metabolism

(3) Are conjugated proteins

(4) Help in regulating metabolism

Q.299 Which one of the following makes use of RNA as a template to synthesize DNA - **[AIPMT - 2005]**

(1) DNA dependant RNA polymerase

(2) DNA polymerase

(3) Reverse transcriptase

(4) RNA polymerase

Q.300 Nuclotides are building blocks of nucleic acids. Each nucleotide is a composite molecule formed by - **[AIPMT - 2005]**

(1) Base-sugar-OH

(2) Base-sugar-phosphate

(3) Sugar-phosphate

(4) (Base-sugar-phosphate)

Q.301 Protein synthesis in an animal cell occurs- **[AIPMT - 2005]**

(1) On ribosomes present in cytoplasm as well as in mitochondria

(2) On ribosomes present in the nucleolus as well as in cytoplasm

(3) Only on ribosome attached to the nuclear envelope and endoplasmic reticulam

(4) Only on the ribosomes present in cytosol

Q.302 Which one of the following hydrolyses internal phosphodiester bonds in a polynucleotide chain- **[AIPMT - 2005]**

(1) Lipase (2) Protease

(3) Exonuclease (4) Endonuclease

Q.303 Carbohydrates, the most abundant biomolecules on earth, are produced by- **[AIPMT - 2005]**

(1) Some bacteria, algae and green plant cells

(2) All bacteria, fungi and algae

(3) Fungi, algae and green plants cells

(4) Viruses, fungi and bacteria

Q.304 Production of a human protein in bacteria by genetic engineering is possible because **[AIPMT - 2005]**

(1) Bacterial cell can carry out the RNA splicing reactions

(2) The mechanism of gene regulation is identical in humans and bacteria

(3) The human chromosome can replicate in bacterial cell

(4) The genetic code is universal

Q.305 During transcription holoenzyme RNA polymerase binds to a DNA sequence and the DNA assumes a saddle like structure at that point. What is that sequence called- **[AIPMT - 2005, 07]**

(1) CAAT box (2) GGTT box

(3) AAAT box (4) TATA box

Q.306 Which functional group participates in disulphide bond formation in proteins - **[AIPMT - 2005]**

(1) Thioether (2) Thiol

(3) Thioester (4) Thiolactone

Q.307 Physical basis of life is - **[RPMT - 2005]**

(1) Cytoplasm (2) Protoplasm

(3) Nucleoplasm (4) Endoplasm

Q.308 Ribosomes are sites of which reaction- **[RPMT - 2005]**

(1) Respiration (2) Photosynthesis

(3) Protein synthesis (4) Fat synthesis

Q.309 In DNA purine nitrogen bases are - **[RPMT - 2005]**

(1) Uracil and Guanine

(2) Guanine and Adenine

(3) Adenine and cytosine

(4) None

Q.310 Which of the following diasaccharide gives two molecules of glucose on hydrolysis - **[RPMT - 2005]**

(1) Maltose (2) Lactose

(3) (1) and (2) both (4) Sucrose

Q.311 Which of the following is the example of acidic amino acid - **[RPMT - 2005]**

(1) Lysine (2) Glutamic acid

(3) Aspartic acid (4) (2) and (3) both

Q.312 Specificity of protein is due to - **[RPMT - 2005]**

(1) Types of amino acid

(2) Sequence of amino acid

(3) Number of amino acid

(4) Quantity of amino acid

Q.313 Bond between phosphate and sugar in a nucleotide is - **[RPMT - 2005]**

(1) H-bond

(2) Covalent bond

(3) Phosphodiester bond

(4) Sulphide bond

Q.314 The other name for glucose is -**[RPMT - 2005]**

(1) Grape sugar (2) Cane sugar

(3) Fructose (4) Galactose

Q.315 Which of the following is formed in nucleolus - **[RPMT - 2005]**

(1) r RNA (2) t RNA

(3) m-RNA (4) DNA

Q.316 Ribosomes are composed of **[RPMT - 2005]**

(1) DNA + Protein (2) DNA

(3) RNA + Protein (4) RNA + DNA

Q.317 The chemical in ovum which attracts sperms **[RPMT - 2005]**

(1) Fertilizin (2) Antifertilizin

(3) Agglutinin (4) Thrombin

Q.318 DNA probes are copied from the messenger RNA molecules with the help of - **[AIIMS - 2005]**

(1) Restriction enzymes

(2) Reverse transcriptase

(3) DNA polymerase

(4) Adenosine deaminase

Q.319 Which of the following biomolecule is insoluble in water - **[AIIMS - 2005]**

(1) α-Keratin (2) Haemoglobin

(3) Ribonuclease (4) Adenine

Q.320 Which one of the following statement is true for protein synthesis (translation) - **[AIIMS - 2005]**

(1) Amino acids are directly recognized by m-RNA

(2) The third base of the codon is less specific

(3) Only one codon codes for an amino acid

(4) Every t-RNA molecule has more than one amino acid attachment site

Q.321 Which antibiotic inhibits interaction between tRNA and mRNA during bacterial protein synthesis ? **[AIPMT - 2006]**

(1) Erthromycin (2) Neomycin

(3) Streptomysin (4) Tetracycline

Q.322 Amino acid sequence, in protein synthesis is decided by the sequence of -**[AIPMT - 2006]**

(1) tRNA (2) mRNA

(3) cDNA (4) rRNA

Q.323 One gene-one enzyme hypothesis was postulated by - **[AIPMT - 2006]**

(1) R.Franklin (2) Hershay and Chase

(3) A.Garrod (4) Beadle and Tatum

Q.324 One turn of the helix in a B-form DNA is approximately - **[AIPMT - 2006]**

(1) 20 nm (2) 0.34 nm

(3) 3.4 nm (4) 2 nm

Q.325 Antiparallel strands of a DNA molecule means that - **[AIPMT - 2006]**

(1) one strand turns anti-clockwise

(2) the phosphate group of two DNA stands, at their ends, share the same position

(3) the phosphate groups at the start of two DNA stands are in opposite position (pole)

(4) one strand turns clockwise

Q.326 The causative agent of mad-cow disease is - **[AIPMT - 2006]**

(1) Bacterium (2) Prion

(3) Worm (4) Virus

Q.327 During protein synthesis in an organism, at one point the process comes to a halt. Select the group of the three codons from the following from which any one of the three could bring about this halt- **[AIIMS - 2006]**

(1) UUU, UCC, UAU

(2) UUC, UUA, UAC

(3) UAG, UGA, UAA

(4) UUG, UCA, UCG

Q.328 Thymine is - **[AIIMS - 2006]**

(1) 5-Methyl uracil (2) 4-Methyl uracil

(3) 3-Methyl uracil (4) 1-Methyl uracil

Q.329 Molecular basis of organ differentiation depends on the modulation in transcription by **[AIPMT - 2007]**

(1) RNA polymerase (2) Ribosome

(3) Transcription factor

(4) Anticodon

Q.330 The Okazaki fragments in DNA chain growth - **[AIPMT - 2007]**

(1) Result in transcription

(2) Polymerize in the 3"-to5' direction and froms replication fork

(3) Prove semi-conservative nature of DNA replication

(4) Polymerize in the 5' to 3' direction and explain 3'-to-5' DNA replication

Q.331 The two polynucleotide chains in DNA are **[AIPMT - 2007]**

(1) Parallel (2) Discontinuous

(3) Antiparallel (4) Semiconservative

Q.332 About 98 percent of the mass of every living organism is composed of just six elements including carbon, hydrogen, nitrogen, oxygen and- **[AIPMT - 2007]**

(1) Phosphrous and sulphur

(2) Sulphur and magnesium

(3) Magnesium and sodium

(4) Calcium and phoshorus

Q.333 A plant requires magnesium for - **[AIPMT - 2007]**

(1) Holding cells together

(2) Protein synthesis

(3) Chlorophyll synthesis

(4) Cell wall development

Q.334 Polysome is formed by - **[AIPMT - 2008]**

(1) A ribosome with several subunits

(2) Ribosomes attached to each other in a linear arrangement

(3) Several ribosomes attached to a single mRNA

(4) Many ribosomes attached to a strand of endoplasmic recticulum

Q.335 Which one of the following pairs of nitrogenous bases of nucleic acids, is wrongly matched with the category mentioned against it ?
[AIPMT - 2008]
(1) Guanine, Adenine-Purines
(2) Adenine, Thymine-Purines
(3) Thymine, Uracil-Pyrimidines
(4) Uracil, Cytosine-Pyrimidines

Q.336 In the DNA molecule - **[AIPMT - 2008]**
(1) the proportion of Adenine in relation to thymine varies with the organism
(2) there are two stands which run antiparallel one in 5', 3' direction and other in 3', 5'
(3) the total amount of purine nucleotide and pyrimidine nucleotides is not always equal
(4) there are two strands which run parallel in the 5', 3' direction

Q.337 Which one of the following pairs of codons is correctly matched with their function or the signal for the particular amino acid ?
[AIPMT - 2008]
(1) AUG, ACG-Start/Methionine
(2) UUA, UCA-Leucine
(3) GUU, GCU-Alanine
(4) UAG, UGA-Stop

Q.338 What is antisense technology?
[AIPMT - 2008]
(1) When a piece of RNA that is complementry in sequence is used to stop expression of a specific gene
(2) RNA polymerase producing DNA
(3) A cell displaying a foreign antigen used for synthesis of antigens
(4) Production of somaclonal variants in tissue cultures

Q.339 What is not true for genetic code -
[AIPMT - 2009]
(1) It is unambigouous
(2) A codon in m RNA is read in a non-contiguous fashion
(3) It is nearly universal
(4) It is degenerate

Q.340 Removal of introns and joining the exons in a defined order in a transcription unit is called ?
[AIPMT - 2009]
(1) Capping (2) Splicing
(3) Tailing (4) Transformation

Q.341 Semiconservative replication of DNA was first demonstrated in - **[AIPMT - 2009]**
(1) Salmonella typhimurium
(2) Dropsophila melanogaster
(3) Escherichia coli
(4) Streptococcus pneumoniae

Q.342 Whose experiments cracked the DNA and discovered unequivocally that a genetic code is a "triplet" - **[AIPMT - 2009]**
(1) Beadle and tatum
(2) Nirenberg and Mathaei
(3) Hershey and Chase
(4) Morgan and Sturtevant

Q.343 If one strand of DNA has the nitrogenous base sequence as ATCTG, what would be the compiementary RNA strand sequence ?
[AIPMT Pre 2012]
(1) UAGAC (2) AACTG
(3) ATCGU (4) TTAGU

Q.344 A normal-visioned man whose father was colour-blind, marries a woman whose father was also colour-blind. They have their first child as a daughter. What are the chances that this child would be colour-blind ? **[AIPMT Pre 2012]**
(1) zero percent (2) 25%
(3) 50% (4) 100%

Q.345 F_2 generation in a Mendelian cross showed that both genotypic and phenotypic rations are same as 1 : 2 : 1. It represents a case of :
[AIPMT Pre 2012]
(1) Dihybrid cross
(2) Monohybrid cross with complete dominance
(3) Monohybrid cross with incomplete dominance
(4) Co-dominance

Q.346 Removal of RNA polymerase III from nucleoplasm will affect the synthesis of :
[AIPMT Pre 2012]
(1) hn RNA (2) m RNA
(3) r RNA (4) t RNA

Q.347 Which one of the following is not a part of a transcription unit in DNA?
[AIPMT Pre 2012]
(1) A terminator (2) A promoter
(3) The structural gene (4) The inducer

Q.348 A certain road accident patient with unknown blood group needs immediate blood transfusion. His one doctor friend at once offers his blood. What was the blood group of the donor ?

[AIPMT Pre 2012]

(1) Blood group AB (2) Blood group O

(3) Blood group A (4) Blood group B

Q.349 Removal of introns and joining of exons in a defined order during transcription is called :

[AIPMT Pre 2012]

(1) Inducing (2) Slicing

(3) Splicing (4) Looping

ANSWER KEY

EXERCISE- 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	4	4	3	3	2	2	2	2	1	4	4	2	1	3	4	4	3	3	4
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	3	3	3	3	1	1	4	1	3	4	2	3	2	4	2	2	2	4	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	4	1	3	2	4	4	2	2	1	4	4	1	4	1	2	4	3	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	1	2	2	4	2	4	3	2	1	1	2	1	2	4	1	3	1	4	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	3	4	1	1	1	1	2	1	3	4	1	1	2	2	2	4	2	2	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	4	3	1	1	4	3	2	3	2	4	3	4	1	2	3	3	3	1	3
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	1	2	3	1	4	4	2	3	4	4	1	1	2	2	4	2	4	2	3	1
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	3	2	3	1	2	4	4	3	1	2	3	2	2	2	3	2	1	3	4	3
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	2	4	1	1	1	2	2	1	1	2	3	3	4	1	2	4	4	2	3	4
Ques.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
Ans.	1	4	1	4	2	2	2	2	4	3	2	1	4	1	3	4	3	3	1	3
Ques.	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
Ans.	2	1	4	4	4	1	3	2	1,3	4	4	1	4	2	2	3	2	3	2	1
Ques.	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Ans.	3	4	3	1	2	1	3	2	3	4	1	3	3	4	3	4	2	1	4	3
Ques.	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
Ans.	3	4	4	1	3	3	2	2	1	2	2	2	1	2	3	3	1	2	4	3
Ques.	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
Ans.	1	2	2	1	1	1	1	1	3	3	2	2	4	3	2	4	1	1	3	3
Ques.	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
Ans.	3	1	2	2	3	4	3	1	1	3	4	1	4	1	2	3	3	4	3	2
Ques.	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
Ans.	1	4	1	4	4	2	2	3	2	1	4	2	2	1	1	3	1	2	1	2
Ques.	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
Ans.	2	2	4	3	3	2	3	1	3	4	3	1	3	3	2	2	4	1	2	2
Ques.	341	342	343	344	345	346	347	348	349											
Ans.	3	2	1	1	3,4	4	4	2	3											

Q.1 Which of the following terms represents a pair of contrasting factors of a character?
(1) Homozygous (2) Allele
(3) Heterozygous (4) Phenotypes

Q.2 Maize has ten pairs of chromosomes. How many linkage groups will be present, if all the genes are mapped?
(1) 20 (2) 5
(3) 40 (4) 10

Q.3 The complete set of chromOsome, inherited as a single unit from one parent, is known as
(1) Genome (2) Linkage
(3) Gene pool (4) Genotype

Q.4 Which of the following explains, how progeny can possess the combinations of traits that none of the parent possessed?
(1) Law of segregation
(2) Chromosome theory
(3) Law of independent assortment
(4) Polygenic inheritance

Q.5 The presence of continuous phenotypic variation in an F_2-generation suggests that a character is inherited by
(1) Gene linkage
(2) Epistasis
(3) Polygenic inheritance
(4) Recombination

Q.6 Colour blindness, in which all colours are perceived as gray, is termed as
(1) Monochromasia (2) Chromasia
(3) Dichromasia (4) All of these

Q.7 The daughters born to haemophilic father and normal mother could be
(1) Haemophilic (2) Normal
(3) Carrier (4) All of these

Q.8 Which of the following are famous for chromosome heredity?
(1) Morgan and Sutton
(2) Beadle and Tatum
(3) Bridges and Morgan
(4) Sutton and Boveri

Q.9 Polyploidy results in rapid formation of new species because of
(1) Isolation behaviour
(2) Genetic recombination
(3) Development of multiple sets of chromosomes
(4) Mutation therapy

Q.10 Cis-trans test is related with
(1) Crossing over (2) Mutation
(3) Genetic map (4) Heredity

Q.11 Which of the following is an example of sex-linked inheritance?
(1) Night-blindness (2) Anaemia
(3) Colour-blindness (4) Cretinism

Q.12 A pregnant woman, who has done amniocentesis test, finds an extra barr body in her embryo. The syndrome which is likely to be associated with embryo is
(1) Edward's syndrome
(2) Down's syndrome
(3) Klinefelter's syndrome
(4) Patau's syndrome

Q.13 Genes present on V-chromosome are called
(1) Polygenic gene (2) Basic gene
(3) Pleiotropic gene (4) Holandric gene

Q.14 The hexaploid wheat is obtained by
(1) Chromosomes map
(2) Hybridomas
(3) Hybridization (4) Both (2) & (3)

Q.15 In sweet peas, genes C and P are necessary for colour in flowers. The flowers are white in the absence of either or both the genes. What will be the percentage of coloured flowers in the offspring of the cross Ccpp × ccPp?
(1) 75% (2) 25%
(3) 100% (4) 50%

Q.16 Epistatic effect, in which the dihybrid cross 9 : 3 : 3 : 1 between AaBb × AaBb is modified as

(1) Interaction between two alleles of the same loci

(2) Dominance of one allete on another aHele of the same loci

(3) Interaction between two alleles of different loci

(4) Dominance of one allele on another allele of both loci

Q.17 When a tall and red flowered individual is crossed with a dwarf and white flowered individual, phenotype in the progeny is dwarf and white. What will be the genotype of tafl and red flowered individual?

(1) TtRr (2) TTrr

(3) TTRr (4) TtRR

Q.18 Distance between two linked genes upon a chromosome is measured in the unit as

(1) Ratio of crossing over between them

(2) Cross-over value

(3) Number of other genes between them

(4) Interferance value

Q.19 The genes, which are confined to differential region of V-chromosome only, are called

(1) Mutant (2) Autosomal

(3) Holandric (4) Sex-linked

Q.20 XO-chromosomal abnormality in human beings causes

(1) Turner's syndrome

(2) Down's syndrome

(3) Klinefelter's syndrome

(4) Jacob's syndrome

Q.21 The root cell of wheat plant has 42 chromosomes. What would be the number of chromosomes in the synergid cell?

(1) 21 (2) 7

(3) 28 (4) 14

Q.22 If a homozygous red-flowered plant is crossed with a homozygous white-flowered plant, the offsprings will be

(1) Half-white flowered

(2) Half red-flowered

(3) All white-flowered

(4) All red-flowered

Q.23 "Gametes are never hybrid". This is a statement of

(1) Law of dominance

(2) Law of independent assortment

(3) Law of segregation

(4) Law of random fertilisation

Q.24 Mendel was not able to say anything about recombination and crossing over because

(1) He did not have a large and strong microscope

(2) He chose only pure type

(3) Traits he chose, were not linked and present on different chromosomes or were far apart

(4) Traits he chose had no genes

Q.25 Albinism and phenylketonuria are disorders due to

(1) Recessive autosomal genes

(2) Dominant autosomal genes

(3) Recessive sex genes

(4) Dominant sex genes

Q.26 Which of the following is the best way to determine paternity?

(1) Protein analysis

(2) Chromosome counting

(3) DNA finger printing

(4) Gene counting

Q.27 A man has enlarged breasts, sparse hair on body and sex compliment as XXV. He then suffers from

(1) Down's syndrome

(2) Klinefelter's syndrome

(3) Edward's syndrome

(4) Turner's syndrome

Q.28 Gene which suppresses other gene's activity but does not lie on the same locus is called as

(1) Epistatic (2) Supplementary

(3) Hypostatic (4) Codominant

Q.29 Barr Body is found in the cytoplasm during

(1) Interphase in cell of female mammal

(2) Interphase in cell of male mammal

(3) Prophase in cell of female mammal

(4) Prophase in cell of male mammal

Q.30 The ratio in a dihybrid test cross between two individuals is given by

(1) 2: 1 (2) 1 : 2 : 1

(3) 3: 1 (4) 1 : 1 : 1 : 1

Q.31 A chromosome carrying the centromere at one of the ends is called

(1) Acentric (2) Acrocentric

(3) Telocentric (4) Metacentric

Q.32 One of the genes present exclusively on the X-chromosome in humans is concerned with .

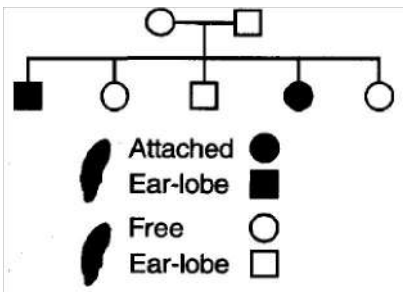
(1) Baldness

(2) Red-green colour blindness

(3) Facial hair/moustaches in males

(4) Night blindness

Q.33 Given below is a pedigree chart of a family with five children. It shows the inheritance of attached earlobes as opposed to the free ones. The squares represent the male individuals and circles the female individuals. Which one of the following conclusions drawn is correct?



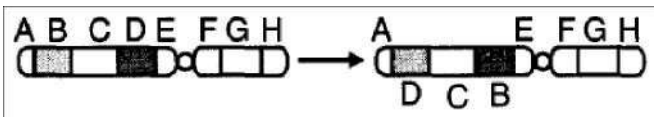
(1) The parents are homozygous recessive

(2) The trait is Y-linked

(3) The parents are homozygous dominant

(4) The parents are heterozygous

Q.34 Given below is a representation of a kind of chromosomal mutation. What is the kind of mutation represented?



(1) Deletion

(2) Duplication

(3) Inversion

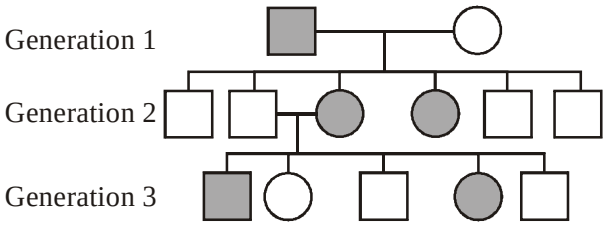
(4) Reciprocal translocation

Q.35 How many different types of gametes can be formed by F_1 progeny, resulting from the following cross : AA BB CC x aa bb cc?

(1) 3 (2) 8

(3) 27 (4) 64

Q.36 Given below is a pedigree chart showing the inheritance of a certain sex-linked trait in humans.



The trait traced in the above pedigree chart is

(1) Dominant X-linked

(2) Recessive X-linked

(3) Dominant V-linked

(4) Recessive V-linked

Q.37 Grain colour in wheat is determined by three pairs of polygenes. Following the cross AABBCC (dark colour) x aabbcc (light colour), in F_2 generation what proportion of the progeny is likely to resemble either parent?

(1) None

(2) Less than 5 percent

(3) One third (4) Half

Q.38 Primary source of allelic variation is

(1) Independent assortment

(2) Recombination

(3) Mutation (4) Polyploidy

Q.39 Which one of the following pair~ of features is a good example of polygenic inheritance?

(1) Human height and skin colour

(2) ABO blood group in humans and flower colour of Mirabi/is jalapa

(3) Hair pigment of mouse and tongue rolling in humans

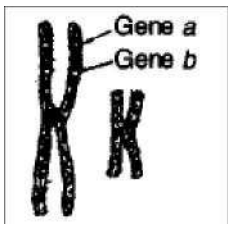
(4) Human eye colour and sickle cell anaemia

Q.40 Mating of an organism to a double recessive in order to determine whether it is homozygous or heterozygous for a character under consideration is called

(1) Reciprocal cross (2) Test cross

(3) Dihybrid cross (4) Back cross

Q.41 Given below is a highly simplified representation of the human sex chromosomes from a karyotype. The gene a and b could be of



(1) Colour blindness and body height

(2) Attached ear lobe and Rhesus blood group

(3) Haemophilia and red-green colour blindness

(4) Phenylketonuria and haemophilia

Q.42 Philadelphia chromosome is found in the patient suffering from

(1) Albinism

(2) Insomnia

(3) Myelocytic Leukaemia

(4) Hepatitis

Q.43 Nitrous acid causes mutation by

(1) Acting as a base analogue

(2) Addition of a base pair

(3) Hydrolysing base sugar linkage

(4) Removing amino group from the bases

Q.44 The "cri-du-char" syndrome is caused by change in chromosome structure involving

(1) Deletion (2) Duplication

(3) Inversion (4) Translocation

Q.45 Which one of the following combinations of the number of chromosomes is the correct representation of present day hexaploid wheat?

Combination	Monosomic		
Haploid	Nullisomic		
Trisomic			
(1) 21	28	42	43
(2) 7	28	40	42
(3) 21	7	42	43
(4) 41	21	40	43

Q.46 Which of the following are initiator codons?

(1) UGA and UAG (2) UUU and UUC

(3) AUG and GUG (4) UAA and UAG

Q.47 The jumping genes are called

(1) Cistrons (2) Mutons

(3) Transposons (4) Recons

Q.48 The new strand synthesised, in small pieces and then joined together during DNA replication, is called

(1) Dead strand (2) Lagging strand

(3) Leading stand (4) All of these

Q.49 Teminism is same as

(1) Transcription

(2) Translation

(3) Reverse transcription

(4) DNA synthesis

Q.50 Which of the following is not required for protein synthesis?

(1) t-RNA (2) r-RNA

(3) m-RNA (4) None of these

Q.51 Which of the following RNAs picks up specific amino acid from amino acid pool in the cytoplasm to ribosome during protein synthesis?

(1) t-RNA (2) m-RNA

(3) r-RNA (4) All of these

Q.52 If one strand of DNA has the nitrogenous base sequence ATGCTTGA, the sequence in the complementary strand will be

(1) TAGGTAGT (2) TACGTACT

(3) TACGAACT (4) TCCGAACT

Q.53 Restriction endonucleases are utilised in genetic engineering as
(1) Molecular scalpels for cutting DNA at specific sites
(2) Molecular builder of nucleotides
(3) Molecular degradation to DNA break up
(4) Molecular cement for combining DNA bits into long chains

Q.54 Extranuclear genes occurs in
(1) Plastids - and not inherited
(2) Plasmid - and not inherited
(3) Mitochondria - and inherited by female
(4) Mitochondria - and inherited by male

Q.55 In RNA thymine is replaced by
(1) Uracil (2) Adenine
(3) Methyl uracil (4) Guanine

Q.56 A point mutation comprising the substitution of a 63. purine by pyrimidine is called
(1) Transition (2) Translocation
(3) Deletion (4) Transversion

Q.57 Frameshift mutation occurs when
(1) Base is deleted
(2) Base is deleted or added
(3) Base is added
(4) Anticodons are not present

Q.58 Wobble hypothesis was given by
(1) R. W. Holley (2) M. Nirenberg
(3) H.G. Khorana (4) F.H.C. Crick

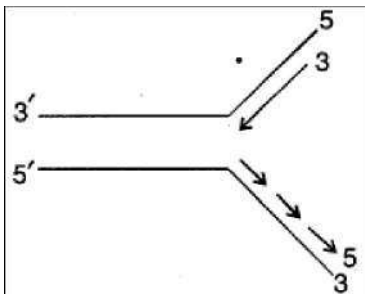
Q.59 Which one of the following pairs of terms / names mean one and the same thing?
(1) Gene pool - genome
(2) Codon - gene
(3) Cistron - triplet
(4) DNA fingerprinting - DNA profiling

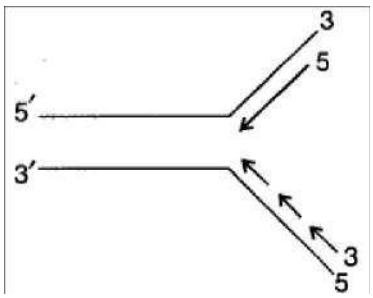
Q.60 What is false about tRNA?
(1) It binds with an amino acid at it 3' end
(2) It has double stranded regions
(3) It has a codon at one end which recognizes the anticodon on messenger RNA
(4) It looks like clover leaf in the two dimensional structure

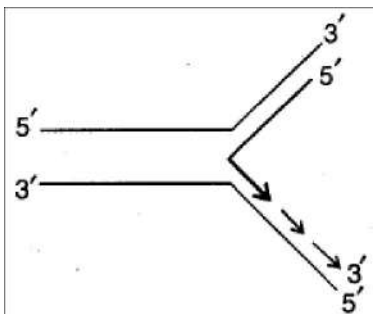
Q.61 Which one of the following codons codes for the same information as UGC?
(1) UGU (2) UGA
(3) UAG (4) UGG

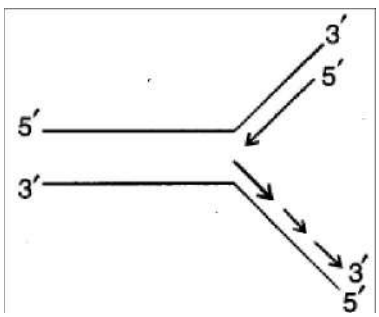
Q.62 The total number of nitrogenous bases in human genome is estimated to be about
(1) 3.5 million (2) 35 thousand
(3) 35 million (4) 3.1 billion

Q.63 Which one of the following correctly represents the manner of replication of DNA?

(1)


(2)


(3)


(4)


Q.64 What is the first step in the Southern Blot technique?
(1) Denaturation of DNA on the gel for hybridization with specific probe
(2) Production of a group of genetically identical cells
(3) Digestion of DNA by restriction enzyme
(4) Isolation of DNA from a nucleated cell such as the one from the scene of crime

Q.65 Which one of the following pairs is correctly matched with regard to the codon and the amino acid coded by it?

(1) UUA - valine (2) AAA - lysine

(3) AUG - cysteine (4) CCC - alanine

Q.66 cDNA probes are copied from the messenger RNA molecules with the help of

(1) Restriction enzymes

(2) Reverse transcriptase

(3) DNA polymerase

(4) Adenosine deaminase

Q.67 During protein synthesis in an organism at one point the process comes to a halt. Select the group of the three codons from the following, from which anyone of the three could bring about this halt,

(1) UUU, UCC, UAU

(2) UUC, UUA, UAC

(3) UAG, UGA, UAA

(4) UUG, UCA, UCG

Q.68 Which of the following correctly represents the flow of genetic information?

(1) DNA $\rightarrow$ RNA $\rightarrow$ protein

(2) RNA $\rightarrow$ DNA $\rightarrow$ protein

(3) RNA $\rightarrow$ protein $\rightarrow$ DNA

(4) Protein $\rightarrow$ RNA $\rightarrow$ DNA

INSTRUCTIONS FOR Q. NO. 69 TO 82

In the following questions (69 to 82), a statement of assertion (A) is followed by a statement of reason (R)

(1) If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark (1).

(2) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark (2).

(3) If Assertion is true statement but Reason is false, then mark (3).

(4) If both Assertion and Reason are false statements, then mark (4).

Q.69 **A :** Drosophila melanogaster is widely used in genetic research.

R : Drosophila melanogaster is readily available insect.

Q.70 **A :** In humans, the gamete contributed by the male determines whether the child produced will be male or female.

R : Sex in humans is a polygenic trait depending upon a cumulative effect of some genes on X-chromosome and some on Y-chromosome.

Q.71 **A :** A father may be a haemophilic only if his mother is carrier.

R : The father cannot pass on a sex-linked gene to his son.

Q.72 **A :** A single strand of m-RNA is capable of forming a number of polypeptide chains.

R : Tarmination codons occur in m-RNA.

Q.73 **A :** The non-allelic genes for red hair and freckles u) are usually inherited together.

R : The genes for red hair and freckles are located on same chromosome in close association.

Q.74 **A :** Chromosomal aberrations are caused by a break in the chromosome or itschromatid.

R : Duplication, deficiency, transversion and trans locations are the cause of chromosomal aberrations.

Q.75 **A :** 'Lac Operon Model' is applicable to E. coli.

R : E. coli. lacks a definite nucleus.

Q.76 **A :** Amber codon is a termination codon.

R : If in m-RNA, a termination codon is present, the protein synthesis stops abruptly whether the protein synthesis is completed or not.

Q.77 **A :** DNA codes are not copied in the synthesis of transfer RNA.

R : Transfer RNA move out of the nucleus and after attaching on the ribosomes, form the template.

Q.78 **A :** Watson and Crick provided experimental proof of semiconservative nature of DNA replication.

R : RNA polymerase binds nucleotides in replication.

Q.79 **A :** The mRNA attaches itself to the ribosome via its 3' and.

R : The mRNA has nucleotide and bases of lagging sequence.

Q.80 **A :** Replication and transcription occur in the nucleus but translation occurs in the cytoplasm.

R : mRNA is transferred from the nucleus into the cytoplasm where ribosomes and amino acids are available for protein synthesis.

Q.81 **A :** An organism with lethal mutation may not even develop beyond the zygote stage.

R : All types of gene mutations are lethal.

Q.82 **A :** Cancer cells are virtualy immortal untill the body in which they reside dies.

R : Cancer is caused by damage to genes regulating the cell division cycle.

ANSWER KEY

EXERCISE - 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	4	1	3	3	1	3	4	3	1	3	3	4	3	2	3	1	2	3	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	4	3	3	1	3	2	1	1	4	3	2	4	3	2	1	2	2	1	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	3	4	1	4	3	3	2	3	4	1	3	1	3	1	4	2	4	4	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	4	4	1	2	2	3	1	2	3	1	2	1	2	2	2	4	4	4	1
Ques.	81	82																		
Ans.	3	2																		

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first allempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

EXERCISE – 1

Q.1 Which of the following was not found in free state during origin of life-
(1) Ammonia (2) Methane
(3) Oxygen (4) Hydrogen

Q.2 Who gave experimental proof that hydrogen, methane, water and ammonia gave rise to amino acids-
(1) Stenley Miller (2) Charls Darwin
(3) Lamarck (4) Oparin

Q.3 Life originated in-
(1) Air (2) Earth
(3) Water (4) None of them

Q.4 Primitive atmosphere was made up of the mixture of-
(1) Oxygen, ammonia, methane, water
(2) Hydrogen, ammonia, methane, carbondioxide
(3) Hydrogen, steam, methane, ammonia
(4) Oxygen, methane, water, nickel

Q.5 Which compounds were formed in the direction of the origin of life-
(1) Urea, nucleic-acid (2) Urea, amino-acid
(3) Proteins, nucleic-acid
(4) Protein, amino-acid

Q.6 There was no life in-
(1) Mesozoic period (2) Cambrian period
(3) Palaeozoic period (4) Azoic period

Q.7 Pasteur gave-
(1) Cellular theory
(2) Recapitulation theory
(3) Germ theory of disease
(4) Germplasm theory

Q.8 Life originated-
(1) 8 billion years ago
(2) 6 billion years ago
(3) 3 billion years ago
(4) 1 billion years ago

Q.9 Stanley Miller synthesized in his experiment-
(1) Virus (2) Protein
(3) Amino acid (4) Cell

Q.10 What is found in bacteriophage-
(1) Nucleoprotein (2) DNA
(3) Carbon & nitrogen
(4) Protein

Q.11 Nucleoproteins gave first sign of-
(1) Species (2) Evolution
(3) Life (4) None

Q.12 What is most important for origin of life-
(1) Carbon (2) Oxygen
(3) Water (4) Nitrogen

Q.13 Miller synthesised simple amino-acid from-
(1) Methane, ammonia, oxygen, nitrogen
(2) Hydrogen, methane, ammonia, water
(3) Ammonia, methane, carbon dioxide, oxygen
(4) Hydrogen, oxygen, water, nitrogen

Q.14 Origin of life took place in which of the following period-
(1) Mesozoic (2) Proterozoic
(3) Precambrian (4) Devonian

Q.15 In which group one-celled animals and plants have been included-
(1) Protozoa (2) Monera
(3) Protista (4) Prokaryota

Q.16 Pasteur succeeded in disproving the theory of spontaneous generation because-
(1) The laboratory was clean
(2) He pulled out the neck of flask into a tube
(3) He was lucky
(4) Yeast used in flask were dead

Q.17 Spallanzani's experiment proved-
(1) Air is necessary for spontaneous generation
(2) Air from outside while entering the flasks carried small bacteria
(3) Air is unnecessary for spontaneous generation
(4) The contents of flask could not be boiled properly

Q.18 Believers of spontaneous generation theory believed that-
(1) Life originated from other similar organisms or spontaneously
(2) Life originated only spontaneously from non living material
(3) Life originated from similar organisms
(4) Life originated from air

Q.19 What it is necessary to boil instruments-
(1) For the comfort of patient
(2) To kill bacteria of operation theatre
(3) To kill bacteria on instruments
(4) For the comfort of doctor

Q.20 Life is not found on moon because of-
(1) Absence of carbon
(2) Absence of water
(3) Absence of nitrogen
(4) None of them

Q.21 Now the basis of origin of life is-
(1) Spontaneous generation
(2) God's desire
(3) Sunlight on garbage
(4) Chemical change

Q.22 Oxygen in atmosphere has been formed by-
(1) Evaporation of water
(2) Photosynthesis of plants
(3) Metabolism of microorganisms
(4) Decaying organisms

Q.23 Atmospheric carbon dioxide comes from-
(1) Action of microorganisms
(2) Smoke of industries
(3) Respiration of organisms
(4) Forest fire

Q.24 Primitive atmosphere was reducing because-
(1) Hydrogen atoms were few
(2) Hydrogen atoms were active and in greater numbers
(3) Nitrogen atoms were more
(4) Oxygen atoms were more

Q.25 Stage between living and non-living-
(1) Euglena (2) Bacteria
(3) Virus (4) Protista

Q.26 Who called larger colloidal particles of primitive sea as coacervates-
(1) Fox (2) Oparin
(3) Ampedocles (4) Haldane

Q.27 Who called water of primitive sea as pre biotic soup-
(1) Haldane (2) Oparin
(3) Fox (4) Huxley

Q.28 Who discovered virus-
(1) Stanley (2) Iwanovsky
(3) Fox (4) Ampedocles

Q.29 On the basis of karyon differentiation is carried out between-
(1) Protista and Monera
(2) Enaima and Anaima
(3) Prokaryota and Eukaryota
(4) None

Q.30 Oparin's Theory is based on-
(1) Artificial synthesis
(2) Spontaneous generation
(3) God's will
(4) All

Q.31 What is the basis of life-
(1) Proteins (2) Nucleic acids
(3) Nucleo proteins (4) Fatty acids

Q.32 Which biologist gave most logical biochemical theory of origin of life-
(1) Urey (2) Oparin
(3) Stanley Miller (4) Haeckal

Q.33 Which of the following set is the best evidence for organic evolution –
(1) Homologous & vestigial organs
(2) Analogous & vestigial organs
(3) Homologous & analogous organs
(4) All of them

Q.34 Kiwi is found in –
(1) India (2) England
(3) South America (4) Newzealand

Q.35 Which of the following structure is a solid proof of organic evolution –
(1) Wings of birds and bats
(2) Jointed legs in Arthropoda and mammals
(3) Gill clefts in vertebrate embryos
(4) Excretory organs of earthworm and cockroach

Q.36 Archaeopteryx is a connecting link because –
(1) It possessed characters of reptiles and aves
(2) It had characters of reptiles and mammals
(3) It was a reptile not a bird
(4) It had characters of nonchordates and chordates

Q.37 Which of the following set in man includes vestigial organs –
(1) Coccyx, vermiform appendix and ear muscles
(2) Body hair, atlas vertebra and ear muscles
(3) Coccyx, wisdom tooth and patella
(4) Body hair, cochlea and vermiform appendix

Q.38 Galapago islands are connected with which scientist –
(1) Wallace (2) Lamarck
(3) Malthus (4) Darwin

Q.39 According to recapitulation theory –
(1) Every animal begins as an egg
(2) Damaged body parts are formed new
(3) Offsprings are like parents
(4) Ontogeny repeats phylogeny

Q.40 Branch of biology which deals with fossils –
(1) Ethology (2) Ecology
(3) Paleontology (4) Ornithology

Q.41 Theory of evolution is best explanation for –
(1) Variation of animals and plant species
(2) Matter, energy and life
(3) Excessive multiplication rate in animals
(4) Environment

Q.42 Which animal has become extinct rather recently –
(1) Dinosaur (2) Pterodactyl
(3) Mammoth (4) Dodo

Q.43 Which of the organs in man is not likely to become extinct soon –
(1) Wisdom tooth (2) Blind spot
(3) Hair (4) Ear muscles

Q.44 Theory of evolution is mainly concerned with–
(1) Spontaneous generation
(2) Theory of special creation
(3) Gradual change
(4) Conditions of environment

Q.45 Peripatus is connecting link between –
(1) Mollusca and Arthropoda
(2) Flat worms and annelida
(3) Annelida and arthropoda
(4) Reptilia & Mammalia

Q.46 Prototheria have developed from –
(1) Birds (2) Eutheria
(3) Amphibia (4) Reptilia

Q.47 According to Haeckel's biogenetic law –
(1) Development of individual metazoa shows embryonic characters of ancestors
(2) Ontogeny repeats phylogeny
(3) Germplasm is immortal
(4) Every organism is produced by its parents

Q.48 Homologous organs have –
(1) Similar origin and similar or dissimilar functions
(2) Dissimilar origin and structure
(3) Dissimilar origin and function
(4) Dissimilar origin and similar functions

Q.49 Which of the following set has analogous organs –
(1) Hands of man, monkey and kangaroo
(2) Wings of insects, birds and bats
(3) Hind limbs of grasshopper, horse and bat
(4) Mouthparts of cockroach, mosquito and honey bee

Q.50 Which of the following set has homologous organs–
(1) Wings of bird and bat
(2) Wing of bat and hand of man
(3) Wings of insect and bird
(4) Wings of butterfly, bird and bat

Q.51 Who was the first to explain recapitulation theory –
(1) Weismann
(2) Von baer and Haeckel
(3) Darwin (4) Malthus

Q.52 Which theory explains 'ontogeny repeats phylogeny'–
(1) Mutation theory
(2) Heredity
(3) Recapitulation theory
(4) Theory of natural selection

Q.53 Analogous organs are –
(1) Similar in function
(2) Similar in structure
(3) Non functional
(4) Similar both in structure and function

Q.54 Connecting link between protozoa and one–celled plants is –
(1) Paramecium (2) Euglena
(3) Amoeba (4) Trypanosoma

Q.55 Which bird can not fly –
(1) Stark (2) Emu
(3) Duck (4) Peacock

Q.56 Connecting link between annelida and Mollusca–
(1) Cuttle fish (2) Octopus
(3) Neopilina (4) Nautilus

Q.57 Change with desent is the basis of which theory–
(1) Recapitulation theory
(2) Oparin's theory
(3) Theory of organic evolution
(4) Cell theory

Q.58 If a particular animal has shelled eggs, hair and teats on the body and has cloaca, it may be a connecting link between –
(1) Reptiles and birds
(2) Birds and mammals
(3) Reptiles and mammals
(4) None of them

Q.59 Which of the following sets do not have homologous organs –
(1) Wings of mosquito and butterfly
(2) Wings of butterfly and bird
(3) Mouth parts of cockroach and butterfly
(4) Forelegs of horse and paddles and butterfly

Q.60 Who attempted to solve mechanism of evolution for the first time –
(1) Darwin (2) Lamarck
(3) Haeckel (4) Oparin

Q.61 Evolution is defined as –
(1) Progressive history of race
(2) History and development of race, with variation's
(3) History of race
(4) Development of race

Q.62 Under which of the following conditions organic evolution could not have taken place –
(1) Acquired characters were not inherited
(2) Somatic variations were not inherited
(3) Individual in a population did not exhibit genetic virations
(4) All of them

Q.63 If a starfish possesses 6 arms instead of 5, it is an example of –
(1) Variation (2) Metamorphosis
(3) Biogenesis (4) Evolution

Q.64 Which represents a connecting link as an example of an evidence from comparative anatomy for organic evolution –
(1) Archaeopteryx between birds & mammals
(2) Java apeman between modern man and peking man
(3) Whale between fish and mammals
(4) Duck bill platypus between reptiles and mammals

Q.65 Life history of frog reflects evolution as shown by –
(1) Larva represents living fossil
(2) Phylogeny repeats ontogeny
(3) Ontogeny repeats natural selection
(4) Ontogeny repeats phylogeny

Q.66 Which of the following is the most primitive mammal–
(1) Spiny ant eater (2) Scaly ant eater
(3) Armadillo (4) All ancestors

Q.67 Primitive mammals providing evidence in organic evolution were found in —
(1) Africa (2) China
(3) India (4) Australia

Q.68 Fossilization can occur where –
(1) Animals are buried by natural process
(2) Animals are destroyed by scavangers
(3) Animals are eaten by predators
(4) Animals are destroyed by environmental conditions

Q.69 Why do we dig fossils and study them –
(1) To find new fossils that have not yet been recovered
(2) Fossil finding gives occupation to scientists
(3) Fossil fills the gaps in the evolution of animals of the post
(4) Fossils throw light on evolution of animals of the post

Q.70 Which of the following exhibit analogy –
(1) Paddles of whale and hands of man
(2) Wings of pigeon and wing of bat
(3) Wings of birds and wings of butterfly
(4) None

Q.71 Fossil X can be considered to have evolved earlier than fossil Y if –
(1) Y has vestigial structures that are homologous to functional structures in fossil X
(2) Y is structurally more complex than fossil X
(3) Y is in better state of preservation than X
(4) X is found in lower stratum of undisturbed sedimentary rock than Y

Q.72 Name of the scientist who gave Mutation theory-
(1) Wallace (2) Mathus
(3) Darwin (4) De Veries

Q.73 Darwin's Theory of Natural selection was based on-
(1) Inheritance of acquired characters
(2) Mutation
(3) Enormous rate of production in organism, struggle for existence and survival of the fittest
(4) Changes due to the use and disuse of organs

Q.74 What was the basic principle of Lamackism-
(1) Inheritance of acquired characters
(2) Survival of the fittest
(3) Natural selection
(4) Variations

Q.75 Book "Philosophie Zoologique" published in the year 1809 was written by-
(1) Darwin (2) Lamarck
(3) De Vries (4) Mendel

Q.76 Which scientist gave theory of continuity of Germplasm-
(1) Weismann (2) Mendel
(3) Lamarck (4) Darwin

Q.77 Which scientist gave the initial idea of survival of the fittest-
(1) Wallace (2) Spencer
(3) Darwin (4) Mendel

Q.78 For organic evolution which theory was given by Lamarck-
(1) Inheritance of acquired characters
(2) Inheritance of vestigial organs
(3) Inheritance of mutant characters
(4) Inheritance of characters from parents to offsprings

Q.79 New breeds of domestic dogs are developed by-
(1) Sexual selection (2) Natural selection
(3) Youth selection (4) Artificial selection

Q.80 Adaptation of organism is its-
(1) Moulting (2) Metamorphosis
(3) Inheritable trait (4) Acquired character

Q.81 Darwin explained origin of species through-
(1) Hybridization (2) Mutation
(3) Acquired characters (4) Natural selection

Q.82 The ship on which Darwin worked as naturalist was-
(1) Beagle (2) Century
(3) Seagel (4) Norway

Q.83 There would be no evolution if-
(1) The inheritance of acquired characters did not take place
(2) Somatic variation were not inheritable
(3) Genic variations were not found among members of population
(4) Somatic variations would not transforms into genic variations

Q.84 The book "Origin of Species" was published in the year-
(1) 1956 (2) 1809
(3) 1859 (4) 1844

Q.85 Who gave theory of Natural Selection-
(1) Charles Darwin (2) Lamarck
(3) Malthus (4) De Vries

Q.86 Which principle is associated with Darwin-
(1) Every cell is produced by a pre-exiting cell
(2) Survival of the fittest in the struggle for existence
(3) Inheritance of acquired characters
(4) Gamete receives only one of the contrasting characters

Q.87 If population of a species is transferred to more suitable environment then it will show-
(1) Protection against enemies
(2) More individuals would survive
(3) Rate of reproduction increases
(4) Unlimited food would be available

Q.88 The weakest point of Darwinism was that it had no explanation for-
(1) Struggle for existence
(2) Survival of the fittest
(3) Variations
(4) Enormous rate of production

Q.89 Snakes do not have legs because-
(1) Legs are lost during their entery in tunnels
(2) Legs are lost during evolution
(3) Ancestor of reptiles did not have legs
(4) There are no legs in lizards

Q.90 Which of the following facts develop suspicions in Lamarckism-
(1) Human female are not born with bored ear pinna although they have been bored thousand of years
(2) Giraffe has long neck to eat leaves of tall trees
(3) A stag can run fast to protect against the enemies
(4) None of them

Q.91 To be successful in evolution a mutation must occur in-
(1) Plasma proteins (2) Somatoplasm DNA
(3) Germplam DNA (4) RNA

Q.92 Of the following changes involved which one is irrelevant in the evolution of man-
(1) Change of diet form hard nuts and hard roots to soft food
(2) Loss of tail
(3) Perfection of hand for tool making
(4) Increase in the ability to communicate with other and develop community behavior

Q.93 One of the revolutionary concepts in biology was Charles Darwin's 'Origin of species' it deals with-
(1) Gene mutation
(2) Use and disuse of organs
(3) Germplasm theory
(4) Natural selection leading to the survival of the fittest

Q.94 Initiating force of evolution is-
(1) Natural selection (2) Mutation
(3) Adaptation (4) None of them

Q.95 What is the ultimate source of organic evolution-
(1) Mutation
(2) Sexual selection
(3) Natural selection
(4) Inheritance of acquired characters

Q.96 While explaining theory of Natural selection, Darwin was influenced by-
(1) Essay on population by Malthus
(2) Cell theory
(3) Mendel's Laws of inheritance
(4) None of them

Q.97 The concept of sudden genetic change which breeds true in a species is represented as-
(1) Inheritance of acquired characters
(2) Natural selection
(3) Laws of inheritance
(4) Mutation

Q.98 Mutations are mainly responsible for-
(1) Increasing population rate
(2) Maintaining genetic continuity
(3) Variation in organisms
(4) Extinction of organisms

Q.99 Mutations can be artificially induced by-
(1) Radiations (2) Chemical
(3) None of them (4) Both of them

Q.100 Mutation rate can be increased by-
(1) Exposing the individuals to sun
(2) Exposing individual to X-rays
(3) Giving nutritional changes to indiduals
(4) Increasing rate of reproduction

Q.101 Most of the natural mutations are-
(1) Useful (2) Harmful
(3) Neutral (4) Semilethal

Q.102 Mutation develops due to-
(1) Nutritional factor
(2) Infection of micro-organism
(3) Drugs
(4) Abrupt changes in genes

Q.103 Cause of mutation-
(1) Changes in DNA
(2) Changes in chromosomes
(3) Changes in gene (4) All of them

Q.104 Mutations are-
(1) Inheritable changes
(2) Changes which are not inheritable
(3) Changes acquired during life time of an individual
(4) Changes which may or may not be inheritable

Q.105 In the population of a species chances of the spreading of a mutant gene increases when it is-
(1) Recessive
(2) Natural selection occurs
(3) Dominant
(4) Neither dominant nor recessive

Q.106 We can not mutate particular gene because-
(1) Genes are very small and can not be seen under light microscope
(2) It is very expensive to do so
(3) Genes are situated on chromosomes
(4) We do not yet know how to exactly do it

Q.107 Which theory explains pure breeding and abrupt inheritable changes-
(1) Theory of inheritance of acquired characters
(2) Natural selection
(3) Mutation theory
(4) Theory of continuity of germplasm

Q.108 Discontinuous variations are-
(1) Acquired characters
(2) Essential factors
(3) Mutations
(4) Non essential factors

Q.109 Chances of inheritance and evolutionary changes are more in such species which reproduce by-
(1) Parthenogenesis
(2) Fission
(3) Sexual reproduction
(4) Asexual reproduction

Q.110 Mutation theory to explain mechanism of evolution was given by Hugo de Vries and he experiment on the-
(1) Garden pea (2) Fruit fly
(3) China rose (4) Evening primrose

Q.111 Which of the following is responsible for evolution according to Neo-Darwinism-
(1) Mutation
(2) Natural selection
(3) Mutation and Natural selection
(4) Either (1) or (2)

Q.112 A scientist kept 72 generations of Drosophila in darkness even after that the flies had normal eyes, this disproves the law of-
(1) Synthetic theory (2) Natural selection
(3) Use and disuse theory
(4) Acquired characters are inherited

Q.113 The ultimate source of organic variation is-
(1) Mutation (2) Sexual reproduction
(3) Natural selection (4) Hormonal action

Q.114 Which is the most important factor for evolution of new species-
(1) Geographic isolation
(2) Extensive in breeding
(3) Extensive out breeding
(4) None

Q.115 Which is a correct match-
(1) Darlington - DNA replication
(2) Mendel - Mutation
(3) Morgan - Father of genetics
(4) De Varies - Oenothera Lamarckiana

Q.116 Theory of continuity of germplasm was given by-
(1) Darwin (2) Larmarck
(3) Weismann (4) De Vries

Q.117 Gene pool is-
(1) Genotype of an individual of a population
(2) Different genes of all individual of a species found in an area
(3) Pool of artificially synthesised genes
(4) Genes of a genus

Q.118 Which of the following evidences does not favour the Lamarckian concept-
(1) Absence of limbs in snakes
(2) Presence of webbed toes in aquatic birds
(3) Melanization in peppered moth in industrial area
(4) Lack of pigment in cave dwelling animals

Q.119 Who wrote the book 'Genetics and origin of species which deals with synthetic theory of evolution –
(1) Dobzhansky (2) Haldane
(3) Mayr (4) De Vries

Q.120 The evolution of any species can be considered as sum total of the species with adaptive changes preserved by –
(1) Inheritance of acquired characters
(2) Isolation
(3) Natural selection (4) Mass conservation

Q.121 For evolution the most important requirement is–
(1) Natural selection
(2) Adaptation of acquired traits
(3) Variations
(4) Continuity of germplasm

Q.122 Use of atomic bombs may lead to abnormalities even in coming generations because of –
(1) Bodily changes
(2) Air pollution
(3) Changed atoms in atmosphere
(4) Genetic mutation

Q.123 Occurrence of 4 horns instead of two in goat is an example of –
(1) Continuous variation
(2) Discontinuous variation
(3) Inheritable variation
(4) Acquired variation

Q.124 Discontinuous variations are –
(1) Acquired character (2) Mutation
(3) Essential character (4) None of them

Q.125 Golden age of Dinosaurs was during
(1) Coenozoic era (2) Palaeozoic era
(3) Archeozoic era (4) Mesozoic era

Q.126 One field in which zoology and geology are closely connected-
(1) Palaeontology (2) Archeology
(3) Zoogeography (4) Morphology

Q.127 Fossils are dated by-
(1) Amount of calcium residues
(2) Amount of radioactive carbon compound
(3) Association with other mammals
(4) Structure of bones

Q.128 There was no life in which era-
(1) Mesozoic era (2) Palaeozoic era
(3) Coenozoic era (4) Azoic era

Q.129 What is sequence in the evolution of man-
(1) Fish → amphibian → bird → man
(2) Insect → fish → bird → man
(3) Fish → amphibian → reptile → man
(4) Fish→amphibians→reptiles→bird→man

Q.130 What helped reptiles to rule the earth for 10 million years-
(1) Large teeth
(2) Shelled eggs
(3) Stiff lungs
(4) External protective skeleton

Q.131 Which animals developed characters of mammals for the first time –
(1) Synapsid reptiles (2) Anapsid reptile
(3) Marsupials (4) Eutherians

Q.132 The name carboniferous period has been given because –
(1) Carbon was freely available in atmosphere
(2) Forests were buried under swamps forming anthracite
(3) Animals and plants started origin in this period
(4) Carbon and ferrous compounds were found in plenty

Q.133 What is the 'Age of Man' –
(1) Proterozoic (2) Recent
(3) Mesozoic (4) 100 years

Q.134 Age of fishes is the name of –
(1) Devonian period (2) Ordovician period
(3) Mesozoic era (4) Coenozoic era

Q.135 Rock mountain revolution took place after –
(1) Coenozoic era (2) Mesozoic era
(3) Paleozoic era (4) Proterozoic era

Q.136 Dinosaurs are –
(1) Primitive amphibians
(2) Extinct reptiles
(3) Giant mammals
(4) Primitive mammals

Q.137 Evolution of birds and mammals occured in –
(1) Eocene and oligocene periods
(2) Silurian and devonian periods
(3) Carboniferous and permian epochs
(4) Jurassic period

Q.138 The mesozoic era of earth is called the –
(1) Age of amphibians
(2) Age of armoured fishes
(3) Age of primitive man
(4) Age of ruling reptiles

Q.139 Study of fossils is called –
(1) Taxonomy (2) Teratology
(3) Gerontology (4) Palaeontology

Q.140 Hoofed animals (horse like) originated in –
(1) Pleistocene epoch (2) Oligocene epoch
(3) Miocene epoch (4) Eocene epoch

Q.141 Dinosaurs originated –
(1) After evolution of mammals
(2) With mammals
(3) Much before mammals
(4) Before mammals and they formed them

Q.142 An era "age of birds and mammals" is –
(1) Mesozoic (2) Palaeozoic
(3) Coenozoic (4) Cretaceous

Q.143 Which geological era / period is regarded as age of reptiles –
(1) Silurian (2) Carboniferous
(3) Mesozoic (4) Proterozoic

Q.144 Earliest fossil form in the phylogeny of horse is–
(1) Mesohippus (2) Equus
(3) Eohippus (4) Merychippus

Q.145 Java man belongs to-
(1) Africa (2) China
(3) Java (4) Africa, China & Java

Q.146 Which primate is closest to man during organic evolution-
(1) Gibbon (2) Gorilla
(3) Sinanthropus (4) Orangutan

Q.147 The prehistoric man which lived on earth during late pleistocene period-
(1) Neanderthal man (2) Australopithecus
(3) Cromagnon (4) Atlantic man

Q.148 Which character applies to Homo sapiens-
(1) Opposable toe (2) Large canine
(3) Craninal capacity 1450 cc
(4) Chin prominence absent

Q.149 Fossils of pithecanthropus have been recovered from-
(1) China (2) Germany
(3) Java (4) Japan

Q.150 Ancestor of man which for the first time showed bipedal movement-
(1) Cro-magnon (2) Australopithecu
(3) Java apeman (4) Peking man

Q.151 Cro-magnon was-
(1) Omnivorous (2) Carnivorous
(3) Herbivorous (4) Frugivorous

Q.152 Homo erectus is biological name of-
(1) Solo man (2) Neaderthal man
(3) Java man (4) Peking and Java man

Q.153 Homo erectus differed from cro-magnon in having-
(1) Jaws protruding out
(2) Tool making
(3) Sloping jaws (4) Arts and Paintings

Q.154 The probable direct ancestor of modern man is-
(1) Java man (2) Peking man
(3) Cromagnon man (4) Neanderthal man

Q.155 The probable first prehistroic man was-
(1) Ramapithecus (2) Homo habilis
(3) Australopithecus (4) Zinjanthropus

Q.156 Which of the following statement is correct-
(1) Proconsul was ancestor of man and ape
(2) Proconsul was ancestor of man and not of ape
(3) Apes were ancestor of man anatomically
(4) None of them

Q.157 Scientific name of man is-
(1) Canis familiaris (2) Homo habilis
(3) Homo erectus (4) Homo sapiens

Q.158 The first ancestor of man whose fossils have been recovered was-
(1) Pithecanthropus (2) Zinjanthropus
(3) Australopithecus (4) Neanderthal man

Q.159 Which character is not in the direction of evolution of man-
(1) Prehensile tail
(2) Steroscopic vision
(3) Small jaws
(4) Raised eyebrow ridges

Q.160 On which continent maximum fossils of prehistoric man have been found-
(1) Africa (2) Europe
(3) Asia (4) America

Q.161 Evolution of man took place because ape-like ancestor had-
(1) Developed brain (2) Binocular vision
(3) Large cranial capacity
(4) Migratory

Q.162 Most recent man found as fossil was -
(1) Java man (2) Peking man
(3) Cro-magnon man (4) Hiedelberg man

Q.163 The fossil of primitive man recovered from shivalik hills in India-
(1) Oligopithecus (2) Paranthropus
(3) Ramapithecus (4) Pliopithecus

Q.164 What was the cranial capacity of Java man-
(1) 400 cc (2) 650 cc
(3) 900 cc (4) 1450 cc

Q.165 Who discovered Java ape man-
(1) Leakey (2) Mayr
(3) Davidson black (4) Dubois

Q.166 The proper burial of dead bodies for the time started with which prehistoric man-
(1) Peking man (2) Neanderthal man
(3) Java man (4) Cromagonon man

Q.167 Scientific name of Java man is -
(1) Homo habilis
(2) Pithecantrhopus erectus
(3) Homo erectus erectus
(4) 2 & 3 both

Q.168 Who formed the tools for the first time-
(1) Australopitherus (2) Pithecanthropu
(3) Sinanthropus (4) Ramapithecus

Q.169 Evolution of man was possible because our ape like ancestor-
(1) Showed bipedal movement in open land
(2) Used fire
(3) Felt difficulty in nutrition
(4) Developed community hunting

Q.170 What is the contribution of W.C. Pei-
(1) He discovered Cro-magnon man
(2) He discovered Peking man
(3) He discovered Java man
(4) None of them

Q.171 C. Fuhlrott made an important discovery in evolution-
(1) Neanderthal man
(2) Cro magnon man
(3) Classification of man
(4) Characters of modern apes

Q.172 Character of Tarsius in the direction of hominid evolution-
(1) Smaller head (2) Nose not flat
(3) Large eyes (4) All of them

Q.173 Character of primitive monkey which was in the direction of evolution of man-
(1) Thumb parallel to fingers
(2) 32 teeth
(3) Prehensible tail
(4) Flat nose

Q.174 Which of the following is not kept in the family of man-
(1) Pithecanthropus (2) Homo
(3) Peking man (4) Shivapithecus

Q.175 Character of man which is most significant from evolution point of view-
(1) Foramen magnum shifted forward
(2) Larger cranial capacity
(3) Face orthognathous
(4) All of them

Q.176 Greatest advantage of bipedal movement-
(1) Forearms becoming free for carrying out order of brain
(2) Greater speed
(3) Supports the body properly
(4) Loss of weight

Q.177 Which fossil man had cranial capacity almost equal to modern man-
(1) Austraopithecus (2) Java ape man
(3) Neanderthal man (4) Peking man

Q.178 Fire for protection and cooking was first used by-
(1) Neanderthal man (2) Cro-Magnon
(3) Java man (4) Peking man

Q.179 Coloured rock paintings were first done by-
(1) Cro-Magnon man (2) Java ape man
(3) Peking man (4) Neaderthal man

Q.180 Evolution of man took place in-
(1) America (2) Australia
(3) Central Africa (4) Central Asia

Q.181 Largest cranial capacity was found in-
(1) Peking man (2) Neanderthal man
(3) Java man (4) Cro-magnon man

Q.182 Which ancestor of man first of all stood erect-
(1) Java apeman (2) Australopithecus
(3) Peking man (4) Cro-magnon

Q.183 Closest relative of man is-
(1) Java man (2) Neanderthal man
(3) Peking man (4) Cro-magnon man

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	3	3	3	4	3	3	3	1	3	3	2	3	3	2	2	2	3	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	2	3	2	3	2	1	2	3	1	3	2	1	4	3	1	1	4	4	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	4	2	3	3	4	2	1	2	2	2	3	1	2	2	3	3	3	2	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	3	1	4	4	1	4	1	4	1	1	4	3	1	2	1	2	1	4	4
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	1	3	3	1	2	2	3	2	1	3	2	4	2	2	1	4	3	4	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	4	4	4	2	4	3	4	3	4	3	4	2	1	4	3	2	3	1	2
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	3	4	2	2	4	1	2	4	3	4	1	2	2	1	2	2	4	4	4	4
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	2	3	3	3	4	3	1	3	3	2	2	4	1	3	2	1	4	3	1	1
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	4	3	3	3	4	2	4	1	1	2	1	4	2	4	4	1	3	3	1	3
Ques.	181	182	183																	
Ans.	4	1	4																	

EXERCISE – 2

Q.1 Founder of Palaeontology is :
(1) Lamarck (2) Erasmus Darwin
(3) G. Cuvier (4) Empedocles

Q.2 Which of the following cannot be explained by Lamarckism ?
(1) Absence of lips in snakes
(2) Long neck of giraffe
(3) Degeneration of visual apparatus in cave dwellers
(4) Dull progeny of Noble Laureate

Q.3 The "use and disuse theory" was proposed by:
(1) Gregor Mendel (2) Konrad Lorenz
(3) Malthus (4) Jean B. Lamarck

Q.4 The ship in which Charles Darwin travelled was:
(1) H.M.S. Beagle (2) Royal Ship
(3) Victoria (4) None of these

Q.5 Organic compounds first evolved on earth and required for origin of life were :
(1) Urea and amino acid
(2) Protein & nucleic acid
(3) Protein and amino acid
(4) Urea and nucleic acid

Q.6 Speciation occurs when :
(1) Populations are isolated by geographical barrier
(2) Populations are reproductively isolated
(3) Both of these
(4) None of these

Q.7 Struggle for existence and survival of fittest are related to :
(1) Lamarckism (2) Darwinism
(3) Oparin's theory (4) Mendelism

Q.8 Lamarckism fails to explain :
(1) Long neck of giraffe
(2) Loss of limbs in snake
(3) Presence of tail in mouse
(4) Webbed feet in swimming birds

Q.9 Gene frequency in a population remains stable unless and until there is-
(1) Random drift (2) Random mating
(3) Selection (4) Mutation

Q.10 Which is most important in speciation :
(1) Geographical isolation
(2) Reproductive isolation
(3) Ecological isolation
(4) Ethological isolation

Q.11 Darwin's explanation of the way in which evolution occurs is :
(1) God determines which species should evolve
(2) Progressive adaptations enable one species to leave more offsprings
(3) Certain species have 'built in' plans of evolution
(4) Those traits used most often persist longer

Q.12 Life cannot originate from inorganic materials upon the present earth because of
(1) High pollution
(2) Low temperature of earth
(3) Large amount of oxygen in atmosphere
(4) High temperature of earth

Q.13 Tectonic is the study of :
(1) Earth's crust (2) Earth quakes
(3) Volcanoes (4) Sand dunes

Q.14 Diversity in the type of beaks of finches adapted to different feeding habits on the Galapagos islands as observed by Darwin provides evidence for :
(1) Origin of species by natural selection
(2) Intraspecific variations
(3) Interspecific variations
(4) Interspecific competition

Q.15 Genetic drift operates only in :
(1) Island population (2) Smaller population
(3) Larger population (4)Mendalian population

Q.16 Successful adaptation simply means :
(1) An increase in fitness
(2) Producing offsprings
(3) Moving to a new place
(4) Evolving new characters

Q.17 Lamarck's theory is an evergreen superstition" was reported by :
(1) Charles Darwin (2) Darlington
(3) Hugo de Vries (4) Carlson

Q.18 Selecting the genetically improved domesticated plants and animals by man is-
(1) Natural selection (2) Artificial selection
(3) Hybrid selection (4) Any of above

Q.19 Theory of Pangenesis was proposed by :
(1) Lamarck (2) Darwin
(3) Hugo de Vries (4) Dobzhansky

Q.20 The phenomenon of Industrial melanism demonstrates :
(1) Natural selection
(2) Artificial selection
(3) Reproductive isolation
(4) Geographical isolation

Q.21 Who proposed germplasm theory against Lamarck's principle of '**use and disuse**'?
(1) Darwin (2) Nuttal
(3) Weismann (4) de Vries

Q.22 Birbal Sahani Institute of Palaeobotany is located at:
(1) New Delhi (2) Lucknow
(3) Kolkata (4) Kanpur

Q.23 What is evolution ?
(1) Development of organisms through time
(2) Development of a cell from chemicals
(3) Development of DNA nucleotides
(4) None of these

Q.24 Charles Darwin's theory of evolution was based on:
(1) Environment
(2) Mutations
(3) Chromosome pairing
(4) Natural selection

Q.25 The raw material for organic evolution is :
(1) Asexual reproduction
(2) Effect of hormones
(3) Nutritive substances
(4) Mutations

Q.26 Who proposed the mutation theory of evolution:
(1) Darwin (2) Hugo de Vries
(3) Lamarck (4) Huxley

Q.27 Chemical theory of origin of life was given by:
(1) Stanley Miller (2) Louis Pasteur
(3) Spallanzani (4) Oparin & Haldane

Q.28 Who did an experiment to prove that the organic compounds are the basis of life:
(1) K. Bahadur (2) Miller and Urey
(3) Melvin Calvin (4) Sydney Fox

Q.29 The book "Origin of Species" was written by :
(1) Darwin (2) Hugo de Vries
(3) Lamarck (4) Huxley

Q.30 Hugo de Vries worked on :
(1) Pisum (2) Lathyrus
(3) Oenothera (4) Mirabilis

Q.31 Industrial melanism is an example of :
(1) Natural selection
(2) Retrogressive evolution
(3) Adaptive convergence
(4) Artificial selection

Q.32 The first amphibians appeared during the period:
(1) Permian (2) Carboniferous
(3) Silurian (4) Devonian

Q.33 As evident from fossil records, which era had no life:
(1) Azoic (2) Proterozoic
(3) Palaeozoic (4) Coenozoic

Q.34 Who wrote the book "**Genetics and Origin of Species**" ?
(1) Hugo de Vries (2) Dobzhansky
(3) Huxley (4) R.A. Fischer

Q.35 Discontinuous variations were called '**sports**' by :
(1) De Vries (2) Lamarck
(3) Bateson (4) Darwin

Q.36 Book "Philosophic Zoologique" was written by:
(1) Lamarck (2) Darwin
(3) Hugo de Vries (4) Bateson

Q.37 Theory of "**Continuity of Germplasm**" was propounded by :
(1) August Weismann (2) Gregor Mendel
(3) Lamarck (4) Darwin

Q.38 Which of the following are homologous organs:
(1) Hand of man, wings of bat
(2) Eyes of man, eyes of squid
(3) gills of fish, lungs of man
(4) Leaf of moss, frond of fern

Q.39 Theory of spontaneous generation was given by

(1) Spallanzani (2) Von Helmont

(3) Redi (4) Pasteur

Q.40 Who disproved the theory of spontaneous generation ?

(1) Redi (2) Pauling

(3) Balkman (4) None of these

Q.41 Darwin's finches show which aspect of evolution ?

(1) Biogeographical (2) Industrial melanism

(3) Biochemical (4) Embryological

Q.42 The synthesis of first protein during the origin of the life was :

(1) from DNA

(2) from RNA

(3) from DNA & RNA both

(4) without nucleic acid and biocatalyst

Q.43 Darwin's theory states that :

(1) Characters are acquired through inheritance

(2) Nature selects species which can adapt

(3) Species changes morphologically with nature

(4) Effect of environment on evolution

Q.44 Similarities in organism with different genotype indicates :

(1) Microevolution

(2) Macroevolution

(3) Convergent evolution

(4) Divergent evolution

Q.45 Which of the following is closely related to man:

(1) Chimpanzee (2) Gorilla

(3) Orangutan (4) Gibbon

Q.46 Which of the following is correct order of the evolutionary history of man :

(1) Peking man,. Homo sapiens sapiens Neanderthal man, Cromagnon man

(2) Hedalberg , Peking man, Neanderthal man, Cromagnon man

(3) Peking man, Hedalberg man, Neanderthal man, Cromagnon man.

(4) Peking man, Neanderthal man, Homosapiens, Hedalberg man

Q.47 Which of the following was homologous organs-

(1) Wing of birds & Locust

(2) Wings of sparrow & wings of bat

(3) Wings of bat & butterfly

(4) Legs of frog and cockroach

Q.48 There is no life on moon due to the absence of:

(1) O_2 (2) Water

(3) Light (4) Temperature

Q.49 According to fossils which have been discovered up to present time, origin and evolution of man was started from which country -

(1) France (2) Java

(3) Africa (4) China

Q.50 The wings of bat, locust and pigeon are the examples of :

(1) Vestigeal organs

(2) Analogous organ

(3) Homologous organs

(4) Exoskeletal organs

Q.51 Convergent evolution is illustrated by-

(1) Rat and dog

(2) Bacterium and protozoan

(3) Starfish and cuttle fish

(4) Dogfish and whale

Q.52 Which one of the following sequences was proposed by Darwin and Wallace for organic evolution?

(1) Overproduction, variations, constancy of population size, natural selection

(2) Variations, constancy of population size, overproduction, natural selection

(3) Overproduction, constancy of population size, variations, natural selection

(4) Variations, natural selection, overproduction, constancy of population size

Q.53 Darwin in his "Natural Selection Theory" did **not** believe in any role of which one of the following in organic evolution ?

(1) Parasites and predators as natural enemies

(2) Survival of the fittest

(3) Struggle for existence

(4) Discontinuous variations

Q.54 Which one of the following describes correctly the homologus structures ?

(1) Organs with anatomical similarties, but performing different functions

(2) Organs with anatomical dissimilarities, but performing same functions

(3) Organs that have no function now, but had an important functions in ancestors

(4) Organs appearing only in embryonic stage and disappearing later in the adult

Q.55 What kind of evidence suggested that man is more closely related with chimpanzee than with other hominoid apes?

(1) Evidence from DNA from sex chromosomes only

(2) Comparion of chromosoems morphology only

(3) Evidence from fossil remains, and the fossile mitochondrial DNA alone

(4) Evidence from DNA extracted from sex chromosomes, autosomes and mitochondria

Q.56 Being all mammals, while dolphins, bat, monkey and horse have some common characters but they also show conspicuous differences. This is due to the phenomenon of-

(1) Normalisation (2) Genetic drift

(3) Divergence (4) Convergence

Q.57 Which one of the following was most likely absent in free form in the primordial atmosphere at the time of origin of life-

(1) Methane (2) Hydrogen

(3) Ammonia (4) Oxygen

Q.58 Initiating force of evolution is-

(1) Variation (2) Natural selection

(3) Adaptation (4) Competition

Q.59 Which one of the following experiments suggests that simplest living organisms could not have originated spontaneously from non-living matter-

(1) Larvae could appear in decaying organic matter

(2) Microbes did not appear in stored meat

(3) Microbes appeared from unsterilized organic matter

(4) Meat was not spoiled, when the heated and kept sealed in a vessel

Q.60 De Vries gave his mutation theory on organic evolution while working on-

(1) *Pisum sativum*

(2) *Drosophila melanogaster*

(3) *Oenothera lamarckiana*

(4) *Althea rosea*

Q.61 There are two opposing views about origin of modern man. According to one view Homo erectus in Asia were the ancestors of modern man. A study of variation of DNA however suggested African origin of modern man. What kind of observation of DNA variation could suggest this-

(1) Greater variation in Asia than in Africa

(2) Greater variation in Africa than in Asia

(3) Similar variation in Africa and Asia

(4) Variation only in Asia and no variation in Africa

Q.62 Which one of the following phenomena supports Darwin's concept of natural selection in organic evolution ?

(1) Development of transgenic animals

(2) Production of Dolly the sheep by cloning

(3) Prevalence of pesticide resistance insects

(4) Development of organs from stem cells for organ transplantation

Q.63 Which of the following is the relatively most accurate method for dating of fossils ?

(1) Radio-carbon method

(2) Potassium-argon method

(3) Electron spin resonance method of amino acid

(4) Uranium lead method

Q.64 Set which includes only analogous organs is-

(1) Wings of butterfly, housefly and bat

(2) Hindlegs of horse, grasshopper and bat

(3) Wings of butterfly and wingspread of bat and birds

(4) Mandibles of cockroach, mosquito and honey bee

Q.65 'Convergent Evolution' is shown by-

(1) Homologous organs

(2) Analogous organs

(3) Vestigial organs

(4) All of the above

Q.66 Example of analogous organs is-

(1) Wings of bird and insect

(2) Forelimbs of horse and man

(3) Teeth of elephant and man

(4) None of the above

Q.67 Which extinct animal shows evidences of evolution-

(1) *Peripatus* (2) *Neopilina*

(3) *Echidna* (4) *Archaeopteryx*

Q.68 The classical example of adaptive radiation in development of new species is-

(1) Darwin finches

(2) Marsupials of Australia

(3) Giant turtle (4) All of these

Q.69 Two organs which are similar in structure and origin, but not necessarily in function are called-

(1) Homologous (2) Analogous

(3) Apocrine (4) None of these

Q.70 Which one of the following amino acids was not found to be synthesized in Miller's experiment ?

(1) Alanine (2) Glycine

(3) Aspartic acid (4) Glutamic acid

Q.71 Jurassic period of the meosozoic era is characterised by-

(1) Flowering plants and first dinosaurs appear

(2) Gymnosperm are dominant plants and first birds appears

(3) Radiation of reptiles and origin of mammals -like reptiles

(4) Dinosaurs become extinct and angiosperms appear

Q.72 Which one of the following is not a living fossil?

(1) Peripatus (2) King Crab

(3) Sphenodon (4) Archaeopteryx

Q.73 Which one is correct.

(1) Wings of birds and insects are homologous

(2) Caecum and appendix in Rabbit and Man are analogous

(3) Paired fins of fish and flippers of whale are analogous

(4) Archaeopteryx lithographica is missing link between birds and mammals.

Q.74 The unit of natural selection is.

(1) A genus (2) A population

(3) An individual (4) Oxygen

Q.75 Which is the correct Aristotle's ladder of nature?

(1) Inanimate matter → lower plants → higher plants → zoophyta → entoma → ostracoderma→ malacia → malacostraca → fish → oviparous → quadrupeds → cetacea → birds → viviparous quadrupeds → humans.

(2) Inanimate matter → lower plants → higher → plants → zoophyta → entoma → malacia → malacostraca → ostracoderma → fish → oviparous quadrupeds → cetacea → birds → viviparous quadrupeds → humans .

(3) Inanimate matter → lower plats → higher → plants → zoophyta → malacia → malacostrace → ostracoderma → fish → oviparous quadrupeds → humans.

(4) Inanimate matter → lower plants → higher plants → zoophyta → entoma → ostracoderma → malacostraca → malacia → fish → cetacea → oviparous → quadrupeds → birds → viviparous quadrupesa → humans.

Q.76 Among the human ancestors the brain size was more than 1000 CC in-

(1) Homo erectus

(2) Ramapithecus

(3) Homo habilis

(4) Homo neanderthalensis

Q.77 Industrial melanism as observed in peppered moth proves that-

(1) The melanic form of the moth has no selective advantage over lighter form in industrial area

(2) The lighter form moth has no selective advantage either in polluted industrial area or non-polluted area

(3) Melanism is a pollution generated feature

(4) The true black melanic forms arise by a reocurring random mutation

Q.78 Select the correct statement from the following-

(1) Fitness is the end result of the ability to adapt and gets selected by nature

(2) All mammals except whales and camels have seven cervical vertebrae

(3) Mutation are random and directional

(4) Darwins variations are small and directionless

Q.79 What is common to whale , seal and shark ?

(1) Thick subcutaneous fat

(2) Convergent evolution

(3) Homiothermy

(4) Seasonal migration

Q.80 One of the important consequences of geographical isolation is-

(1) Preventing speciation

(2) Speciation through reproductive isolation

(3) Random creation of new species

(4) No change in the isolated fauna

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	4	4	1	2	2	2	3	4	2	2	3	1	1	2	4	2	2	2	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	2	1	4	4	2	4	2	1	3	1	4	1	2	4	1	1	1	2	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	4	2	3	1	2	2	2	3	2	4	3	4	1	4	3	4	1	4	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	3	3	3	4	1	4	4	1	4	2	4	3	3	4	4	4	1	2	2

EXERCISE – 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Most advanced theory of origin of life is that of **[CET Chd. 2000]**

(1) Catastrophic (2) Haldane and Oparin

(3) Cosmozoic (4) Spontaneous.

Q.2 Possible early source of energy was **[AIIMS 2000]**

(1) Chlorophyll

(2) CO_2

(3) UV radiations and lightning

(4) Green plants.

Q.3 Swan-necked flask experiment was performed by **[KCET 2001]**

(1) Louis Pasteur (2) Robert Koch

(3) Francisco Redi (4) Aristotle.

Q.4 Spark discharge apparatus for testing chemical origin of life was designed by **[KCET 2001]**

(1) Urey and Miller

(2) Jacob and Monod

(3) Oparin and Haldane

(4) Dixon and Joly.

Q.5 Which is the most important for origin of life? **[Pb. PMT 2000]**

(1) Oxygen (2) Water

(3) Nitrogen (4) Carbon.

Q.6 Chemical theory for origin of life was given by **[Manipur 2006]**

(1) Stanley Miller (2) Oparin and Haldane

(3) Spallanzani (4) Louis Pasteur.

Q.7 Theory of spontaneous creaftion was supported by **[AFMC 2000]**

(1) Van Helmont (2) Redi

(3) Spallanzani (4) Pasteur.

Q.8 One of the greatest advocates of the theory of special creation was **[Pb. PMT 2000]**

(1) C. Darwin (2) Aristotle

(3) Father Saurez (4) Huxley.

Q.9 A compound important in prebiotic evolution was **[Har. PMT 2000]**

(1) SO_2 (2) CH_4

(3) SO_3 (4) NO

Q.10 Simple one-celled cyanobacteria-life organisms developed on earth **[Kerala 2000]**

(1) 5600 million years (2) 5000 million years

(3) 4600 million years (4) 3600 million years

(5) 3000 million years.

Q.11 Which ones are the most essential for origin of life ? **[AIIMS 2001]**

(1) Enzymes (2) Proteins

(3) Carbohydrates (4) Nucleic acids

Q.12 Approximate age of earth (in million years) is **[HPPMT 2001]**

(1) 3600 (2) 4600

(3) 7200 (4) 6000.

Q.13 According to theory of abiogenesis, life originates from **[Kerala 2002, DPMT 2009]**

(1) Non-living

(2) Spontaneously

(3) Chemicals

(4) Other planets.

Q.14 A biogenesis is **[CPMT 2002]**

(1) Origin of life from non-living organisms

(2) Origin of microbes from living organisms

(3) Spontaneous

(4) Origin of microbes and viruses.

Q.15 Experiment to prove chemical basis of origin of life carried out by Urey and Miller used NH_3 and **[Bihar PMT 2002]**

(1) H_2O and H_2 (2) H_2, CH_4 and H_2O

(3) CH_4 and H_2O (4) CH_4 and O_2

Q.16 Miller's experiment provided evidence for theory of **[Orissa 2002]**

(1) Special creation

(2) Biogenesis

(3) Abiogenesis

(4) Organic evolution.

Q.17 Experimental proof that organic compounds formed the basis of evolution was given by **[DPMT 2002]**

(1) Oparin (2) Pasteur

(3) Miller and Urey (4) Spallanzani.

Q.18 Which of the following has been basic to origin of life **[CET Chd. 2003]**

(1) Carbohydrates (2) Proteins

(3) Nucleic acids (4) Nucleoproteins.

Q.19 Theory of abiogenesis or spontaneous generation was finally disapproved by **[Kerala 2003]**

(1) Louis Pasteur (2) A.I. Oparin

(3) A.R. Wallace (4) Sidney Fox.

Q.20 Given below are assertion and reason. Point out if both are true with reason being correct explanation (A), both true but reason is not correct explantion (B), assertion true but reason is wrong (C), both are wrong (D). **Assertion.** Coacervates are believed to be precursors of life. **Reason.** Coacervates were self duplicating aggregates of proteins surrounded by lipid molecules. **[AIIMS 2004, 2008]**

(1) (2)

(3) (4)

Q.21 Coacervates were experimentally produced by **[KCET 2004]**

(1) Oparin and Sidney Fox

(2) Fischer and Huxley

(3) Jacob and Monod

(4) Urey and Miller.

Q.22 Who disapproved abiogenesis for the first time? **[Manipal 2004]**

(1) Lamarck (2) F. Redi

(3) Pasteur (4) Darwin.

Q.23 Which experiment suggests that simplest living organisms could not have originated spontaneously from non-living matter ? **[CBSE 2005]**

(1) Microbes did not appear in stored meat.

(2) Microbes appeared from unsterilised organic matter.

(3) Larvae could appear in decaying organic matter.

(4) Meat was not spoiled when heated and kept in sealed vessel.

Q.24 Origin of life from pre-existing life is propounded by **[JKCMEE 2005, Har PMT 2007]**

(1) Biogenesis theory

(2) Abiogenesis theory

(3) Special creation theory

(4) Extra terrestrial theory.

Q.25 Extra terrestrial origin of life was proposed by theory of **[DPMT 2005]**

(1) Catastrophism

(2) Spontaneous generation

(3) Special creation

(4) Panspermia.

Q.26 Stanley Miller's experiment supports+ **[Manipal 2005]**

(1) Abiogenesis (2) Biogenesis

(3) Pangenesis (4) Chemical theory.

Q.27 Cyanobacteria originated on earth about **[HPPMT 2005]**

(1) 4·3–4·8 billion years ago

(2) 3·3–3·8 billion years ago

(3) 2·3–2·8 billion years ago

(4) 1·3–1·8 billion years ago.

Q.28 Coacervates belong to the category of **[Pb. PMT 2005]**

(1) Protozoans

(2) Molecular aggregates

(3) Molecular aggregates surrounded by lipid membrane

(4) Cyanobacteria.

Q.29 The oldest fossil record of blue-green alga is 2.9 billion years old. It is **[Pb. PMT 2005]**

(1) Stromatolites (2) *Archaeopteryx*

(3) *Archaeopteroides* (4) *Chlamydomonas.*

Q.30 First life consisted of **[Pb. PMT 2005]**

(1) Provirus (2) Virus

(3) Bacteria (4) Protovirus.

Q.31 Which of the following amino acids was not found to be synthesised in Miller's experiment? **[CBSE 2006, AFMC 2008]**

(1) Alanine (2) Glycine

(3) Aspartic acid (4) Glutamic acid.

Q.32 Given below are assertion and reason. Point out if both are true with reason being correct explanation (A), both true but reason is not correct explantion (B), assertion true but reason is wrong (C), both are wrong (D).

Assertion. The earliest organisms that appeared on earth were nongreen and presumably anaerobes.

Reason. The first autotrophic organisms were the chemoautotrophs that never released oxygen **[AIIMS 2006, 2008]**

(1) (2)

(3) (4)

Q.33 Miller and Urey performed an experiment to prove the origin of life. They took gases ammonia and hydrogen alongwith **[AMU PMDC 2006, 2008]**

(1) N_2 and H_2O (2) CH_4 and N_2

(3) H_2O and CH_4 (4) CO_2 and NH_3

Q.34 The term hot dilute soup was given by **[HPPMT 2007, DPMT 2008]**

(1) Haldane (2) Urey

(3) Oparin (4) None of the above

Q.35 Coacervates are **[DPMT 2007]**

(1) Protein aggregates

(2) Protein and lipid aggregates

(3) Chemical aggregates

(4) Protobionts with polysaccharides, proteins and water.

Q.36 Concept of chemical evolution of life is based on **[CBSE 2007]**

(1) Effect of solar radiations on chemicals

(2) Interaction of water, air and clay under intense heat

(3) Combination of chemicals under hot moist environment coditions

(4) Crystallisation of chemicals.

Q.37 Select the wrong pair **[Keral 2007]**

(1) Haldane ..... Hot dilute soup

(2) Oparin ..... Protobionts

(3) Spallanzani ..... Abiogenesis

(4) Fox ..... Coacervates

(5) Redi ..... Biogenesis.

Q.38 The living form resulting from the final stage of chemical evolution of life is called **[COMED-K's 2007]**

(1) Prebiont (2) Protobiont

(3) Protenoid (4) Probiont.

Q.39 Scientists believe that life on earth originated by **[HPPMT 2007, Orissa 2010]**

(1) Spontaneous generation

(2) Chemical evolution/Abiogenesis

(3) Special creation

(4) Extraterrestrial transfer.

Q.40 Which of the following was formed in S. Miller's exeriment ? **[CPMT 2008]**

(1) Microspheres (2) Nucleic acids

(3) Amino acids (4) UV radiations.

Q.41 S.L. Miller's closed flask contained **[JKCMEE 2008]**

(1) CH_4

(2) NH_3 and water vapours

(3) H_2 (4) All the above

Q.42 Microspheres possessed a membrane of **[DPMT 2008]**

(1) Lipid and protein (2) Lipid

(3) Carbohydrates (4) Fats.

Q.43 Which is incorrect about protobionts in abiogenic origin of life ? **[CBSE 2008]**

(1) They were partially isolated from surroundings

(2) They could maintain an internal environment

(3) They were able to reproduce

(4) They could separate combination of molecules from the surroundings.

Q.44 Origin of life occurred in **[MPPMT 2009, 2010]**

(1) Precambrian (2) Coenozoic

(3) Palaeozoic (4) Mesozoic.

Q.45 In their experiment to prove origin of life, Miller and Urey took gases **[CPMT 2009]**

(1) Methane, ethane, hydrogen, ammonia

(2) Methane, ethane, ammonia, water vapours

(3) Methane, ethane, ammonia, water vapours

(4) Ammonia, water vapours, butane, hydrogen.

Q.46 Miller performed experiment to prove abiogenetic molecular evolution of life. Which molecule was not present in Miller's experiment **[CPMT 2010]**

(1) Water (2) Methane

(3) Oxygen (4) Ammonia.

Q.47 Which is incorrect **[CPMT 2010]**

(1) J.B.S Haldane – Law of continuity of germplasm

(2) Lauis Pasteur – Germ theory of disease and immunology

(3) De vries – Mutation theory

(4) Lemaitre – Big bang theory.

Q.48 In early earth, water and carbon dioxide were produced by the combination of O_2 with **[Kerala 2010]**

(1) Ammonia and methane

(2) Organic matter

(3) Hydrogen sulphide

(4) Hydrogen.

Q.49 Primitive atomosphere of earth contained water vapours, hydrogen, ammonia and **[HPPMT 2010]**

(1) CO_2 (2) O_2

(3) N_2 (4) Methane

Q.50 Oparin-Haldane's view on the origin of life was first experimentally proved by **[JKCMEE 2010]**

(1) Malthus (2) Plato

(3) Louis Pasteur (4) Stanley Miller

Q.51 Fossils are studied for **[CET Chd. 2000]**

(1) Tracing evolutionary history of organisms

(2) Studying extinct organisms

(3) Filling gaps in our study

(4) Providing jobs to scientists.

Q.52 Theory 'Ontogeny recapitulates Phylogeny' was proposed by **[AMU 2000]**

(1) Mendel (2) Haeckel

(3) Erasmus (4) Weismann.

Q.53 Monkeys and some lower groups have certain blood groups which are **[AMU 2000]**

(1) Identical to those of man

(2) Identical to those of anthropod apes

(3) Identical to those of anthropod apes

(4) Some what similar to white persons

(5) Not identical to those of man.

Q.54 Organic evolution is change in **[AMU 2000]**

(1) Single individual

(2) A few members of population

(3) Major portion of population

(4) Entire population.

Q.55 A bird with teeth is **[AMU 2000]**

(1) Kiwi (2)Ostrich/King Vulture

(3) Dodo (4) *Archaeopteryx*.

Q.56 Heart is four chambered in **[AMU 2000]**

(1) Amphibia (2) Fishes

(3) Mammals (4) Reptiles.

Q.57 Living organism with oldest fossil history is **[CPMT 2000, AMU 2000]**

(1) Dinosaur (2) *Archaeopteryx*

(3) Horse (4) Man.

Q.58 Homologus organs are **[AMU 2000]**

(1) Humna eyes and Squid eyes

(2) Gills of Fish and lungs of Man

(3) Hands of Man and wings of Bat

(4) Leaf of Moss and frond of Fern.

Q.59 Coal has been mainly formed by **[AFMC 2000]**

(1) Bryophytes

(2) Pteridophytes/pteridosperms

(3) Angiosperms

(4) Algae.

Q.60 Darwin's finches provide evidence evolution from **[CBSE 2000, AFMC 2007]**

(1) Anatomy (2) Morphology

(3) Biogeography (4) All the above.

Q.61 Which one is not vestigial in humans ? **[CBSE 2000, AFMC 2007]**

(1) Third molar

(2) Coccyx

(3) Segmental abdominal muscles

(4) Finger nails.

Q.62 Vestigial pelvic girdle and bone remnants of hind limbs are characteristic of **[Har. PMT 2000]**

(1) Whale (2) Dolphin

(3) Shark (4) Seal.

Q.63 The statement "nothing in biology makes sense except in the light of evolution" was given by **[Kerala 2000]**

(1) Dobzhansky (2) Darwin
(3) Oparin (4) Hooker
(5) Wallace.

Q.64 The sequence in evolution of horse was **[Kerala 2000]**

(1) *Equus, Eohippus, Mesohippus, Merychippus*
(2) *Eohippus, Mesohippus, Merychippus, Equus*
(3) *Mesohippus, Eohippus, Equus, Mesohippus*
(4) *Merychippus, Mesohippus, Eohippus, Equus.*

Q.65 Origin of life occurred in **[Kerala 2000]**

(1) Carboniferous (2) Cambrian
(3) Pre-cambrian (4) Ordovician
(5) Silurian.

Q.66 Evolution of a species or group can be studied through **[CET Chd. 2001]**

(1) Fossils (2) Carbon dating
(3) DNA analysis (4) All the above.

Q.67 Phenomenon of organisms having similar structure with a similar origin is **[Manipal 2001]**

(1) Mimicry (2) Analogy
(3) Homology (4) Both A and B

Q.68 Homologous organs indicate **[CPMT 2001]**

(1) Convergent evolution
(2) Parallel evolution
(3) Natural selection (4) Common descent

Q.69 Age of evolution of man is measured by **[CPMT 2001]**

(1) Electron microscope
(2) Chemical reaction
(3) Radioactive dating (4) Ultraviolet radiation.

Q.70 Modern birds rose in **[CPMT 2001]**

(1) Palaeozoic (2) Coenozoic
(3) Mesozoic (4) Archaeozoic.

Q.71 Tasmanian Wolf is a marsupial while Wolf is a placental mammal. This shows **[DPMT 2001]**

(1) Convergent evolution
(2) Divergent evolution
(3) Parallelism
(4) Inheritance of acquired characters.

Q.72 Ontogeny recapitulates phylogeny. This is **[MPPMT 2004, JKCMEE 2008]**

(1) Hardy Weinberg law
(2) Pauling law
(3) Biogenetic law
(4) Thomas law.

Q.73 Jurassic period belongs to era **[Kerala 2001]**

(1) Palaeozoic (2) Mesozoic
(3) Coenozoic (4) Proterozoic
(5) Archaeozoic.

Q.74 Pioneers in the field of organic evolutio were **[KCET 2001]**

(1) Darwin, Lamarck, Landsteiner and De Vries
(2) Darwin, De Vries, Lamarck, Huxley
(3) Lamarck, Landsteiner, Malthus, De Vries
(4) Lansteiner, De Vries, Malthus, Darwin.

Q.75 Occurrence of higher number of endemic species in South America and Australia is due to **[CBSE 2001, AFMC 2007]**

(1) Retrogressive evolution
(2) Continental separation
(3) These species have become extinct from other regions
(4) Absence of terrestrial links between these places.

Q.76 Similarities between organisms of different genotypes is due to **[CBSE 2001]**

(1) Convergent evolution
(2) Divergent evolution
(3) Microevolution
(4) Macroevolution.

Q.77 Half life of ^{14}C is **[CBSE 2001]**

(1) 50 years (2) 500 years
(3) 5000 years (4) 5×10^4 years.

Q.78 Which of the following is not atavistic in humans ? **[CPMT 2001]**

(1) Tail in some babies
(2) Enlarged canines
(3) Six fingers
(4) Dense body hair.

Q.79 Which are not homologous ? **[CPMT 2001]**

(1) Fore arm of humans and fins of fishes

(2) Wings of bat and insects

(3) Fins of fishes and flippers of Whales

(4) Human fore arms, Bat's wings and flippers of Whale.

Q.80 Presence of two chambered heart and gills in tadpole is example of **[Har. PMT 2001]**

(1) Neo-Darwinism (2) Gause's law

(3) Chargaff's law (4) Biogenetic law

Q.81 Presence of tail and coarse hair in human baby is **[Pb. PMT 2007, MPPMT 2007]**

(1) Radiation (2) Atavism

(3) Mutation (4) Crossing over.

Q.82 Unit of evolution is **[MHTCET 2001, Orissa 2008]**

(1) Population (2) Species

(3) Individual (4) Subspecies.

Q.83 Possibility of occurrence of coal in an area is determined by study of **[BHU 2002]**

(1) Microfossils

(2) Ecology

(3) Economic Botany

(4) Mining contents.

Q.84 Darwin's finches occur in **[Wardha 2002, Orissa 2007]**

(1) Australia (2) Galapagos islands

(3) Siberia (4) India.

Q.85 Covolution does not occur in case of **[BHU 2002]**

(1) Parasitism (2) Mutualism

(3) Both A and B (4) Commensalism.

Q.86 Ancestral amphibians were tetrapods that evolved during **[BHU 2002]**

(1) Carboniferous period

(2) Cretaceous period

(3) Jurassic period

(4) Devonian period.

Q.87 Evidences for evolution from fossils belong to the domain of **[JKCMEE 2002, 2010]**

(1) Biogeography (2) Embryology

(3) Palaeontology (4) Anatomy.

Q.88 Dinosaurs were dominant features during the period of **[JKCMEE 2002]**

(1) Jurassic (2) Cretaceous

(3) Triassic (4) Palaeocene.

Q.89 Which of the following is not correctly paired **[Orissa 2002]**

(1) Mesozoic–Age of mammals

(2) Study of fossils–Palaeontology

(3) Mulation theory–Hugo de Vries

(4) Origin of Species–Charles Darwin.

Q.90 Study of plant fossils is **[RPMT 2002]**

(1) Paedology (2) Palynology

(3) Palaeoinsectology (4) Palaeobotany.

Q.91 Interacting populations are **[AMU 2002]**

(1) Symbiotic (2) Mutualistic

(3) Parasitic (4) Coevolved.

Q.92 *Archaeopteryx*, toothed fossil bird occurred during **[AMU 2002, MPPMT 2002]**

(1) Jurassic (2) Triassic

(3) Cretaceous (4) Permian.

Q.93 Mesozoic era is known as golden age of **[Kerala 2003, MPPMT 2007]**

(1) Fishes (2) Amphibians

(3) Reptiles (4) Molluscs.

Q.94 Continental drift explains **[AMU 2002]**

(1) Mass extinctions

(2) Distribution of fossils on earth

(3) Geographical upheavals

(4) All the above.

Q.95 Reptilian feature of *Archaeopteryx* is **[EAMCET 2002]**

(1) U-shaped furcula (2) Beak

(3) Abdominal ribs (4) Feathers.

Q.96 *Archaeopteryx* is connecting link between **[CPMT 2007, MHTCET 2007]**

(1) Fishes and amphibians

(2) Amphibians and birds

(3) Amphibians and reptiles

(4) Reptiles and birds.

Q.97 Which is not vestigial in man ?

[Kerala 2002, BHU 2008]

(1) Tail vertebrae

(2) Nails

(3) Nicttitating membrane

(4) Vermiform appendix

Q.98 Development of adaptations along parallel lines in unrelated groups of animals is

[MPPMT 2002]

(1) Adaptive convergence

(2) Adaptive radiation

(3) Adaptive divergence

(4) Adaptive induction.

Q.99 Which of the following is vestigial in humans

[AFMC 2002]

(1) Mammary glands in males

(2) Knee bones

(3) Nictitating membrane

(4) Ear pinna.

Q.100 Which is a pair of vestigial organs ?

[AIIMS 2002]

(1) Coccyx and intercostal muscles

(2) Coccyx and auricular muscles

(3) Facial hairs in ladies

(4) Coccyx and premolars.

Q.101 Which one is used for dating archaeological specimens like bones, shells and wood ?

[JIPMER 2002]

(1) 3 H (2) 14 C

(3) 121 I (4) 32 P

Q.102 Which is sequenced during study of phylogeny? **[CBSE 2002]**

(1) m-RNA (2) r-RNA

(3) t-RNA (4) DNA

Q.103 Convergent evolution is illustrated by

[CBSE 2003]

(1) Rat and Dog

(2) Bacterium and Protozoan

(3) Starfish and Cuttle fish

(4) Dogfish and Whale.

Q.104 Which one correctly describes homologous structures **[CBSE 2003, Pb. PMT 2003]**

(1) Organs with anatomical similarities but performing different functions

(2) Organs with anatomical similarities but performing different functions

(3) Organs that have no function now but had an important function in ancestors

(4) Organs appearing only in embryonic stage and disappearing later in the adult.

Q.105 The early stage human embryo distinctly possesses **[AIIMS 2003]**

(1) Gills

(2) Gill slits

(3) External ear (pinna)

(4) Eye brows.

Q.106 Mesozoic era was dominated by **[CPMT 2003]**

(1) Birds (2) Fishes

(3) Reptiles (4) Mammals.

Q.107 Law of embryonic development was proposed by **[CPMT 2003]**

(1) Darwin (2) Von Baer

(3) Haeckel (4) Mendel.

Q.108 Wings of bird and bat are **[Kerala 2003]**

(1) Homologous with no analogy

(2) Analogous with no homology

(3) Neither homologous nor analogous

(4) Both homologous and analogous

Q.109 Which is not a vestigial organ **[Kerala 2003]**

(1) Flipper of Seal (2) Coccyx of man

(3) Pelvic of Python (4) Wings of Kiwi.

Q.110 Organs related through common descent but now functionally different are

[CPMT 2004, JKCMEE 2005]

(1) Analogous (2) Homologous

(3) Divergent organs (4) Parallel organs.

Q.111 Which one is incorrect **[Orissa 2004]**

(1) Wings of insects and birds are analogous

(2) Wings of bat and birds are homologous

(3) Wings of insects and bat are analogous

(4) Wings of insects and birds are homologous.

Q.112 Age of fossils was previously determined by redioactive elements. More precise recent method which has led to revision of evolutionary periods is

[CBSE 2004, AIIMS 2007]

(1) Study of carbohydrate and protein in fossils

(2) Study of conditions of fossilisation

(3) Electron spin resonance and fossil DNA

(4) Presence of carbohydrate and protein in rocks

Q.113 Flippers of Seal are modified **[AFMC 2004]**

(1) Hind limbs (2) Fore limbs

(3) Fins (4) Gills.

Q.114 Potato and Sweet Potato have edible parts which are **[AIIMS 2004, DPMT 2008]**

(1) Homologous

(2) Analogous

(3) Recent introductions

(4) Two species of the same genus.

Q.115 Given below are assertion and reason. Point out if both are true with reason being correct explanation (A), both true but reason is not correct explanation (B), assertion true but reason is wrong (C), both are wrong (D). **Assertion.** Natural selection is the outcome of difference in survival and reproduction among individual that show variation in one or more traits.

Reason. Adaptive forms of a given trait tend to become more common. Less adaptive ones become less common or disappear.

[AIIMS 2004]

(1) (2)

(3) (4)

Q.116 Organs having similar functions but different orgin and development are known as

[JKCMEE 2004, Har. PMT 2005]

(1) Homologous organs

(2) Analogous organs

(3) Metalogous organs (4) Vestigial organs.

Q.117 The classical example of adaptive radiation during formation of new species is

[CPMT 2004]

(1) Marsupials of Australia

(2) Darwin's finches

(3) Giant Tortoise (4) All the above.

Q.118 Mammals like Whale, Dolphin, Bat, Monkey and Horse have some common characters but also show conspicuous differences. This is due to phenomenon of **[MPPMT 2004]**

(1) Divergence (2) Convergence

(3) Genetic drift (4) Normalisation.

Q.119 Which of the following pairs of structures is homologous ? **[MPPMT 2004]**

(1) Wings of Grasshopper and forelimbs of Flying Squirrel

(2) Tentacles of *Hydra* and *arms* of Starfish

(3) Forelimbs of a Bat and forelegs of a Horse.

(4) Wings of a bird and wings of a Moth.

Q.120 According to Darwinism, fossils of organisms found in South America resemble fossils of

[Orissa 2004]

(1) North America (2) Africa

(3) Australia (4) Both B and C.

Q.121 The biogenetic law of Haeckel is

[BHU 2005, CPMT 2009]

(1) *Omnis vivum e vivum*

(2) *Omnis cellula e cellula*

(3) Ontogeny repeats phylogeny

(4) Phylogeny repeats ontogeny.

Q.122 Given below are assertion and reason Point out if both are true with reason being correct explanation (A), both true but reason is not true explanation (B), assertion true but reason is wrong (C), both are wrong (D).

Assertion. Comparative biochemistry provides a strong evidence in favour of common ancestry of living beings.

Reason. Genetic code is universal.

[AIIMS 2005]

(1) (2)

(3) (4)

Q.123 Which is relatively most accurate method of dating of fossils ? **[CBSE 2005]**

(1) Radiocarbon method

(2) Potassium–Argon method

(3) Electron spin–resonance method

(4) Uranium–lead method.

Q.124 Dinosaurs were presnet during the **[JKCMEE 2005]**

(1) Palaeozoic era (2) Coenozoic era

(3) Mesozoic era (4) Precambrian era.

Q.125 Which is correct ? **[Orissa 2005]**

(1) 99% of existed species are extinct

(2) 65% of existed species are extinct

(3) 40% of existed species are extinct

(4) 30% of existed species are extinct.

Q.126 What is correct arrangement of periods of palaeozoic era in ascending order in geological time scale ? **[EAMCET 2005]**

(1) Cambrian → Devonian → Ordovician → Silurian → Carboniferous → Permian

(2) Cambrian → Ordovician → Silurian → Devonian → Carboniferous → Permian

(3) Cambrian → Ordovician → Devonian → Silurian → Carboniferous → Permian

(4) Silurian → Devonian → Cambrian → Ordovician→ Permian → Carboniferous.

Q.127 An important evidence in favour of oranic evolution is the occurrence of **[CBSE 2006, DPMT 2008]**

(1) Homologous and analogous organs

(2) Homologous and vestigial organs

(3) Analogous and vestigial organs

(4) Homologous organs only.

Q.128 Jurassic period of mesozoic era is characterised by **[CBSE 2006]**

(1) Flowering plants and first dinosaurs appear

(2) Gymnosperms are dominant plants and first birds appear

(3) Radiation of reptiles and angiosperms appear

(4) Dinosaurs become extinct and angiosperms appear.

Q.129 Evolutionary history of an organism is known as **[CBSE 2006, AFMC 2008]**

(1) Ontogeny (2) Phylogeny

(3) Ancestry (4) Palaeontology

Q.130 Which is correct Aristotle's ladder of nature? **[Kerala 2006]**

(1) Inanimate matter → Lower plants → Higher plants → Zoophyta → Entoma → Ostracoderma → Malacia → Malacostraca → Fish → Oviparous quadrupeds → Cetacea → Birds → Viviparous quadrupeds → Humans

(2) Inanimate matter → Lower plants → Higher plants → Zoophyta → Entoma → Malacia → Malacostraca → Ostracoderma → Fish → Oviparous quadrupeds → Cetacea → Birds → Viviparous quadrupeds → Humans

(3) Inanimate matter → Lower plants → Higher plants → Zoophyta → Malacia → Entoma → Malacostraca → Ostracoderma → Fish → Oviparous quadrupeds → Cetacea → Birds → Viviparous quadrupeds → Humans

(4) Inanimate matter → Lower plants → Higher plants → Zoophyta → Entoma → Ostracoderma → Malacostraca → Malacia → Fish → Cetacea → Oviparous quadrupeds → Birds → Viviparous quadrupeds → Humans

(5) Inanimate matter → Lower plants → Higher plants → Zoophyta → Entoma → Ostracoderma → Malacia → Malacostraca → Fish → Cetacea → Birds → Oviparous quadrupeds → Viviparous quadrupeds → Humans.

Q.131 Major radiation of mammals, birds and pollinating insects took place in the epoch **[Kerala 2006]**

(1) Oligocene (2) Palaeocene

(3) Pliocene (4) Eocene

(5) Miocene.

Q.132 Which is correct **[CET Chd. 2006]**

(1) Wings of birds and insects are homologous

(2) *Archaeopteryx lithographica* is missing link between birds and mammals

(3) Paired fins of fish and flippers of whale are analogous

(4) Caecum and appendix in Rabbit and man are analogous.

Q.133 First mammals are found in era-period **[CPMT 2007]**

(1) Permian ..... Palaeozoic

(2) Triassic ..... Mesozoic

(3) Tertiary ..... Coenozoic

(4) None of these.

Q.134 Most of the fossils occur in rocks **[Orissa 2007]**

(1) Sedimentary (2) Metamorphic

(3) Igneous (4) None of the above.

Q.135 Duck-billed Platypus is connecting link between **[Orissa 2007, AFMC 2009]**

(1) Echinodermata and chordata

(2) Arthropoda and mollusca

(3) Reptilia and mammalia

(4) Reptilia and aves.

Q.136 Plants and animals of Galapogos islands resemble plants and animals of main land in **[Orissa 2007]**

(1) North Africa (2) South Africa

(3) North America (4) South America.

Q.137 Fossils found in Mandla district of M.P. is **[MPPMT 2007]**

(1) 260 million years old

(2) 100 million years old

(3) 50 million years old

(4) 20 million years old.

Q.138 Tendrils of *Cucurbita* and thorns of *Bougainvillea* are **[DPMT 2007, CBSE 2008]**

(1) Homologous organs

(2) Analogous organs

(3) Vestigial organs (4) Atavistic divergance.

Q.139 Parallism is due to **[DPMT 2007]**

(1) Adaptive divergence

(2) Adaptive convergence

(3) Adaptive convergence of unrelated species

(4) Adaptive convergence of closely ralated species.

Q.140 Which one is correct **[CBSE 2007]**

(1) There is no evidence of presence of gills in mammalian embryos

(2) Ontogeny repeats phylogeny

(3) All plant and animal cells are totipotent

(4) Stem cells are specialised cells.

Q.141 Finches of Galapogos provide evidence for **[CBSE 2007]**

(1) Retrogressive evolution

(2) Special creation

(3) Biogeographical evolution

(4) Evolution due to mutation.

Q.142 Two species of different geneology show resemblance due to similar adaptation. The phenomenon is **[CBSE 2007]**

(1) Convergent evolution

(2) Divergent evolution

(3) Micro-evolution (4) Co-evolution

Q.143 Adaptive radiation is **[CBSE 2007]**

(1) Evolution of different species from a common ancestor

(2) Adaptation due to geographical isolation

(3) Migration of members of a species to different geographical areas

(4) Power of adaptation of an individual to a variety of environments.

Q.144 What is common to Whale, Seal and Shark **[CBSE 2007]**

(1) Homoiothermy (2) Seasonal migration

(3) Thick subcutaneous fat

(4) Convergent evolution.

Q.145 Which ones are not analogous organs **[Kerala 2007, CPMT 2009]**

(1) Wings of birds and wings of butterfly

(2) Eye of *Octopus* and eye of mammals

(3) Flippers of penguins and fippers of Dolphi

(4) Thorns of *Bongainvillea* and tendril of *Cucurbita*

(5) Tuberous root of Sweat Potato and stem tuber of Potato.

Q.146 Descendent of fossil Protylopus is **[MHTCET 2007]**

(1) Giraafe (2) Camel

(3) Elephant (4) Cow

Q.147 Vestigial organs provide evidence of organic evolution in the category **[JKCMEE 2007]**

(1) Anatomical (2) Embryological

(3) Morphological (4) Palaeontological.

Q.148 Life has existed on earth for the last **[HPPMT 2007]**

(1) 2·3 billion years (2) 3·9 billion years

(3) 4·3 billion years (4) 5.0 billion years

Q.149 Darwin's finches show **[HPPMT 2007, CBSE 2008, 2010]**

(1) Adaptive radiation

(2) Parallel evolution

(3) Homology (4) Natural selection.

Q.150 Connecting link between annelida mollusca is **[BHU 2007, AFMC 2010]**

(1) *Nautilus* (2) *Neopilina*

(3) Glochidium (4) Veliger larva.

Q.151 Which one is the earliest era ? **[Orissa 2008]**

(1) Coenozoic (2) Mesozoic

(3) Palaeozoic (4) Pre-cambrian.

Q.152 Wings of birds and fore-limbs of horse are **[Orissa 2008]**

(1) Vestigial (2) Analogous

(3) Homologous (4) None of the above

Q.153 Closely related species with different traits exhibit **[Orissa 2008]**

(1) Convergent evolution

(2) Divergent evolution

(3) Parallel evolution (4) None of the above.

Q.154 Which isotope is used in finding age of fossil of more than 4500 years ? **[DPMT 2008]**

(1) 238U (2) 235U

(3) 235Po (4) 12C.

Q.155 Which period is largely associated with extinction of dinosaurs, increase in flowering plants and reptiles ? **[DPMT 2009]**

(1) Triassic (2) Jurassic

(3) Cretaceous (4) Permian.

Q.156 Mass extinction at the end of mesozoic era was probably caused by **[DPMT 2009]**

(1) Continental drift (2) Massive glaciation

(3) Collision of earth with large meteorite

(4) Change in earth's orbit.

Q.157 *Tachyglossus* is connecting link between **[DPMT 2009]**

(1) Reptiles and mammals

(2) Reptiles and birds

(3) Amphibians and reptiles

(4) Birds and mammals.

Q.158 Phylogeny is **[CET Chd. 2009]**

(1) Evolutionary history

(2) Life history

(3) Group of phyla

(4) Genetics of animals.

Q.159 Relatedness of two species is tested through **[Orissa 2009]**

(1) RNA and proteins

(2) DNA and proteins

(3) Antibodies and transposons

(4) None of the above.

Q.160 As per Allen's rule, mammals of cold regions conserve body heat through **[AMU 2009]**

(1) Larger body mass

(2) Small body mass

(3) Longer extremities

(4) Smaller extremities.

Q.161 *Peripatus* is connecting link between **[CBSE 2009]**

(1) Porifera and coelenterata

(2) Ctenophora and platyhelminthes

(3) Mollusca and echinodermata

(4) Annelida and arthropoda.

Q.162 Origin of first toothed birds and gymnosperms occurred during **[CPMT 2009]**

(1) Cretaceous (2) Jurassic

(3) Triassic (4) Permian.

Q.163 A living connecting link that provides evidence of organic evolution is **[CPMT 2009]**

(1) *Sphenodon* between reptiles and birds

(2) *Archaeopteryx* between reptiles and birds

(3) Lung fishes between pisces and reptiles

(4) Duck-billed *Platypus* between reptiles and mammals.

Q.164 After the industrial revolution, melanic moths survived because **[COMED-K's 2010]**

(1) They had black colour

(2) They had grey body colour

(3) They shifted to different habitat

(4) They reproduced vigorously.

Q.165 In evolution of horse, two most important anatomical and morphological changes brought about are **[CET Chd. 2010]**

(1) Limbs and tail (2) Limbs and teeth

(3) Teeth and tail (4) Limbs and height.

Q.166 Vesitiges of girdles are found in **[AMU 2010]**

(1) Rattle snake (2) Krait

(3) Cobra (4) Python.

Q.167 An evolutionary pattern characterised by a rapid increase in number of kinds of closely related species is called **[AMU 2010]**

(1) Divergent evolution

(2) Convergent evolution

(3) Adaptive radiation

(4) Parallel evolution.

Q.168 The first seed plants appeared in **[MPPMT 2010]**

(1) Cretaceous era (2) Carboniferous era

(3) Devonian era (4) Silurian era.

Q.169 Which was the biggest land dinosaur **[HPPMT 2010]**

(1) *Protoceratops*

(2) *Amptosaurus*

(3) *Tyrannosaurus rex*

(4) *Ichthyosaurus.*

Q.170 Organs that perform same function but are not similar in structural details and origin are called **[JKCEE 2010]**

(1) Analogous organs

(2) Homologous organs

(3) Vestigial organs

(4) None of these.

Q.171 Homologous organs have **[AFMC 2010]**

(1) Similar morphology

(2) Similar anatomy

(3) Different anatomy

(4) All the above.

Q.172 Given below are four statements (a–d) with one or two blanks. Select the option which fills up the blanks in two statements.

(a) Wings of butterfly and birds look alike and are the result of ....(i).... evolution

(b) Miller showed that CH4, H2, NH3 and ....(i).... when exposed to electric discharge in a flask resulted in formation of ....(ii) evidence of evolution

(c) Vermiform appendix is a ....(i)....organ and ....(ii)....

(d) According to Darwin evolution took place due to ....(i).... and ....(ii).... of the fittest **[CBSE Mains 2010]**

(1) d – (i) small variations, (ii) survival, a – (i) convergent

(2) a – (i) convergent, b – (i) oxygen, (ii) nucleolides

(3) b – (i) water vapours (ii) amino acids c – (i) rudimentary (ii) anatomical

(4) c – (i) vestigial (ii) anatomical, d – (i) mutations (ii) multiplication.

Q.173 What was the most significant trend in the evolution of moden man (Homo spiens) from his ancestors ? **[AIPMT Pre 2012]**

(1) Binocular vision

(2) Increasing cranial capacity

(3) Upright posture

(4) Shortening of jaws

Q.174 Which one of the following options gives one correct example each of convergent evolution and divergent evolution? **[AIPMT Pre 2012]**

	Convergent evolution	**Divergent evolution**
(1)	Thorns of Bougainvillia and tendrils of *Cucurbita*	Wings of butterflies and birds
(2)	Bones of forelimbs of vertebrates	Wings of butterfly and birds
(3)	Thorns of Bougainvillia and tendrils of *Cucurbita*	Eyes of Octopus and mammals
(4)	Eyes of octopus and mammals	Bones of forelimbs of vertebrates

Q.175 The extinct human who lived 1,00,000 to 40,000 years ago, in Europe, Asia and parts of Africa, with short stature, heavy eye brows, retreating fore heads, large jaws with heavy teeth, stocky bodies, a lumbering gait and stooped posture was : **[AIPMT Pre 2012]**

(1) Neanderthal human

(2) Cro-magnan humans

(3) *Ramapithecus*

(4) *Homo habilis*

Q.176 Evolution of different species in a given area starting from a point and speading to other geographical areas is known as : **[AIPMT Pre 2012]**

(1) Naturation

(2) Migration

(3) Divergent evolution

(4) Adaptive radiation

ANSWER KEY

EXERCISE – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	1	1	2	2	1	3	2	4	4	2	1	3	2	4	3	3	1	4
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	2	4	1	4	4	2	2	3	4	4	2	3	1	4	3	3	2	2	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	2	3	1	3	3	1	1	4	4	2	2	1	3	4	3	3	3	2	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	1	1	2	3	1	3	4	3	2	1	3	2	2	2	1	3	3	2	4
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	1	1	2	4	4	3	1	1	4	4	2	3	4	3	4	2	1	3	2
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	4	4	1	2	3	2	4	1	2	4	3	2	2	1	2	4	1	3	4
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	3	2	3	3	1	2	1	2	2	4	2	3	2	1	3	4	3	1	4	2
Ques.	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans.	3	1	1	4	4	2	3	2	1	2	4	3	2	1	3	3	1	1	2	4
Ques.	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176				
Ans.	4	3	4	1	2	4	3	2	3	1	2	1	2	4	1	4				

These questions consist of two statements each, printed as Assertion and Reason. While answering to choose any one of the following four responses.

(1) If both Assertion & Reason are True & the reason is correct explanation of the Assertion.

(2) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(3) If Assertion is True but the Reason is False.

(4) If both Assertion & Reason are false.

Q.1 **A :** Tnhere is no life on moon.

R : Water is absent on moon.

Q.2 **A :** The first living organism on earth were autotrophs.

R : They were capable to performing chemosynthesis.

Q.3 **A :** Base analogous induced transition.

R : Base analogous performs forbiddan pairing.

Q.4 **A :** Sympatric species are geographically isolated.

R : Sympatric species are reproductively isolated.

Q.5 **A :** Somatic mutations are sometime inheritable.

R : Some organism show vegetative propagation.

Q.6 **A :** Plant having odd number of sets of chromosomes are fertile.

R : Plant having even number of sets of chromosomes are sterile.

Q.7 **A :** Colchicine induces polyploidy.

R : Colchicine causes disjunction of chromosomes.

Q.8 **A :** Change in structure of chromosome is called chromosomal aberration.

R : Substitution is an example of chromosomal aberration.

Q.9 **A :** First life originated in water.

R : Conditions were favourable for origin of life in water.

Q.10 **A :** A single mutation may produce a new species.

R : Mutation may cause major variation in genetic material and these are inheritable.

Q.11 **A :** Evolution is not occuring at present.

R : Evolution take a very long time to occur.

Q.12 **A :** Analogous organs show common ancestory.

R : Analogous organ show evolution.

Q.13 **A :** Lung fish is a connective link between fishes and amphibia.

R : Lung fish show characters of both fishes and amphibia.

Q.14 **A :** Bird's embryo show tooth bud's for some time.

R : Ontogeny repeats phylogeny.

Q.15 **A :** Liger in a hybrid animal.

R : Liger is fertile.

Q.16 **A :** Jurrasic period is considered the age of reptiles.

R : Reptiles dominated in all habitats during jurassic period.

Q.17 **A :** Muscles of external ears are fully developed in humans.

R : Ear muscles close the ears during excessive noise.

Q.18 **A :** Human and apes have a common ancestry.

R : Man and chimpanzee have similar banding pattern of chromosome.

Q.19 **A :** Homologous organs suggest same origin.

R : Organs which are similar in function and dissimilar in internal morphology called as Homologous organs.

Q.20 **A :** Presence of tail in children is a vestigial character.

R : This happens due to the phenomenon called atavism.

Q.21 **A :** In mammals the forelimbs perform, different functions.

R : The forelimbs in different mammals consist of different sets of bones.

Q.22 **A :** There is no scientific explanation to organic evolution.

R : Evolution is a discontinuous process.

Q.23 **A :** Analogous organs suggest same origin.

R : Fore legs of horse and hand of human are analogous organs.

Q.24 **A :** Mammals have evolved from egg laying species.

R : Prototherians are oviparous.

Q.25 **A :** Missing links are most important to study evolutionary history.

R : They fill the gaps of closely related groups

Q.26 **A :** Ear muscles of external ear in man are vestigial.

R : These muscles in man are useful which move external ear freely to detect sound efficiently.

Q.27 **A :** Vestigeal organs are those parts of body which are greatly reduced and are useless.

R : These are the ramnants of once fully developed organs which are gradually lost as there were no longer necessary.

Q.28 **A :** Snakes lost their legs. They donot have use of legs.

R : All the living organism can reduced or increase the organ with the help of internal vital force.

Q.29 **A :** Translocation is a illigal crossing over.

R : Translocation is exchange of chromosomal segments between nonhomologous chromosomes.

Q.30 **A :** Chemical mutagens are more harmful then substitution or point mutation.

R : Acredine and proflavin induces frame shift mutation.

Q.31 **A :** Chemical mutagens are more harmful then radiations.

R : Chromosomal mutagens are cause more variations.

Q.32 **A :** Substitution or point mutations are more harmful as compared to frame shift mutation.

R : Substitution cause major change in structure of protein.

Q.33 **A :** Chromosomal abbreation are more harmful as compared to gene mutation.

R : Substitution are less harmful as compare to frame shift mutation.

Q.34 **A :** In sickle cell anaemia disease Hbs gene is presented in the population.

R : The lose of Hbs gene is balanced by balancing selection.

Q.35 **A :** Australopithecus was first ancestor of man who show bipedal locomotion.

R : Mutation are raw material for evolution.

Q.36 **A :** Reducing atmosphere was essential for origin of life on earth.

R : The early proteins and nucleic acids are formed by non enzymetic process.

Q.37 **A :** Probably DNA evolved after the RNA.

R : RNA has both catalytic and genetic information transfer function.

Q.38 **A :** Electron spin resonance method is used to determine the age of fossils.

R : Fossils mainly present in igenous rocks.

Q.39 **A :** Life originated about 3.9 billion years ago.

R : Life originated in pre cambrian era.

Q.40 **A :** A.R. Wallace divide whole world into six major realms.

R : India is present in oriental realm.

Q.41 **A :** Mimicry is a kind of adaptation.

R : Mullarian mimicry is an example of aggressive mimicry.

Q.42 **A :** Evolution occurs with in populations.

R : Relative frequencies of different variations of DNA change over time.

Q.43 **A :** Duckbilled platypus and spiny anteaters lay egg's like birds (Cleidoic egg) but they are mammals.

R : Presence of cleiodic egg in prototherism show reptilian ancestory of mammals.

Q.44 **A :** Nucleoprotein were first sign of life.

R : The protocell represented the beginning of life.

Q.45 **A :** Origin of virus like structure is an example of retrograssive evolution.

R : "Descent with modification" is a fundamental concept of evolution.

Q.46 **A :** Sedimentry rocks are also called as slate rocks.

R : Rocky mountain revolution took place after paleozoic era.

Q.47 **A :** When the two species are morphologically similar but do not normally interbreed, such species are called sibling species.

R : Stabilising selection reduces variation but does not change the mean value.

Q.48 **A :** Lamarck published the theory of evolution in 1809 the year Charles Darwin was born.

R : According to Lamarckism if an organ in used constantly, it will tend to become developed, whereas disuse result in degeneration.

Q.49 **A :** The aquatic mammals like dolphins whales etc. do not contain gills slits.

R : Their adaptation to aquatic life is secondary.

Q.50 **A :** Unaltered fossils are mostly found in ice-laden areas.

R : These fossils consist of only the hard parts of organisms.

Q.51 **A :** Dinosaurs disappeared due to mass extinction.

R : Mass extinction occurred due to spread of epidermic.

Q.52 **A :** The homologous organs show convergent evolution.

R : The analogous organs show divergent evolution.

Q.53 **A :** Intraspecific struggle occurs between the individuals of different species.

R : Lobester culture in aquarium is an example of interspecifc struggle.

Q.54 **A :** Without variations, evolution is impossible.

R : Only useful variations are transmitted to the next generation.

Q.55 **A :** *Australopithecus* is called African ape-man.

R : It had both human as well as ape characters.

Q.56 **A :** *Homo habilis* was the first tool maker.

R : He was cave-dweller.

ANSWER KEY

EXERCISE – 4

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	4	1	4	1	4	3	3	1	1	4	4	1	1	2	1	4	1	3	4
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	4	4	1	1	3	1	4	1	2	2	4	2	1	2	2	1	3	2	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56				
Ans.	3	1	1	2	2	4	2	2	1	3	3	4	3	3	1	2				

Bansal Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first attempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

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Module - 13
Ecology

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Ramdeo Misra
(Father of Indian Ecology)

ORGANISM AND ENVIRONMENT

INTRODUCTION :

(i) The term ecology was coined and described by – **E.Haeckel.**

(ii) The term ecology was first authentically used by – **Reiter**

(iii) Father of ecology – **Reiter**

(iv) The term Ethology for ecology was used by – **Geoffroy Hilaire**

(v) The term Hexicology for ecology was used by – **G.H. Mivart**

(vi) Study of ecology was initiated in India by – **W. Dudgeon**

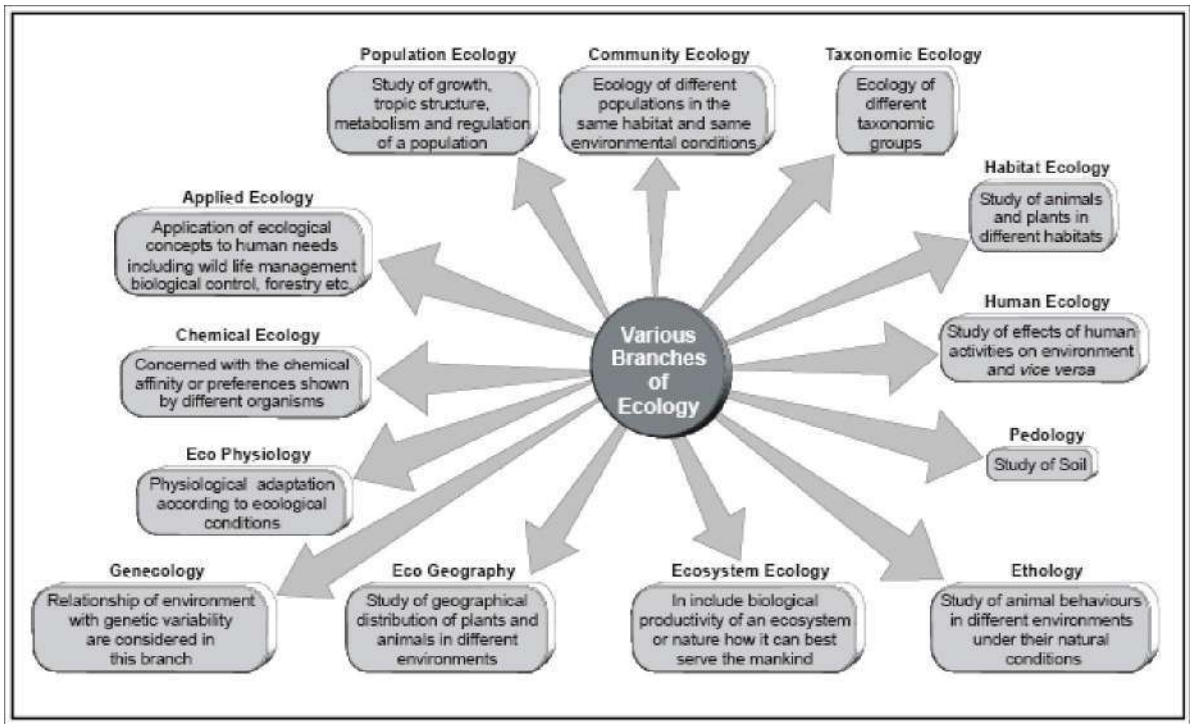
(vii) Father of Indian Ecology – **Prof. Ram Deo Misra**

(viii) First of all term ecology was employed for plants by – **Warming**

(ix) Organism and environment are always interdependent, inter related or mutually reactive.

Branches of Ecology – It is based on organism level

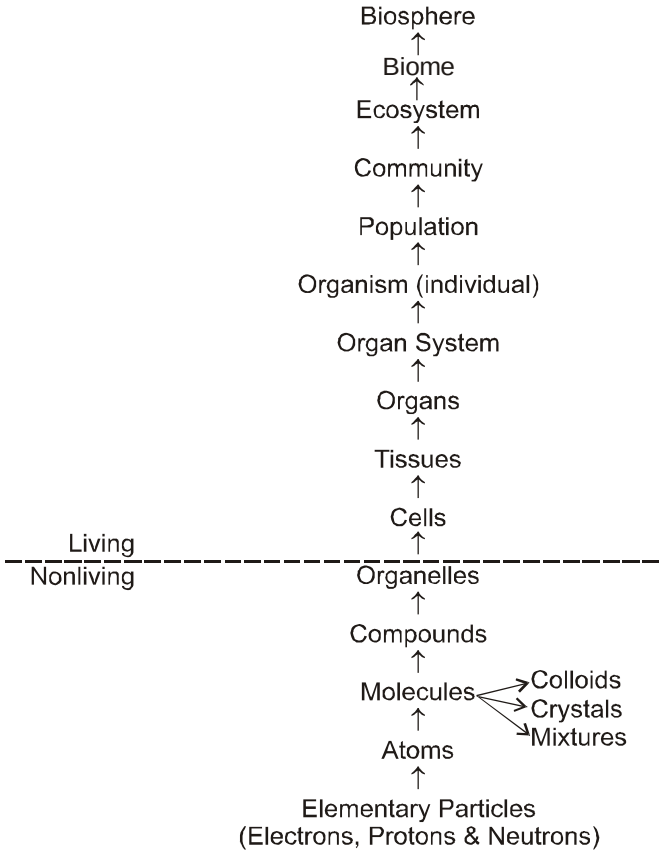
1. **Autecology or species ecology –** Study of the relation of a species or population with its environment is known as autecolocy
2. **Synecology or Biocoenology or Community ecology –** Study of the relation of the group of different species with their environment

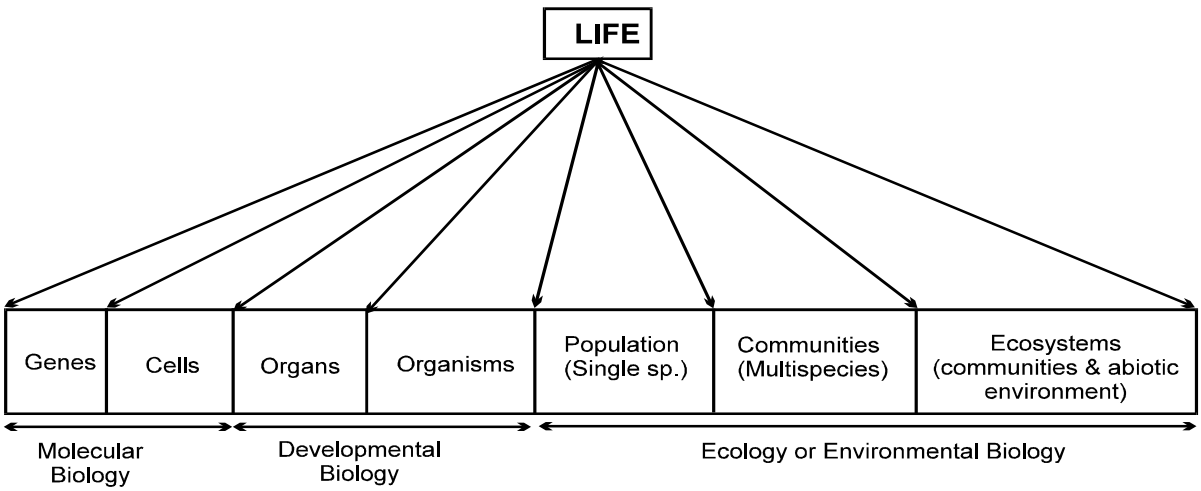


AIMS & SCOPE :

The main aim of ecology is to study the interrelationship between organisms. i.e., Plants, animals and environment. Studies like pollution, soil conservation, soil erosion, proper use of land, afforestation, control on deforestation, regulation of overgrazing, flood control, maintenance of soil fertility etc., are also done in the ecology.

ECOLOGICAL HIERARCHY :





1. ENVIRONMENT :

A. Environment is the sum total of all biotic (living) and abiotic (non-living) factors that surround and potentially influence an organism. Some components of the environment serve as resources, while other act as a regulatory factor.

B. The different components of the environment are interlinked and interdependent. The environment can be understood both at large and global climatic patterns, as well as the local climatic conditions, the microclimate.

Spatial and Time scale of Environment :

Most organisms interact with their environment at several spatial and time scales. For example a single bacterium in soil, interacts with air and water within a fraction of a cubic centimeter space.

On the other hand, a tree in soil interacts, with a large volume of air, water. The activities of organism influence the hydrosphere, the lower atmosphere and the near-surface part of the lithosphere, through exchanges of matter and energy.

Organisms have to cope with the external environment over a range of time scales, varying from few minutes to days, seasons or over a much longer period of geological time scale. For example, phytoplankton populations may change within a few days with the change in light conditions in aquatic systems. On the other hand, the variations in lithosphere occur very slowly over a long period of time.

2. CLIMATE :

A. The short-term properties of the atmosphere (such as temperature, pressure, humidity, rainfall, sun-shine, cloud cover and wind), at a given place and time, is called as **weather**. **Climate** is the average **weather of an area,** including general patterns of atmospheric conditions, seasonal variations and weather extremes averaged over a long period.

B. Weather reflects the hourly, daily or weekly chages in the above properties, climate entails longer periods, such as seasons or years. **Temperature** and **rainfall** are the two most important factors which determine the climate of an area.

C. Global variations of temperature and rainfall result from differential **input of solar radiation** in different region and from the redistribution of heat energy by winds and ocean currents. Variations in temperature, rainfall and humidity in different regions of the globe form global climate patterns, which govern all life on earth.

D. On the basis of variation in mean temperature along latitude, the main climatic regions are-

(i) Tropical (0º - 20º latittude)

(ii) Subtropical (20º - 40º latitude)

(iii) Temperate (40º - 60º latitude)

(iv) Arctic and Antarctic (60º - 80º latitude)

E. The mean temperature declines as we move from tropical to arctic region. A similar climatic zonation occurs with increasing altitude in the mountains. A mountain located in a tropical region will successively have tropical, subtropical, temperate and alpine zones with increasing altitude. Similarly, in temperate zone, the high altitudes will have alpine climatic conditions.

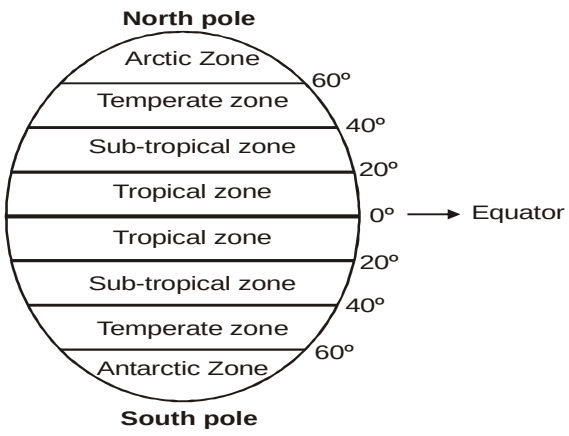
F. Within each temperature-based climatic zone, the annual precipitation (rainfall and/or snowfall) varies considerably. These two factors, temperature and precipitation, together determine the vegetation and soil type.

G. Altitude is height above the sea surface of any place. and Latitude is the distance of any place from the equator.

Note :

The temperature and light values are maximum at the equator, decreases gradually towards the pole. Effect of altitude and latitude are almost same on temperature.

The types of vegetation from sea level to increasing altitude are similar to increasing latitude (distance from equator).



H. **Microclimate :-** The microclimate represents the climatic conditions that prevail at a local scale, or in areas of limited size, such as the immediate surroundings of plants and animals. Microclimate generally differs from the prevailing regional climatic conditions. For example, in a forest, dense foliage reduces the amount of light reaching the ground. This also results in a changed air temperature profile. The day-time air temperature inside the forest is lower than outside. Also, the interior of a forest may be more humid than a nearby non-forested area.

3. HABITAT AND NICHE :

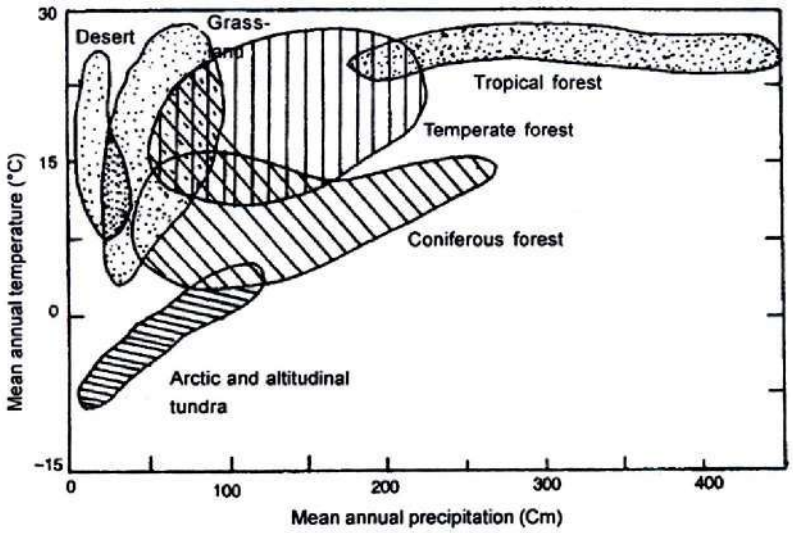
The place where an organism lives is called its habitat. Habitat are characterised by conspicuous physical features, which may include the dominant forms of plant and animal life. We may also understand that habitat may refer to the place occupied by an entire bilogical community. For example, a large number of species are found in a forest habitat.

A. Plants and animals, as influenced by the environmental conditions of a particular habitat, indicate some specific traits. For example, plants growing on saline soils have several characteristics not found in plants growing on normal non-saline soils.

B. A habitat can contain many ecological niches and support a variety of species. The ecological niche of an organism represents the rage of conditions that it can tolerate, the resource it utilises, and its functional role in the ecological system. Each species has a distinct niche, and no two species are believed to occupy exactly the same niche.

4. BIOME

Large ecosystem is called biome, mainly large aquatic and terrestrical ecosystem are called biomes. Altitude and latitude determine the boundary of biome.



Types of world biome : From the poles towards the equators.

(i) Tundra Biome : 60-80ºN latitude.

(ii) Northern coniferous forest or Needle leaf forest : 40-60ºN latitude (Taiga or North wood)

(iii) Temperate Deciduous forest : 40-60ºN latitude or Temperate broad leaf forest.

(iv) Tropical Rain forest : 20-40ºN latitude.

(v) Tropical deciduous forest : 20-40ºN latitude.

(vi) Chaparral (Mediterranean scrub forest) Biome

(vii) Tropical Savanna Biome

(viii) Grassland Biome

(ix) Desert Biome

Major Grasslands are :

Prairies - North America

Pampas - South America

Steppes - Europe and Asia

Tussocks - New zealand

Veldts - Africa

Main desert biomes are :

Sahara - North Africa

Tibet, Gobi, Thar - Asia

Major forest Biomes of India :

(i) Tropical Rain Forest Biome : Western Ghat and North-Eastern Himalaya.

(ii) Tropical Deciduous Forest : In Northern and Southern parts in plain and hilly areas.

(iii) Temperate Broad leaf forest : Western Himalaya.

(iv) Temperate Needle leaf or Coniferous forest : Himalaya.

Forest type	Mean annual temperature (ºC)	Mean annual rainfall (mm)	Dry months during the year*
Tropical rain forest	23-27	2000-35000	2-3
Tropical deciduous forest	22-32	900-1600	6-8
Temperate broad-leaf forest	6-20	1000-2500	3-5
Temperate needle-leaf forest	6-15	500-1700	3-5

Month in which rainfall is < 50 mm.

	Biome	Latitude	Altitude	Vegetation
1	Tundra	Above 60º North	3600 meter height of Himalaya	**Lichen, Moss, Grass** **Note :** * This biome is tree less and also known as arctic desert or alpine tundra. * Timber line - Line beyond which trees are not found. * Perma forst - In this region soil is covered by snow or ice.
2	Northern coniferous or Needle leaf or temperate forest	40º - 60º	1700 to 3000 meter	**Pine (Pinus), Deodar (Cedrus), Cypress (Cupressus torulosa), Spruce(Picea smithiana), Silverfir (Abies pindrow)** **Note :** * Coniferous forest posses needle like leaves * This forest also known as Taiga.
3	Temperate decidous or broad leaf forest	40º - 60º	1500 to 2400 meter	**Oak (Quercus)** **Note :** * Trees shed their leaves in autumn and bear again in spring.

4	Tropical Rain Forest	Tropical rain forest are found at equational region around the earth. In India tropical rain frest are distributed mainly along western Ghat and Eastern Himalaya (Assam, W.Bengal, Andman, Manipur)	**Depterocarpus and Hopea are most common tree species in India. Lianas are also found.**
5	Tropical deciduous forest	Occur widely in the Northern and Southern part of our country in plain and low hilly area.	**Sal (Shorea robusta), Teak (Tectona Grandis), Tendu, Chiraungi, Khair** **Note :** * Leaves of most of the tree fall before summer.
6	Chaparral (Mediterranean scrub forest)	These forest are found pacific coast of North America and South coast of Australia	Draught resistant and fire resistant plant species are found. eg. Small tree, Shrub (sage)
7	Tropical Savanna biome (Thorn forest)	Tropical Savanna biome are found in South America and Aurstralia.	**Coase grass - Dichanthium, Sechima, Phragmites** **Trees - Acacia, Eucalyptus, Zizuphus, Capparis** **Note :** * In this biome grass are found with scattered tree. * This biome also known as tropical grass land.
8	Grass Land Biome		**Name of Grasslands** → **Place** Prairies → North America Pampas → South America Steppes → Europe and Asia Tussocks → Newzealand Veldts → Africa
9	Desert Biome		**Note :** * Gobi desert is cold desert. * Sahara and Thar are hot desert. **Name of Desert** → **Place/Area** Sahara → North Africa Tibbat, Gobi, Thar → Asia

5. BIOSPHERE

All the living and non living (Biotic + Abiotic) components of the earth (biomes) combine together to consitute a big eccosystem called Biospher. Biosphere is also called **Ecosphere**. The term **ecosphere** for biosphere was used by **Cok**. Biosphere (space ship or earth) is closd system for minerals and biosphere is an open system for energy. **Noo-Sphere** (Noo-mind, Sphere-domain) is because of development of human civilisation biosphere is changed in to human dominating environment called noo sphere.

A. Lithosphere – The living components and non-living components present on the earth surface consititutes the lithosphere.

B. Hydrosphere – All living components and non living components present in water consitutes the hydrosphere.

C. Atmosphere – All livign components and non living compoments of air consituted the atmosphere. Atmosphere may be defined as a transparent gaseous envelope surrounding the earth. The vertical profile

of the atmosphere shows several concentric layers. These layers vary in density, temperature, composition and properties. The density is highest near the earth's surface and decreases with altitude. The thin layer from the surface of the earth upwards are :

(i) Troposphere (ii) Stratosphere

(iii) Mesosphere (iv) Thermosphere (v) Exosphere

(i) Troposphere :

A. This is the region up to 8-16 km. height from the earth surface. Therefore wind's clouds, dust particales, spores and pollen and more than 90% of gases of atmosphere are present here.

B. Temperature decrease with increasing of height upto tropopause (Top of troposphere).

C. The temperature average 15ºC near the soil surface and lower down to –57ºC at tropopause, which make transistion to the stratosphere.

(ii) Stratosphere :

A. The region lies up to 16-50 km. from the earth above the trophosphere. There is absence of large convectional current's (wind) so it is excellent region for air travel.

B. Ozone layer is present in the stratosphere which protect us from the harmful U.V. radiations from the sun.

C. Stratopause is transist layer between stratosphere and mesosphere.

(iii) Mesosphere :

A. The region lies up to 50-80 km. from the earth above the stratosphere.

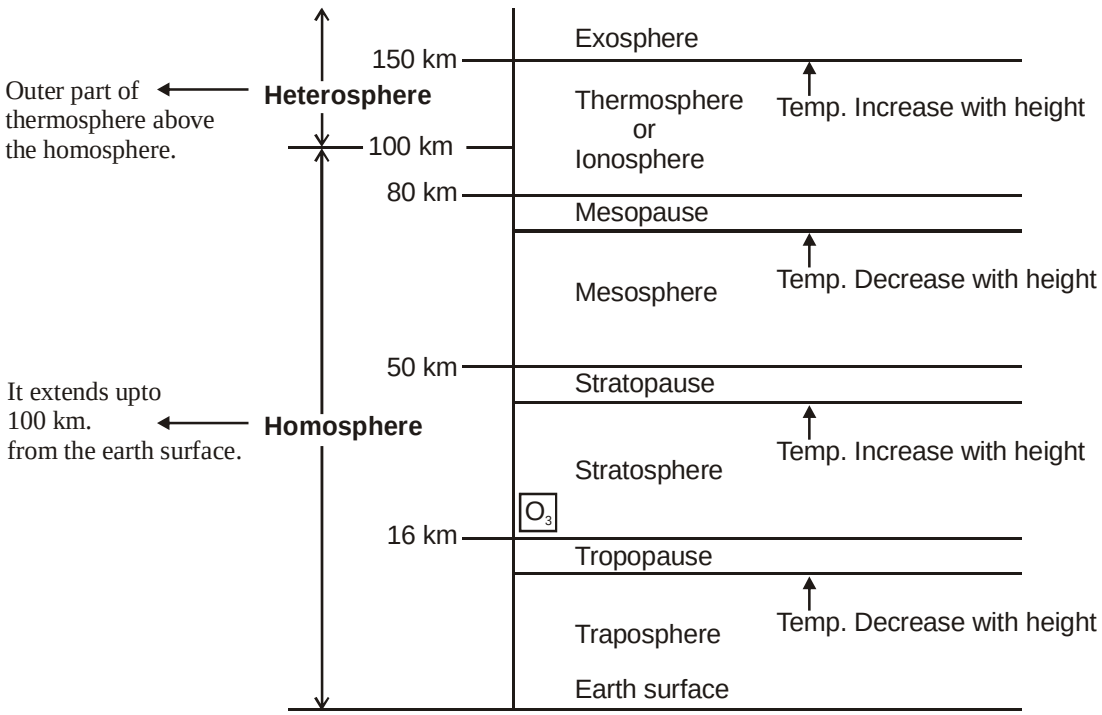
B. It show decrease in temperature with height.

(iv) Thermosphere :

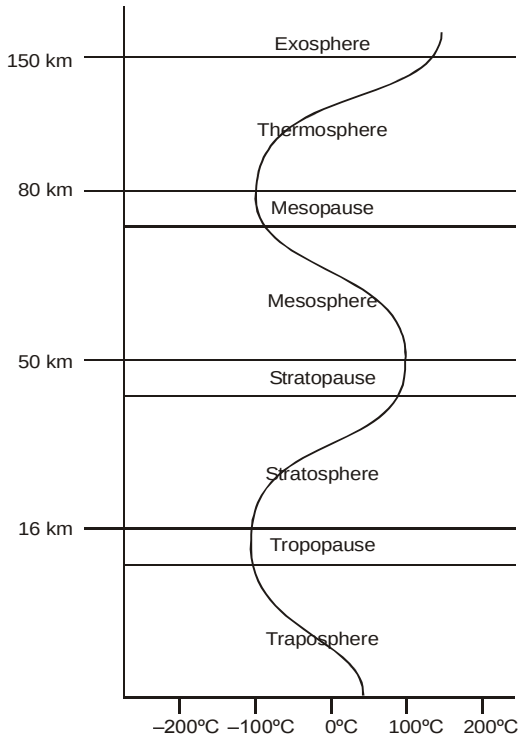
This region lies up to 80-150 km. from the earth above the mesosphere is thermosphere, which contains free electrons and ions. All the communication, satellites are launched only in this layer, because ions and electrons transmits or reflects radio waves (Signals) from the surface of earth.

(v) Exosphere :

The outer fringe of the atmosphere known as the exosphere is extremely rarefied and gradually merges with the outer space. So above the thermosphere is exosphere.



Lapse rate : In troposphere, temperature decreases with increase in altitude. The vertical temperature gradient over earths surface is called lapse rate, it is 6.5ºC per 1000m.



6. ATMOSPHERIC AIR – Atmospheric air contain these gases -

a. $N_2 \rightarrow$ 78.8% b. $O_2 \rightarrow$ 20.92%

c. $CO_2 \rightarrow$ 0.033% d. Argon $\rightarrow$ 0.93% e. Trace components $\rightarrow$ 0.04%

7. LIGHT – Atmosphere get enosmous sun light in the form of electro megnetic speater

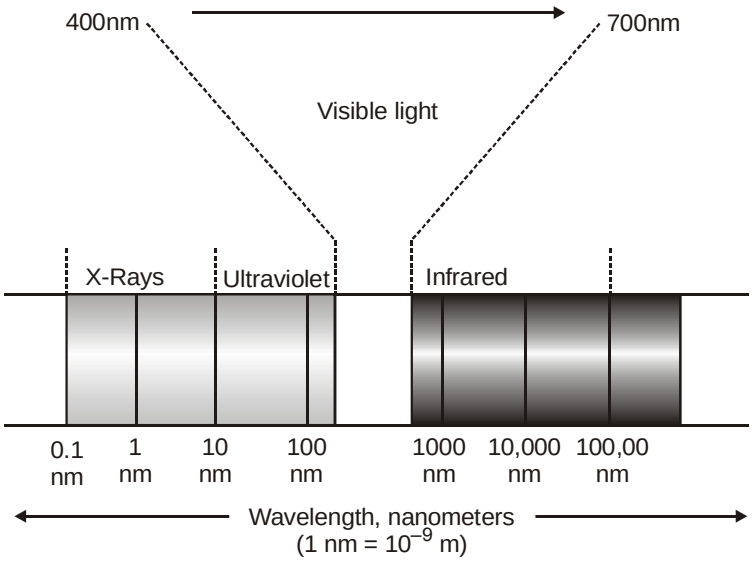


Diagram-I : Showing the electromagnetic spectrum of solar radiation

(i) Solar Constant : Light is measured by **luxmeter or photometer.** Solar radiation before entering the atmosphere carries energy at a constant rate i.e., 2 cal cm^{-2} min^{-1} known as the **solar constant**. In solar radiation wavelength (λ) of light or visible spectrum is **400-700 nm**, it is also called photosynthetically active radiation **(PAR) -**

The U.V. radiation distinguished in

U.V. - C ➡ 100 to 280 nm (Lethial)

U.V. - B ➡ 280 to 320 nm (Quite harmful)

U.V. - A ➡ 320 to 400 nm (Moderatialy harmful)

(ii) Albido value -

The ability of a surface to reflect the incoming radiation is called albido value (AV) it is 80% for fresh snow, 20-30% for sand, 5-10% for the forest.

Out of the total sun light only 1-5% is utilised in photosynthesis.

Only 2-10% of PAR is utilised by plant in photosynthesis.

(iii) Effect of light -

(a) **Photokinesis -** Regulation of speed of locomotion due to light is called photokinesis. **eg.,** Larvae of mussel crab move faster if light intensity increases.

(b) Photomorphogenesis in plants. Photoperiodism, seed germination, plant movements and distribution of plants.

(c) Distribution of plants as heliophytes and sciophytes.

(d) **Phenology -** Timing of seasonal activities of plants in relation to change in environmental condition (Flowering in particular season, leaf abscission etc.) Distribution of animals in aquatic ecosystem - Lake, Pond, Ocean. Light also affects the seasonal and diurenal activities of animals like foraging, reproductive and migratory activities. Light affects distribution of plants and animals in aquatic ecosystem. Light is limiting factor for plants in deep water. The different stratification is observed in lake, pond, oceanic ecosystems due to distribution of light.

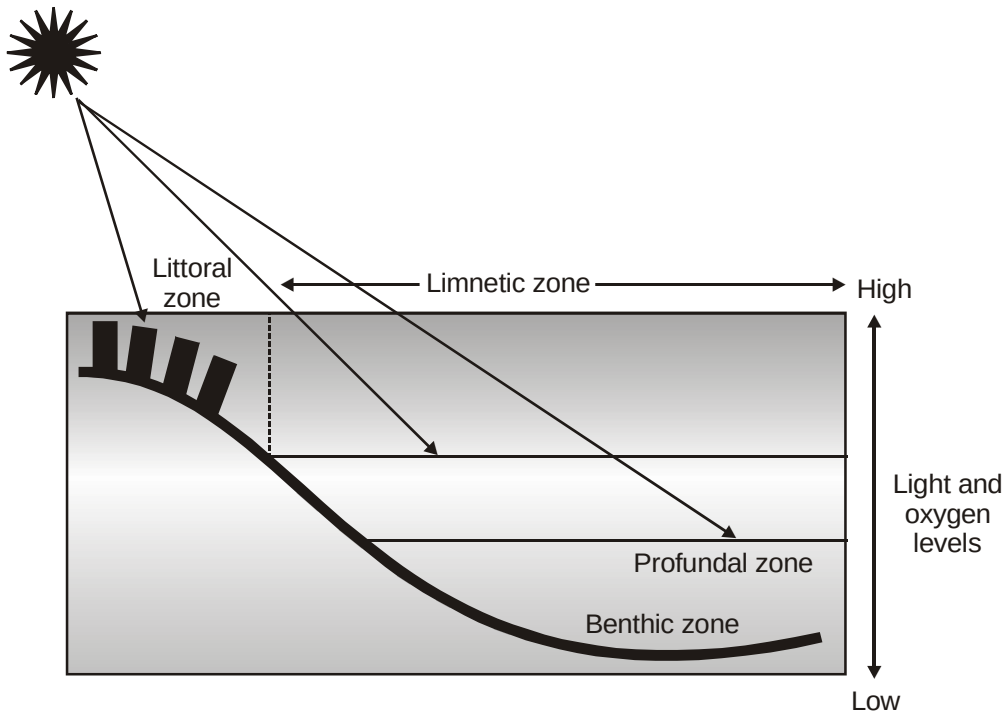
(iv) Stratification in lake on the basic of light :

In deep lake, zonation or stratification may be according to the need of **light**. There are three types of zones differentiated in a deep lake.

A. Littoral Zone - This zone is found at bank of lake with very shallow water or marshy bank is present. Rooted vegetation is found in this zone.

B. Limnetic zone - This is the zone of lake water, where light reaches in sufficient amount to entire surface area. It means this is not too deep. In this region different types of floating plants **(phytoplanktons)**, suspended and submerged plants are present.

C. Profundal zone - It is very deep area of the lake where light does not reach properly up to the bottom. Only **heterotrophs** are present in this zone.



(v) Stratification in Ocean on the basic of light :

All the ocean basins are roughly of the shape of a wash basin or an inverted hat.

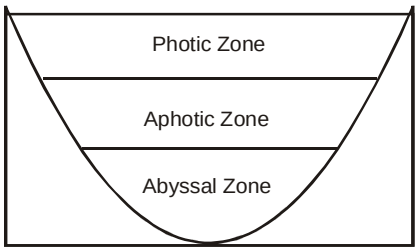
(a) Type-I – On the basis of structure :

From the coast line a gradually sloping region extends for about **160 km** into the sea. This zone is called **continental shelf** and has a depth of **8-200 meters.** The angle of the slopes then abruptly steepens to form the **continental slope.** The continental slope levels off into a more or less horizontal **ocean floor.** The depth of the ocean floor is in the range of several thousand meters.

(b) Type-II – On the basis of availability of light :

The vertical zones of the ocean are determined by the availability or penetration of light for photosynthesis that is-

1. **Photic or Euphotic zone -** It is upper lighted zone up to a depth of about 200 meters.
2. **Aphotic zone -** Middle region where diffused light penetrate which is insufficient for photosynthesis. It extends up to the depth of 200-2000 meters.
3. **Abyssal zone -** It is deeper part where light do not reach below 2000 meter, is the area of perpetual darkness.



(c) Type -III – On the basis of environment :

Three major environment may be recognised in the **ocean basin.**

1. **The Littoral zone -** Comprising the sea floor from the shore to the edge of the continental shelf.
2. **The benthonic zone -** Formed of sea floor along with the continental slope and the aphotic and abyssal zone.
3. **The pelagic zone -** Constituting the water of the ocean basin.

Note :

(A) The shallow shore region of a marine area is called **neritic zone.**

(B) The part have been cut off from river is called **ox-bow-lake.**

(C) Estuaries - The region where, river enter the ocean are known as **estuaries.**

8. TEMPERATURE

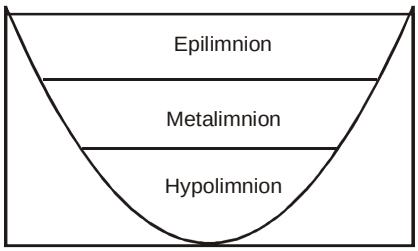
Temperature is the degree of hotness or coldness of a substance. Factors which affects the temperature are latitude, altitude, topography, vegetation and slope. The vertical temperature gradient over earth's surface is called **lapse rate.** And it's value is 6.5ºC per 1000m elevation. Temperature has significant effect on climatic conditions, growth responces of plants, activities of organisms. Plants are affected by temperature like vernalization, thermoperiodism (effect of day-night temperature on various activities) etc. Temperature also affects plant, animal distribution in aquatic ecosystems like in lake.

(i) Thermal stratification in lakes :

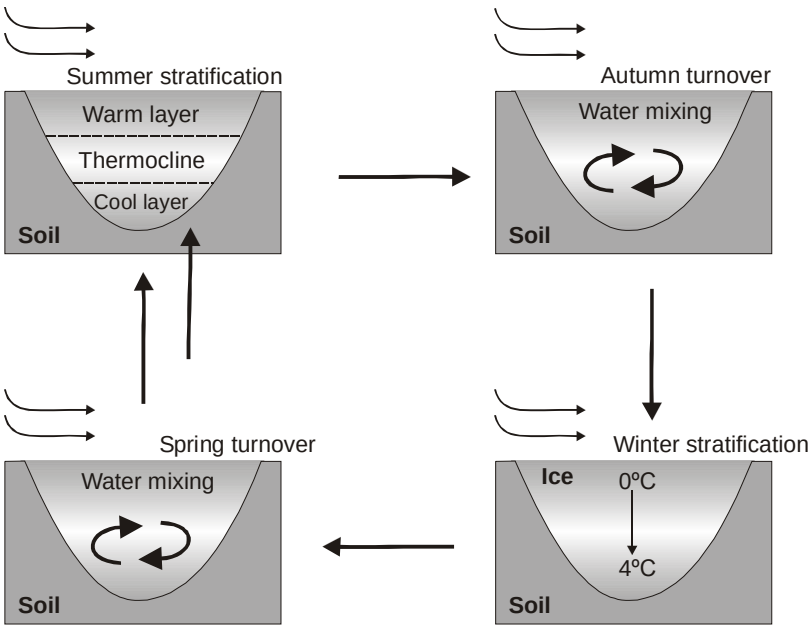
Thermal stratification occurs in deep water body because of difference in temperature of water at different depth. Mainly three layer or zone occurs in water-

1. **Epiliminion -** The top layer gains warmth.

2. **Metalimnion/thermocline -** Middle region where steady decline in temperature or a gradual change in temperature.
3. **Hypolimnion -** Bottom which is not affected by temperature.



4. During summer, temperature is higher on the surface water, whereas in lower layer temperature is low. During winter in a temprate lake, water is at freezing temperature on the surface, whereas in the lower layer temperature is about 4ºC. The surface water is cooled during autumn, and warmed in spring. This results in a free mixing of water in the whole water body, also known as **autumn** and **spring turnover**. During spring and autumn due to turnover of water oxygen and nutrients are redistributed, resulting in a bloom of phytoplankton growth while during winter and summer, **growth of phytoplankon** is low due to low nutrients and oxygen availability.



(ii) Type of plants and animals on the basis of temperature :

(a) On the basis of temperature vegetation is divided into four groups

1. **Megatherms :** The plants growings in high temperature througout the year eg., Tropical rain forest.
2. **Mesotherms :** The plants growing in alternate high and low temperature. eg., Deciduous tropical forest.
3. **Microtherms :** Plants growing in low temperature. eg., Coniferous forest
4. **Hekistotherms :** Plant growing in very low temperature. eg., alpine vegetation

(b) On the basis of temperature animals divide into two groups

1. **Eurythermous or Homeothermal/endothermal/warm blooded -** Animals which are able to tolerate wide variation of temperature. eg., Birds, Man, etc.

   They regulates their internal body temperature by physiological mean, even the outside temperature fluctuates

   Maintainance of relatively constant internal environment under variable environment is called **Homeostasis.**

2. **Stenothermous or Poikilothermal/ectothermal/cold blooded -** Animals which are unable to tolerate wide variation in temperature. eg., Arctic fishes, Reptiles, Amphibians.

   Their body temperature tends to match with environment in which they live. So they control their body temperature by physical mean like move in shade. Some ectotherms are nocturnal and feed during night.

Effect of Temperature on animal :

Temperature affect the absolute size of an animal and its body parts.

1. **Bergman rule -** Birds and mammals attain greater body size in cold region and lesser in warm region.
2. **Allens rule -** The tail, ears, limbs, eyes, snout and hair of mammals are smaller in colder region and larger in warm region.
3. **Jorden's rule -** Fishes in cold water posses more vertebrae than those living in warm water.
4. **Gloger rule -** Warm blooded animals in hot and humid area (tropical region) are more darker in colour (heavily pigmented) than cold area.
5. **Renschs rule -** Birds in cold region have narrow wings and in warm region have broader wings.

9. WATER

The only inorganic liquid occuring on earth which can functions as a resource, condition and habitat. Water regulates the climate through it's role in **rainfall distribution** and **temperature modification**. It also affects vegetation type and it's composition**.** Water presence in soil is of various kinds.

(a) Holard – The total amount of water present in the soil is called holard.

(b) Hygroscopic water : A thin layer of water attached tightly to soil particles due to forces of cohesion or adhesion. This is not available to plants.

(c) Gravitational water : The water that moves downwards due to gravity, it is non available to plants.

(d) Capillary water : Inter particle spaces or porous spaces act as minute capillaries and some amount of water is present in these capillaries due to surface tension. This is capillary water. It is the only form of soil water which is available to plant.

(e) Chemically Combined water - The water which is present as hydroxides of iron, aluminium, silicon, etc. is called combined water.

Some Terminology :

(a) Field capacity - When soil hold all the water except gravitational water, it is known as field capacity. It is upper limit of water availability.

Field capacity = Holard – Gravitational water,

or

Field capacity = Capillary water + Hygroscopic water + Chemically combined water.

(b) Water holding capacity (Storage capacity) - Amount of capillary water retained by any soil. **W.H.C. =** Holard – (Hygroscopic water + Combined water + Gravitational water)

(c) Permanant Wilting Percent (PWP)/Wilting point : The lower limit of water availability of a soil is called wilting point. It is generally hygroscopic and combined water.

Note :

(i) The water potential of soil water at field capacity is **(–0.01 Mpa) [Mpa = Mega pascal]**

(ii) The water potential of soil water at wilting point is **(–1.5 Mpa)**

(iii) Amount of water in soil measured by **tensiometer.**

10. SOIL

Soil is the upper most weathered layer of earth's crust. It composed on minerals and partially decomposed organic matter. Soil is formed when rock are weathered are deposited by water and wind erosion. It is formed due to interaction among parent rock, climate, living organism, time and topography.

Soil Profile :

(a) O - layer - This is made up of **litter.**

(b) A - layer / Top soil - This layer consists of mainly humus. Minerals are also found here. Most of microfauna and micro flora are present in this layer of soil. Four feet thick top soil is essential for growth of plants. The destruction of 'A' layer is called **soil erosion**. A-layer is divided in two parts - A_1, A_2

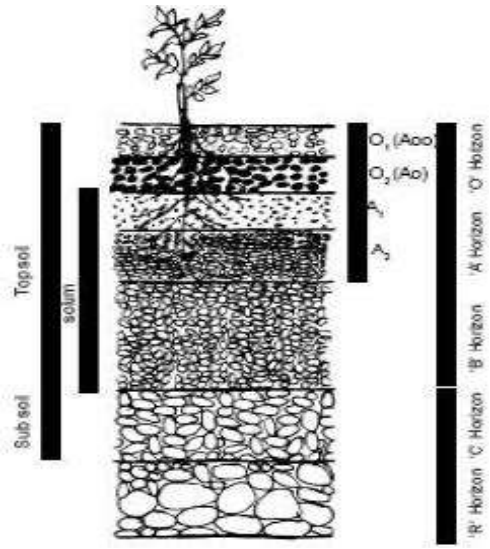
1. **A_1 -** The upper part of A layer (A_1) is also called humic or melanized zone because dark black humus is present.
2. **A_2 -** The lower part of A layer (A_2) is known, as podosolic or eluvial zone or zone of leaching. It is light coloured region because of little amount of organic matter.

(c) B - layer or subsoil - This layer is made up of big soil particles or minerals. This layer has less amount of humus, it contains compounds of iron, aluminium and maganese in higher amount, it is also known as illuvial zone. It is second mineral layer in which the material leached from A_2 zone accumulate. So also called as zone of illuviation or accumulation.

(d) C - layer - This layer is composed of incompletely weathered rock materials.

(e) R - layer - This layer is present in unweathered parental rocks.

A Horizon + B Horizon = **Solum**



Soil Profile

Type of soil on the basis of the mode of their formation -

(a) Residual soil - The soil in which soil formation i.e., weathering and pedogenesis, occurs at same place.

(b) Transported soil - Soil in which weathering process occurs at one place and pedogenesis occurs at another place.

1. **Colluvial soil** ➡ It is brought by gravity.
2. **Alluvial soil** ➡ It is brought through water, it is highly fertile soil.
3. **Glacial soil** ➡ Soil is brought by ice.
4. **Eolian soil** ➡ This soil is brought through wind.

Some Terminology Related to soil

(a) Literization :

In the **tropical area** due to high temperature, high rainfall, litter is decomposed very rapidly in A-layer. Due to mineralization of **Al** and **Fe** are liberated in the upper layer (A-layer) of soil, colour of this soil becomes **redish-brown,** this process is known as laterization and soil is **literite.**

(b) Podsolization :

In **temperate area** temperature is low and high humidity occurs. Humus and minerals contents dissolve and percolate with water and are leached from A layer to B layer. Due to loss of chemicals the colour of soil of A-layer (horizon) turns to **light ash** colour. This process is known as podosolization and soil is known as **podosols.**

(c) Gleization :

In **tundra** region due to low temperature and humid condition humus is formed in less quantity and moves slowly in B-layer. So colour of B-layer becomes **blue-grey** due to deposition of **Fe** salt. This process is known as gleization and soil is known as **gleys**.

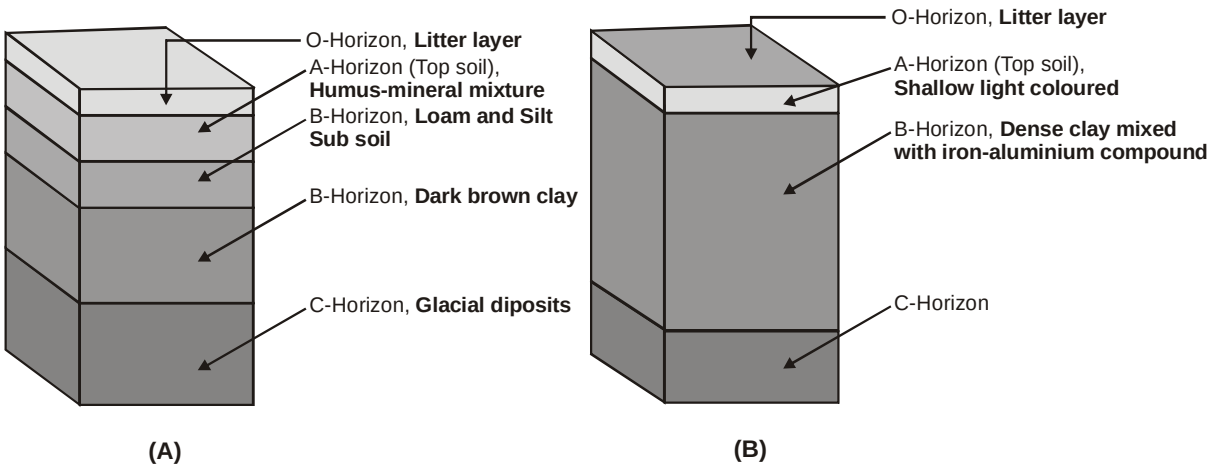


Fig.: Comparison of soil profile (A) temperate deciduous forests, (B) tropical rain-forest.

(d) Soil Organic Matter :

The dead organic matter present in soil is called humus, which is formed by decomposition of plant and animal remains. Freshly fallen plant and animal material called **detritus** or **litter,** partially decomposed litter is called **duff.** Fully decomposed litter is called **Humus.**

Detritus/Litter ➡ Duff ➡ Humus

(e) Soil mineral matter :

Minerals 45% + Water 25% + Air 25% + Organic matter (Living + Non living) **5%**

Soil formation is slow process 1 inch soil is formed in 500-1000 years.

Pedogenesis – Development of soil or soil formation.

Pedology (Edaphology) – Study of soil.

Type of Soil

(a) As a result of weathering the mineral particles of different size are formed. The soil is divided into five types on the basis of **size of soil particles.**

Soil Type	Size of particles
Clay	Less than 0.002 mm
Silt	0.002 – 0.02 mm
Fine sand	0.02 – 0.20
Coarse sand	0.20 – 2.0
Gravel or Grit	2 mm – 5 mm
Coarse Gravel	Above 5.00

Sandy soil	=	85% sand + 15% clay or silt or both
Loamy soil	=	70% sand + 30% clay or slit or both
Silt soil	=	90% silt + 10% sand

(b) Loam soil is the **best soil for growing of crops,** it has high water holding capacity, high aeration and high root penetration.

(c) On the basis of the soil condition there are seven ecological group of plant.

Halophytes – Plants grow in saline soils.

Psamophytes – Plants grow in sand.

Lithophytes – Plants grown on rock surface.

Chasmophytes – Plants grow in rock crevices.

Chersophytes – Plant grow in waste land.

Eremophytes – Plant grow in dry area.

Cryophytes or Psychrophytes – Plant grow in low temperature or cold soil.

11. OTHER ABIOTIC COMPONENT

(i) Precipitation - It is a source of soil water. The hydrological cycle is the movement of water between earth, air and atmosphere.

Forms of precipitation -

(1) Drizzle – Minute drops of water floating in air.

(2) Rain – Large drops of water.

(3) Snow – Water in solid form.

(4) Sleet – Ice in minute granular form.

(5) Hails – Large balls of ice.

(ii) Humidity – Atmospheric moisture in the form of invisible vapour is known as humidity. It is expressed in terms of relative humidity (RH) and it is the amount of moisture in air as percentage of the amount which the air can hold at saturation at the existing temperature.

If temperature ↑ RH ↓

R.H. is measured by **Psychrometer** and Wind speed is measured with the help of **anemometer.**

(iii) Topography –

It includes the physical features of the earth like **altitude**, slope, **exposure**, **mountain chains, valleys, plants**. It affects distribution of organism by influencing the climatic factor like light, wind, rainfall etc.

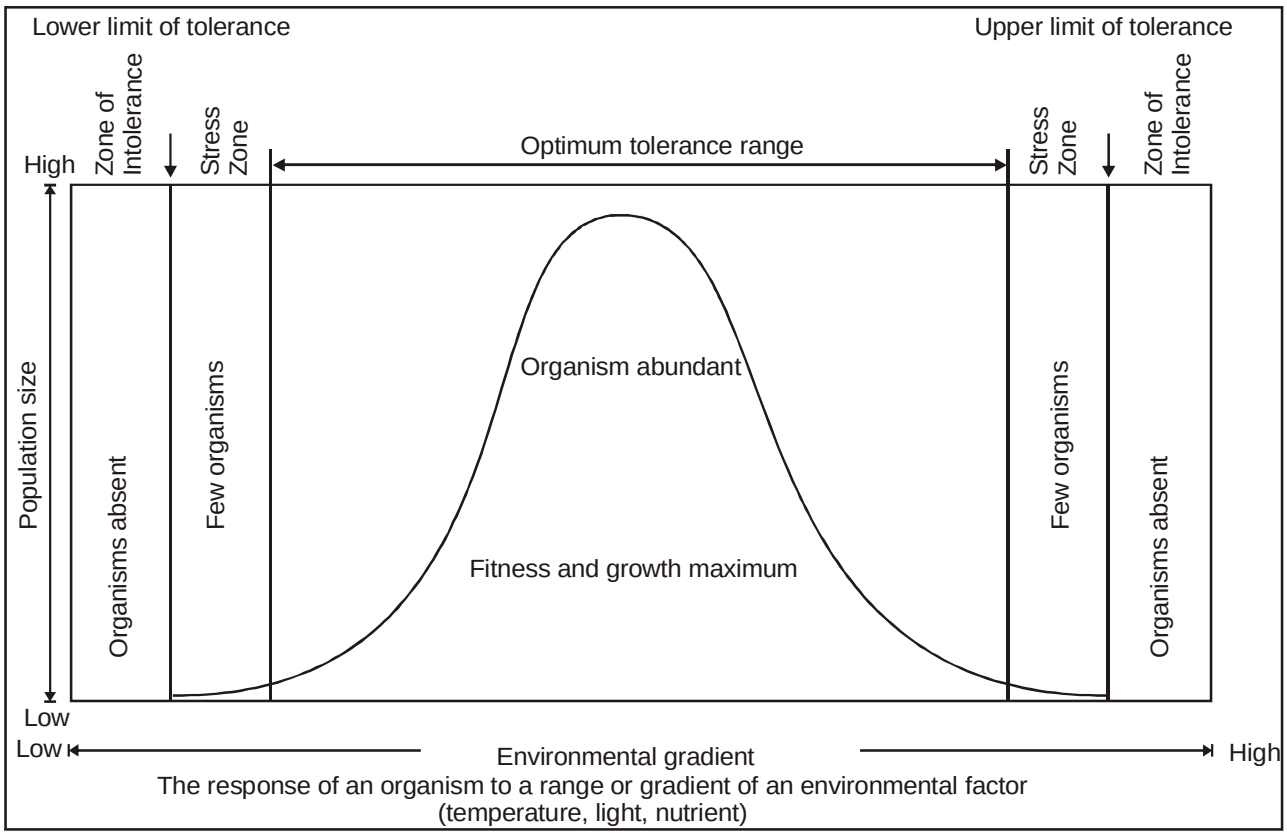
RESPONCE TO ABIOTIC FACTORS :

(i) Adaptations :

The environmental conditions of a habitat are not always constant but change with time. The organisms show various kinds of Adaptations to cope with changed abiotic or environmental conditions. Acclimatisation is a gradual physiological adjustment of the organism to the slowly changing new environmental condition. If there is a shift in some environmental factor beyond the tolerance range of an organism the latter can come to the resting stage or migrate or can undergo acclimatisation.

(ii) Shelford law of tolerance -

(a) Every organism has minimum and maximum limit of tolerance **(ecological amplitude)** with respect to the environmental factor like temperature, sunlight or nutrient concentration. In between these limits the central optimum range is found in which organisms are abundant this is known as **optimum zone of tolerance.**



(b) The organisms have ability to maintain the internal body environment suitable for all biochemical and physiological function to proceed with maximal effeciency and increase the fitness of the species.

(c) It could be in terms of optional body temperature and osmotic concentration of body fluid.

(d) Organisms are of four types on the basis of regulation of internal body environment with changing external environment.

1. Regulators / Regulates 2. Conformers/Conforms 3. Migration 4. Suspend

1. Regulators / Regulates :

(a) Organims which can maintains homeostatasis by **physiological** (Sometime behavioral/physical also) **means** and maintains constant body temperature.

(b) All **birds** and **mammals**, some **lower invertebrates** and **vertebrates.** For example, human beings or mammals maintains their constant body temperature 37ºC in summer by sweat results in cooling and in winter by shivering. Which produce heat and raise body temperature.

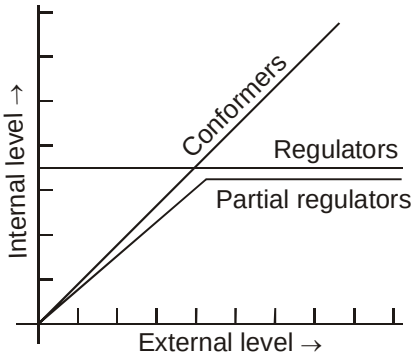
(c) Plants can not show homeostasis so in different climatic zones different plants species are successfully survive.

2. Conforms :

(a) Organisms which are not able to maintains their internal environment (Temperature, osmotic concentration). It means their body temperature change with change in temperature.

(b) About 99% of animals and plants are conforms. For example in small animals like shrews and humming birds, the heat loss or heat gain is function of surface area. So they have to expand much energy to generate body heat through metabolism. Thats why small animals are rarely found in polar region or animals are large in size, in polar region.

(c) Some species have evolved the ability to regulate, but over a limited range at environmental conditions, beyond which they are conform and they are called **partial regulaters.**



3. Migration :

(a) If stressfull external conditions are localized or remain only for a short duration then some organisms show migration and suspension.

(b) The organisms can move away temporarily from stressful habitat to more suitable area and returns when streessful period is over.

(c) For example, birds migration. **Keoladev National Park** of Bharatpur Rajasthan hosts thousands of migratory birds coming from **Siberia** and other extremely cold northern regions.

Some Examples of Migration

Type of migration	Examples	Activities
Long-distance	Arctic tern	Nests close to north pole in summer. Flies from North (Arctic) to Antarctica in autumn and returns to North pole again each spring.
Short-distance	Caribou, Elk and whale	Migrates in search of food each winter to warmer place.
Periodic	Locust (Tiddi)	Large population migrate in search of feeding grounds.

Note : Thermal Migration - Thermal migration has been seen in birds (siberian cranes, arctic tern), mammals (Bison, caribou), fishes (salmon) etc.

4. Suspend ;

(a) In bacteria, fungi, lower plants, various kind of thick walled spores are formed which helps them to survive unfavorable condition and germinate on return of favorable condition.

(b) In higher plants seeds show suspended stage of plant life.

(c) In animals **hibernation** (winter sleep) shown by bears, frogs, during winter. While **aestivation** (summer sleep) shown by some fishes & snails in summer which is mode of time escape or suspension.

(d) In unfavorable conditions many zooplanktons species in lakes and ponds enter in stage of suspended development called **diapause.**

ADAPTATIONS IN ANIMALS :

In the polar sea aquatic mammals like **seals** have a **thick layer** of fat (blubber) below their skin that acts as an **insulator** and **reduces loss of body heat.** Some organisms posses adaptations that are physiological which allow them to respond quickly to a stressul situation. If you had ever been go any high altitude place you must have experienced what is called **altitude sickness.** Its symptoms include nausea, fatigue and heart palpitation. This due to the low atmospheric pressure at high altitudes, body does not get proper oxygen. In human beings the body compensates low oxygen availability by increasing red blood cells (RBC) production, decreasing the binding capacity of haemoglobin and by increasing breathing rate.

(i) Aestivation and Hibernation

In **very cold** or **dry environments**, animals incapable of migration shift to a physiological dormant state. Spending winter in dormant condition is called **hibernation.** On the other hand, spending the dry-hot period in an inactive state is known as **aestivation**. (Examples are shown in table)

Type	Examples	Processes and activities
Hibernation	Northern ground squirrels	True hibernators go into sleep during winter; body temperature drops; breathing and heartbeat become slow.
Aestivation	Ground squirrels in south-west deserts	Avoids heat by spending dry-hot period in a torpid state into burrows.
Cryptic appearance (camouflage)	Leaf-like grasshopper (*Arantia rectifolia*) Paraying mantis (*Phyllocrania paradoxa*)	Grasshopper resembles the complete leaf or appears to be a part of leaf. Mimics a dead leaf and resembles background vegetation.
Batesian mimicry	Monarch butterfly and the mimic viceroy butterfly	Monarch butterfly (contains toxins in the body) and mimicked by viceroy butterfly (contains no toxins).
Mullerian mimicry	Monarch butterfly and the mimic queen butterfly	Both butterfly species look similar and are also distasteful.
Echolocation	Horseshoe bat	Produce high frequency sounds; detect the presence of the echoes produced from the objects on the same principle of sonar.

(ii) Camouflage

In some animals, the capcity to blend with surroundings or camouflage is a common adaptation. Some of them change their bodies, which make difficult to distinguish them from shadows and branches, or from other members of the group.

(iii) Mimicry

Two species resemble each other closely, one speceis, called **mimic**, is palatable to its predator, but resembles

another species, called the **model**, which is distasteful to the predator. In ***Batesian* mimicry,** the mimic is defenseless, but has anti-predatory marks, like the model which has a defense against predators; hence, the mimic is able to protect itself from the attack of the predator. Similarly, the monarch butterfly (containing poison, toxic to predator) is mimicked by the vicerory butterfly (containing no poison). ***Mullerian mimicry*** is the process when the mimic shares the same defensive mechanism as the model.

(iv) Adaptations to Water Scarcity :

(a) Two types of adaptations are prominent in animals living in arid regions. viz. lowering of water loss as much as possible and adapting to arid conditions.

(b) For example, the kangaroo rat conserves water by excreting solid urin, and can live from birth to death without even drinking water. The camels show unique adjustments to desert conditions, being very economical in water use, tolerant to wide fluctuations in body temperature, and are able to maintain blood stream moisture even during extreme heat stress.

(v) Adaptations of Cold :

(a) Sessile animals, such as barnacles and molluscs, living in very cold inter-tidal zones of northern shores, and several insects and spiders resist the effect of cold spells by a process known as cold hardening.

(b) The freeze tolerant organisms have ice nucleating proteins, which induce ice formation in the extracellular spaces at very low sub zero temperatures.

(c) Some freeze-avoiding animals can tolerate environmental temperatures below 0ºC by accumulating glycerol or antifreeze proteins that lower freezing point of their body fluids. Presence of such antifreeze compounds allows the fish in Antarctica region to remain active in sea water.

ADAPTATIONS IN PLANTS :

The plants which are found on the earth, posses some specific characters in order to survive, successfully. Plant develops various types adaptation to protect itself from these adverse factors. Warming, classified plants into three groups on the basis of availability of water.

1. **Hydrophytes :** Plants found in places where excess of water is present are called hydrophyte.
2. **Xerophyte :** Plants found in places where very insignificant amount of water is present are called xerophyte.
3. **Mesophyte :** Places where is neither too much water nor less availability of water. Their habitats is having relative amount of sufficient water.

Note : Ecological adaptations are found in xerophyte and hydrophytes.

1. **Hydrophytes :** Hydrophytes are divided into five groups

(a) Free floating hydrophyte :

This group includes such type of plants which remains floating at water surface which are not in contact with soil of water reservoir from their roots. e.g. ***Lemna, Wolffia, Salvinia, Eichhornia***

Eichhornia is "water hyacinth" and sorrow/terror of Bengal. It is aquatic weed, inhabitant of America.

(b) Suspended hydrophyte :

These plants are suspended in water but not fixed with their root. This do not have contact with the substratum of water body. e.g. ***Najas, Utricularia, Hydrilla***

Utricultria is also known as 'Bladder wort'. This is root less insectivorous plant. The apparatus for catching the insect is formed by the modification of leaf in plant.

(c) Submerged hydrophytes :

These plants entirely submerged under the water and into the mud with their roots. e.g. ***Potamogeton, Vallisneria, Ceratophyllum, Eloidea***

(d) Fixed floating hydrophyte :

This group include such type of plants in which their root are fixed in the mud and leaves are floating on the surface of the water. e.g. ***Nymphaea, Nelumbium*** (Lotus), ***Victoria regia, Trapa***

(e) Emergent hydrophyte :

The basal part of such plants are embedded in water and remaining part floats upon the surface of water such plants grows both type of characteristic as aquatic and terrestrial. So, they are known as **amphibious plants**. e.g. **Typh*a, Juncus, Jussiaea, Sagittaria, Ranunculus aquatlis*** **and** ***Cryptostegia*** **etc.**

Adaptation of hydrophytic plants :

(a) Osmotic Pressure - The osmotic pressure of cells of aquatic plants is very less, so plants do not absorption unwanted water due to low osmotic pressure.

Note : But, osmotic pressure of cells is high in those plants which live in salty water as in sea and sambhar of Rajasthan because it can reduce the loss of water.

(b) Mucilage - Mucilage is found on the surface of aquatic plants. Mucilage protects the plants from the action of bacteria and fungus.

(c) Cuticle - Cuticle is absent on the surface of aquatic plants. These plants exchanged gases through the general body surface. But cuticle and wax is present on the floating leaves, so it become hydrophobic.

(d) Aerenchyma - Aerenchyma is present in hydrophytes which provide buoyancy to the plants and store oxygen which is produce in photosynthesis.

(e) Chlorenchyma - The chlorenchyma tissue of these plants in well developed. The intensity of light is the limiting factor in photosynthesis of aquatic plants. The intensity of light decreases in the deep water so, absorption of more light takes place through well developed chlorenchyma. The whole plant is green excluding roots.

Note : Photosynthetic green roots are present in Trapa.

(f) Epidermis - The epidermis of aquatic plants bear chloroplast.

(g) Mechanical tissue - Mechanical tissue is less developed in hydrophytes. Sclerechyma is either absent or reduced. So, aquatic plants are soft.

(h) Conducting tissues - Conducting tissues [xylem & phloem are poorly developed in hydrophytes]

Xylem of these plants is not differentiated completely. Tracheids and vessels less devoleped. Water is absorbed by the whole surface of aquatic plants so the need of conducting tissue is less.

Phloem is also less developed because whole plants prepare its own food.

(i) Roots - The root system of hydrophytes are either absent [Wolffia and Utricularia] or reduced [Trapa and Eichhornia].

Note : Root cap is absent in Eichhornia. In place of root cap, root pocket is present which is filled by air.

(j) Leaf - The leaves of suspended and submerged hydrophytes are either dissected [Hydrilla and Ceratophyllum] or long, soft and ribbon like [Vallisnaria]. Dissected and ribbon's like leaves do not produce resistance to current so that, protected from destruction.

Usually heterophylly is present in emergent hydrophytes. Two types of leaves are found in these plants. The emerged leaves are dissected and aerial leaves are large and complete. But leaves of floating hydrophyte are long, broad and strong, astrosclereids and trichosclereids are present in these leaves. The leaves becomes solid due to presence of these sclereids. The leaves of Victoria are strongest and highest in diameter. Their diameter is approximately 1 meter.

Astomatic - The leaves of suspended and submerged plants are astomatic. In their leaves stomata are either absent or reduced. These plants exchange gases through the general surface of the body.

Epistomatic - Floating leaves are epistomatic, it means stomata are present only on upper surface of the leaf the lower surface remains in contact of water, therefore stomata are absent on the lower surface.

(k) Reproduction : Hydrophytes reproduce vegatatively and sexual reproduction is found less. Sexual reproduction only takes place in adverse climatic conditions.

Note : The vegetative reproduction takes place vigorously so that these plants becomes a weeds.

2. Xerophytes :

These plants live in deficiency of water. This deficiency of water may be of two types.

(a) Physical dryness - In desert and the slopes of hills where only 20 cm rain fall or less than this condition are present called physical dryness. These plants grow in that region which have very less amount of water is called physical dryness.

(b) Physiological dryness - Sometimes water is present in the habitat but due to some reasons plant can not absorb this water, is called physiological dryness. High concentration of salt water, and low temperature habitat is a type of physiological dryness habitat.

Xerophytic plants are of many types on the basis of Habitat
1. Halophyte - Those plant which grow in saline habitat known as halophyte. Such soil is called marshy soil. Such type of land is unfertile and barren.
2. Epiphyte - Such type of autotrophic plant which grows on other plants are called epiphytes.
3. Psychrophyte - Those plants which grow in cold soil such as plants grown on high range of Himalaya.
4. Chasmophyte - These plants are grow in the crevices of rocks.
5. Psamophyte - Such plants which grow in sandy soil are called psamophyte.
6. Lithophyte - These plants are grown on either rocks or sedimentary soil. Plants grown on the slope of Aravali hill.

1. Xerophytes are divided into three groups by Kerney and Shantz on the basis of their habit -

(a) **Drought Escapers or Ephermerals -** Such type of plants usually grown in desert. These plants complete their life cycle in favourable moisture (humid) season. They leave their mature seed and degenerates before unfavourable condition. These plants are not facing the scarcity of water, so they are **not true (real) xerophytic** plants.

Adapatation : These plants do not have xerophytic adaptation. Spines are found on the surface of these plant, which protect them from the grazing animals. e.g. *Argemone mexicana* (Yellow kanteli) *Solanum xanthocarpum* (Blue or violet kanteli)

(b) **Drought Resistant or Succulent Xerophytes -** These plants absorb water in moist season and stored in plant organs. They stored maximum amount of water and they continue their life processes on this stored water during the drought, so, these plants are not facing the drought. Therefore, they are also **not true xerophytes**. They are the most successful plants in places where deficient water supply. The most of the plants of this group are lithophytes.

Adapatation : The specific type of adaptation are found on these plants for absorption of higher amount of water and to avoid the loss of water.

(i) **Mucilage -** Mucilage is present in the plant organs. It is a colloidal substance. Colloids have a great capacity of imbibition of water. Colloids can absorb more water than its weight. These plants becomes succelent due to presence of mucilage and absorption of water.

(ii) **Stomata - Scotoactive stomata** are found in these plants. Such type of stomats remains close during the days and opens at night. The possibility of transpiration is more during the day. They mainly exchange gases during the night.

All the plants of Cactaceae and Crassulaceae families are succulent plants. Most of the plants of Eurphobiaceae family are succulent.

(c) **Drought Endurers or Non Succulent Xerophytes -**

Psamophytes are included in it. The plants which are found in desert are perennial. They do not store water in their plants organs. However the plant continues to be alive during the drought. Therefore, they are **true xerophytes**.

Adapatation :

(a) Root System - The root system is very long and penetrate the soil to great depth and is well developed. The shoot is less developed (Hight root-shoot ratio) as compared to the root, so that it reduces the transpiration.

(b) Leaves - The maximum adaptations are related with the leaves. The leaves are pinnately compound in most of the plant of this group. A thick layer of the cuticle and wax is present on the upper surface of leaf.

(c) Rolling leaves : Rolling leaves are found in some of the xerophytic plants. The leaves of these plant fold during the mid day. For example : *Ammophila, Emptera, Poa* etc.

(d) Stipules - The stipules of xerophytic plants are modified into spines. These spines protect the plant from the grazing animals e.g. Acacia (Babool).

(e) Stomata - The stomata are present only on the lower surface of the leaf i.e. leaves are hypostomatic. Stomata are sunken type. A cavity is present out side the stomata which is called hypostomatic cavity.

These stomata are surrounded by hairs. Such type of stomata prevent the loss of water. The presence of hair on the leaves are called trichophilly.

(f) Mechanical tissue and vascular tissue - The mechanical tissue and vascular tissue are well developed in these plants. The intercellular spaces are absent, so that cells are tightly arranged. e.g.

(i) *Calotropis* - This plant is most successful in the desert. This is a sand-bounded plant and prevent soil erosion. The leaves of calotropis are simple, but maximum amount of wax is present on it.

(ii) *Caparis aphylla* - The leaves are completely absent in this plant.

(iii) *Nerium* is a typical xerophytic plant. The maximum adaptation are found in this plant such as follows.

(a) The epidermis of the both surfaces are multilayered. A sclerenchymatous hypodermis is present below the epidermis.

(b) Palisade tissue is found on both the surfaces. Vascular bundles are surrounded by sclerenchymatous endodermis.

(c) All the adaptations are only to check the transpiration. Thick cuticle is found in Nerium and wax is present on it.

STUDY OF SOME SPECIAL XEROPHYTES

(i) Halophytes : The plants which grow in salty soils or saline soils are called halophyte. Physiological dryness is found in halophytes.

Adaptation :

1. Osmotic Pressure : The osmotic pressure of cell sap is highest of these plants. The osmotic pressure of cell sap reaches 30 mm of Hg - (atmosphere pressure).

2. **Chalk Glands :** Chalk glands are found on the leaves and roots in some plants of halophytes, which secretes lime. e.g. Atriplex, (maximum)

3. **Mangrove Vegetation :** This is a special group of halophyte. They are found in saline marshy areas of sea-shores and near estuaries. Mangrove vegetation is found in Sunder-bans [W. Bengal] in India. Marshy places are physiologically dry due to the presence of salts. Specially, seed of these plants can not geminates in swampy land.

   The following adaptations are found in mangrove plants.

(i) **Pneumatophores :** Some special type of respiratory roots are found in Magrove vegetation called the **pneumatophore**, they are negative geotropic. Pores are present at the apex of the pneumatophore, they exchange gases through the pores from the atmosphere.

(ii) **Vivipary :** The germination of seed takes place inside the fruit while it is attached to the parent plant that juvenile plant is present in fruit, falls on the marshy soil.

   e.g. *Rhizophora, Sonneratia, Avisinia, Salicornia, Salsola, Heritiera*

(ii) Epipihytes :

Epiphytes are extensively distributed in trophical rain forest. Such type of rain forest lies on the equatorial region around that earth. The main feature of this biome is the good amount of annual rain fall which is more than at lest 140 cm. per year. Such type of forests are found in Assam, W.Bengal, Meghalaya and Andaman Nicobar in India.

Epiphyte are those autotrophic plants which grows on other plants. They do not get water and food from them. Their roots are not present in soil. They absorb atmospheric moisture. Therefore epiphytes are only growing in moistened places. Epiphyte never grows in Rajasthan.

Adaptations

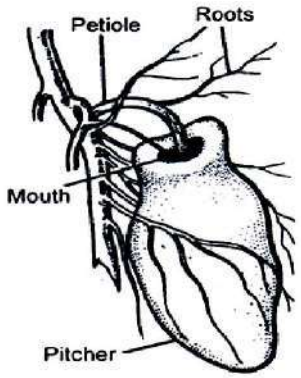
Heterorhizy : These plants are heterorhizomous ie., two type, of roots are found in these plants.

(i) **Clasping Roots :** Their function is only to provide support (fix) the plant.

(ii) **Hanging Roots :** These roots hang in the air these roots have special epidermis which is **multilayered** and made up of thick walled cells, this type of epidermis of root is known as **velamen**. So velamen is an epidermal tissue **Velamen** tissue is is **hygroscopic** in nature. It adsorbs atmospheric moisture.

Note :

1. The plants of Orchidaceae family are known as orchids.
   Orchids are epiphytes. e.g. *Vanda*.
2. **Dischidia** is known as pitcher plant. The leaves modified
   into a pitcher in this plants. Rainy water is collected in the pitcher.



Dischidia

(iii) Physchrophytes :

They are also known as hekistotherms. These plants are grown in cold soil (land). Psychrophytes are found in north and south polar regions. The plants grown at 11000 feet or above are only psychrophytes. They known as Alpines. Such plants are grown on Himalaya.

Cold lands are represent physiologically dry condition. Plants are unable to absorb water because temperature of soil is very less, other reasons are as follows -

1. The viscosity of the water increase due to decrease in temperature.
2. Water potential of water decreases due to low temperature.
3. The permeability of plasma membrane decreases at low temperature.
4. The true characters of xerophytes are found in these plants, such as small leaves, thick cuticle and very deep root system. e.g. *Rhododendron, Delphinium, Anemone, Primula, Sexifraga.*

DIFFERENCES BETWEEN HYDROPHYTES, MESOPHYTES, XEROPHYTES & HALOPHYTES

S.No	Hydrophytes	Mesophytes	Xerophytes	Halophytes
1.	Roots absent or poorly developed.	Fibrous as well as tap root present. Root hair also present.	Long, dense & well developed roots. They are many times longer than sooot.	Roots not completely developed. Pneumatophores & stilt root more developed.
2.	Stem aerial, soft & f1exible. Underground stem more developed.	Stem hard, rigid &stout.	Stem well developed branched & bush like sometime modified into phylioclade.	Stem aerial & well developed.
3.	Leaves thin, narrow, dissected & hairy.	Leaves long, thin have cuticle on outer surface.	Leaves fleshly & leathery. Sometime it is absent or modified into spines.	Leaves thick, leathery & large.
4.	Aerenchymas present	Aerenchyma absent.	Aerenchyma absent.	Aerenchyma some time present.
5.	Cuticle present on outer surface of stem.	Cuticle may be present on outer surface of stem.	Stem outer surface is covered with cuticle or wax.	Outer surface covered with wax.
6.	Stomate absent, if present than very less & only on upper epidermis of leaf.	Stomata are present on both sides of leaves.	Stomata less & sunken, only at lower surface of leaf.	Stomata present but only on lower side of leaves.
7.	Mesophyll not differe-ntiated into palisade cells and spongy parenchyma.	Mesophyll well differe-ntiated into palisade cells & spongy parenchyma.	Mesophyll differentia-ted but palisade more & on both side of leaves.	Mesophyll differentiated, but palisade more than spongy parenchyma.
8.	Growth of plant is slow.	Growth of plant is normal.	Growth of plant is slow.	Growth normal but have viviparous germination.
9.	Mechanical tissues are poorly developed.	Mechanical tissue present & developed.	They are very well developed.	They are developed but lignin is absent.

10.	Transpiration less but Guttation is more.	Transpiration is normal.	Transpiration is reduced by sunken stomata & cuticle layer.	Transpiration very less and Guttation is absent.
11.	Gaseous exchange occur at air spaces.	Gaseous exchange is through stomata.	Gaseous exchange is through stomata.	Gaseouse xchange is through pnematophores.

SPECIAL POINT :

Life Forms : According to Raunkiaer's life forms are of following types. It is bases on the position and the degree of protection to perennating organs (bud) during adverse season,

1. **Phanerophytes -** The bud are located much above the surface of the earth. Such type of plants are found more in tropics. Epiphytes are included in phanerophytes.
2. **Chamaeophytes -** The buds are situated very close/near to the ground surface. Such type of plants are found in cold places or high altitudes.
3. **Hemicryptophytes -** The bud present just below or just above the surface of ground. Such plants are found in temperate climate.
4. **Cryptophytes -** The buds lie very deep in the ground.
5. **Therophytes -** Those plants which are passing the unfavourable climate through their seeds.

Note :

- **Black cotton** – Soil of Maharashtra are commonly known as regur soil.
- **Sierozen** – Light coloured soil of arid region.
- **Bog soil** – Soil of marshed and swamps.
- **Solnetz/Solansltz** – Black alkaline soil.
- **Peat soil** – In which 90% humus in present.
- **Solonchak** – White alkaline & Saline soil.
- Many tribes live in high altitude of Himalaya have high RBC's than people living in the plains. Many xerophytes may accumulate proline (an amino acid) in their cells to maintain osmotic and water potential in their leaves.
- The heat shock protein (chaperonins) provide physiological adaptations to plants to high temperature. This protein helps other proteins to maintain their structure and prevent denaturation at high temperature.
- *Dunaliella* species (green and halophytic algae found in hyper saline lakes) can tolerate saline conditions by accumulating glycerol in the cells, which helps in osmoregulation. The main source of CO_2 for aquatic plants are Carbonates and bicarbonates.

SOME ECOLOGICAL TERMS

1. **Aestivation (Summer sleep) -** Escape from heat of sun
   e.g. Lung fishes, Snails, Goround squirrels in south-west desert
2. **Arboreta -** Botanical graden where specific trees and shrubs species are cultivated.
3. **Benthonic -** The sedentary organisms of sea are called benthonic. e.g. Crabs, Snails, Star fishes
4. **Biodiversity -** The term biodiversity refers to the totality of genes, species and ecosystem of a region.
   (a) Species diversity : Variety of species within a region.
   (b) Species richness : The number of species in per unit area.

5. **Biological (phyto-climatic) spectrum -** The ratio or percentage distribution of different life forms in any plant community is called biological spectrum.

6. **Biome :** Large regional unit or ecosystem characterised by major vegetation type (flora) and associated founa in a specific climatic zone.

7. **Biosphere :** All the earth's terrestrial biomes and aquatic systems constitute biosphere. It includes lower atmosphere the land and the oceans, rivers and lakes, where living beings are found.

8. **Biotic potential (Reproductive potential or potential ability) -** The term biotic potential was first used by Chapmann. Under most favourable environmental conditions the maximum reproductive capacity of an species is known as biotic potential.

9. **Botanochemicals -** Plants can also be used for the manufacture of innumerable synthetic products called botanochemicals.

10. **Calcarious soil** – Soil having excess of calcium carbonate.

11. **Calcifuge Plants** – Those plants which can grow in little amount of calcium in soil (pH - 3.8 to 4.0) eg., Rhododendron, Rumax etc.

12. **Community :** Assemblage of different populations in an area, interacting with each other.

13. **Competitive release -** A species whose distribution is restricted to a small geographical area because of the presence of a comparatively superior species.

14. **Cyclomorphosis -** Change in body shape with the change in temperature
    e.g. Daphnia, Cladocera

15. **Ecocline -** Offsprings of ecotypes are called "Ecocline".

16. **Ecological Equivalents -** Organism that occupy the same or similar ecological niche in different geographical regions are known as Ecological equivalents. e.g. **(a)** Arctic fox and African Jackel, both are scavengers. **(b)** Grazers of North America and Kangaroo's of Australia.

17. **Ecosystem :** Biological communities intergrated with it's physical environment through the exchange of energy and recycling of nutrients.

18. **Ecotone -** The transition zone in between two communities is called ecotone or tension zone. It has greater number of species and density or it is a transition zone between two communities where one type of community is modified into another type of community is known as ecotone.

19. **Edge effect -** Species which occur most abundantly and spend their time in ecotone are called edge species. The tendency to increase variety and density of some organism at the community border is known as edge effect.

20. **Gause's competitive exclusion principle -** This principle state that two closely related species competing for the same resourse cannot co-exist indefinitely and the competitively inferior will be eliminated eventually. This is true if resources are limiting but not otherwise.

21. **Guild -** Organism of same trophic level is known as guild (e.g. Cow, Goat, Rabbit).

22. **Hibernation - Winter sleep** or period of dormancy
    (i) Cold blooded animals
    e.g. Amphibians, reptiles
    (ii) Hot blooded animals
    e.g. Polar bear, North ground squirrels

23. **Land scape :** A unit of land with natural boundary having a mosaic of patches, which represents different ecosystems.

24. **Nektons -** Those aquatic plants and animals which are capacble of swimming actively are called nektons. They have well developed locomotory organs. It includes -

(i) Phytonektons - usually flagella are present in these plants.

e.g. Chlamydomonas and Dinoflagellates

(ii) Zoo Nektons (animals) - Jelly fishes, sharks, fishes, frog, cuttle fishes.

25. **Organism :** Basic unit of study of ecology.

26. **Periphyton -** Organism which lives on hydrophytes like. Vorticella, Hydra, Rotifers

27. **Phenotypic Plasticity**

The phenotype is the physical expression of the interaction between genotype of an organism and its environment. The phenotypes show variations due to difference in the environment conditions with in the local habitat such type of variatons are known as phenotypic plasticity.

28. **Planktons -** Planktons are free floating and small organisms which swim to water currents. They lack locomotory organs or the locomotory organs may be reduced. It includes –

(i) Phytoplankton - Microscopic, floating plants e.g. Diatoms

(ii) Zooplankton - Microscopic, floating animals e.g. Protozoans, Crustaceans, Larvae.

29. **Population :** Group of individuals of a plant or animal species inhabiting a given area or group of individuals of a species.

30. **Resource partitioning -** If two species compete for the same resource, they could avoid competition by choosing alternatives. For instance different item for feeding or different foraging patterns.

31. **Species :** Similar organisms having the potential for interbreeding and producing fertile offspring.

32. **Vitality -** Capacity of normal growth and reproduction for survival of a species. It depends upon weight of plant, stem height, root length,leaf number etc.

COMMUNITY AND INTERACTIONS

SPECIES

Is a basic unit of classification, defined as the group of living organism similar in structure, function and behaviour and produced by similar parents, have common gene pool, can interbreed under natural conditions and reproductively isolated from other group of organism.

(i) Endemic Species or Endemism :

A species which is found only in a particular area is known as endemic species. e.g. Meta sequoia is found only in valley of China, Kangaroo in Australia.

(ii) Key-stone Species :

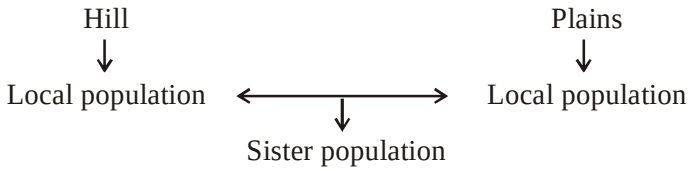
The species which have great influence on the community's characteristics relative to their low aboundance or biomass are called key-stone species. The activities of key-stone species determine the structure of the community. e.g. Lion in forest, Kangaroo rat in desert

(iii) Critical Link Species :

The species which establishes an essential link with other species to help the latter in some vital activity is called link species. e.g. Mycorrhizal fungi, many insect species which works as pollinators of flowers.

POPULATION

A group of individuals (members) of same species living at one place (specific geographical area) constitute a population. Local Population or demes (Sub groups of population) is population of organism inhabiting a particular area. e.g. *Homo sapiens* inhabiting hills, plains. Sister population is different population of same kind of organisms which are found in different places are known as sister population.



Meta population – A set of local population which are interconnected by dispersing individuals.

CHARACTERISTICS OF POPULATION

(i) Birth rate and Death rate :

Population have many features that features are different from a individual. Like individuals have birth and death, while population has birth rate (Natality) and death rate (Mortality). In a poulation these rates are called as per capita birth and death. It can be calculated as for example In a pond 20 lotus plants in last year, 8 new plants are added means current population is 28.

So birth rate of population is $\frac{8}{20} = 0.4$

If out of 20 lotus plants 4 are died then death rate of populations is $\frac{4}{20} = 0.2$

(ii) Sex ratio :

An individual is either male or female, but a population has **sex ratio**. i.e., ratio of male and female like 60% of population are female and 40% are male.

(iii) Age pyramid :

(a) A population at any given time is composed of individuals of different ages. If the age distribution (percent individuals of a given age or age group) is plotted for the population. the resulting structure is called Age pyramid. For human population, the age pyramid generally show age distribution of males and females in a combined digram.

(b) Age pyramid reflects the growth status of the population. i.e.,
(A) Growing (B) Stable (C) Declining

(c) Various age groups in a population determine it's reproductive status. In a population three ages i.e.,Prereproductive, Reproductive and Post reproductive are considered as ecological ages. Distribution of age groups influence the population growth.

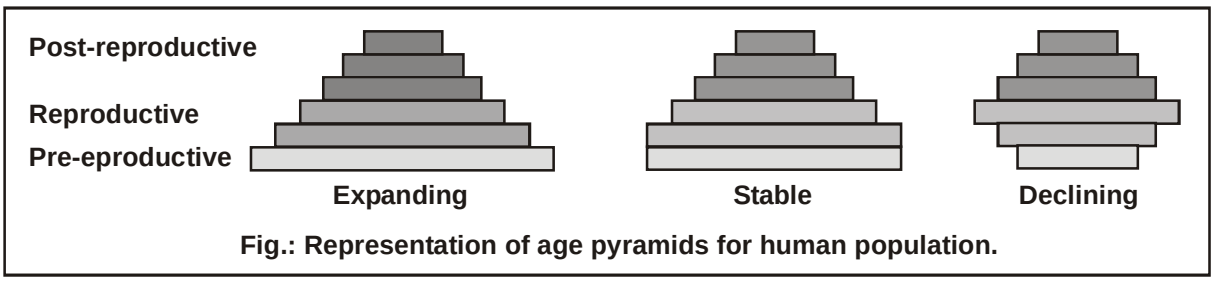


Fig.: Representation of age pyramids for human population.

(iv) Population Density or Population size :

(a) Population density is total number of individuals present per unit area or volume at a given time. For example 50 individuals of tree species grown per hectare and 70 individuals of grass cynodon per square meter. The size of the population is represented by population density.

(b) Census or Counting of human population done every ten year.

(v) Biotic potential and Environmental resistance :

Biotic potential : The inherent maximum capacity of an organism to reproduce or increase in number. Biotic potential (symbol '**r**') can be realised only when environmental conditions are most favourable. So that natality rate is maximum and mortality rate is minimum. In this condition population size increase at maximum rate.

Environmental Resistance : The environmental control on population size, on it's biotic potential. Nature keeps a check on expression of biotic potential. With increase in population size, the environmental resistance (against population) increase.

Environmental resistance do not allow organisms to attain their biotic potential and keep the population size at much lower level.

(vi) Population Growth Forms :

Population have characteristics patterns of growth with time known as population growth form**.** The growth or size of a population of a species is not a static parameter, but it keep changing time to time, due to change in biotic (Food avalability, predation pressure) factors and abiotic factors (water, nutrients, space, weather). But main cause of change in population density in a given habitat during a given period of time is due to change in four basic processes.

1. Natality 2. Mortality 3. Immigration 4. Emigration

1. Natality :

(a) The increase in number of individuals in a population under given environmental conditions is called Natality.

(b) Birth, Hatching, Germination, Vegetative propogation cause increase in number of individuals of population.

(c) The increase in number of individuals in per unit time is called **Natality rate** or **Birth rate.**

2. Mortality :

(a) The loss of individuals due to death in a population under given environmental conditions is called mortality.

(b) Number of individuals of population on dying over a unit time is called **Mortality rate.**

3. Immigration :

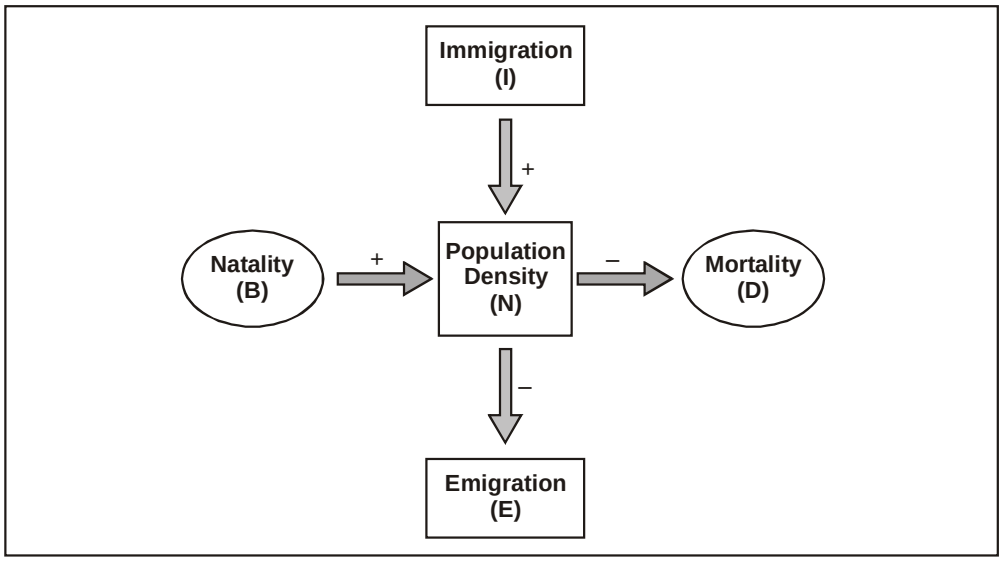
The number of individuals of some species that have come into habitat from elsewhere during given period of time.

4. Emigration :

(a) The number of individuals of population who left the habitat and gone elsewhere during given time period.

(b) So if **'N'** is population density at time **'t'** then at time **t + 1**. It's density is :

$$N_{t+1} = N_t + [(B + I) - (D + E)]$$



The population growth forms (Characteristic pattern of growth in unit time) is of two types.

(i) **J-shaped or Exponential or Geometric Growth Form**

(ii) **S-shaped or Sigmoid or Logistic or Verhulst-Pearl Logistic Grwoth Form**

1. J-shaped growth : In the case of **J-shaped growth** from, the population grows exponentially, and after attaining the peak value, the population may abruptly crash. The exponential growth cannot be sustained infinitely because not only environment is ever changing, food and space are also limited. For example, many insect populations show explosive increase in numbers during the rainy season, followed by their disappearance at the end of the season. The J-shaped growth form is represented by the following exponential equation :

$$\frac{dN}{dt} = rN$$

Where, **dN/dt** is the rate of change in population size, **'r'** is the **biotic potential,** and **'N'** is the **population size**

2. S-shaped or sigmoid growth form shows an initial gradual increase in population size, followed by an exponential increase and then a gradual decline to a near-constant level. This slow-down following

the exponential phase, occurs due to increasing environmental resistance. In such cases, plotting of the rate of increase of population over time gives an **S-shaped** or **sigmoid curve**.

Generally, the population size stabilieses with time, with minor fluctuations around this upper limit. The maximum number of individuals of a population that can be sustained indefinitely in a given habitat, represents its **carrying capacity (K).** The S-shaped sigmoid growth from is represented by the following equation, which includes an expression for environmental resistance:

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right) = rN\left(1-\frac{N}{K}\right)$$

Where, dN/dt, r and N are the same as in the equation for J-shaped growth form, and (K – N)/K or (1– N/K) stands for environmental resistance.

COMMUNITY :

Biotic community is the organization of populations of different species which are interdependent and interact with each other in a habitat. Large number of biotic communities are found in nature due to Existance of diverse habitat with characterstic environmental conditions and co-occurence of different species whose tolerance range overlap with environmental conditions obtained in that habitat.

When similar conditions are repeated at another location the same biotic community established over there. Each biotic community have ecological characteristics which differentiate it from another community.

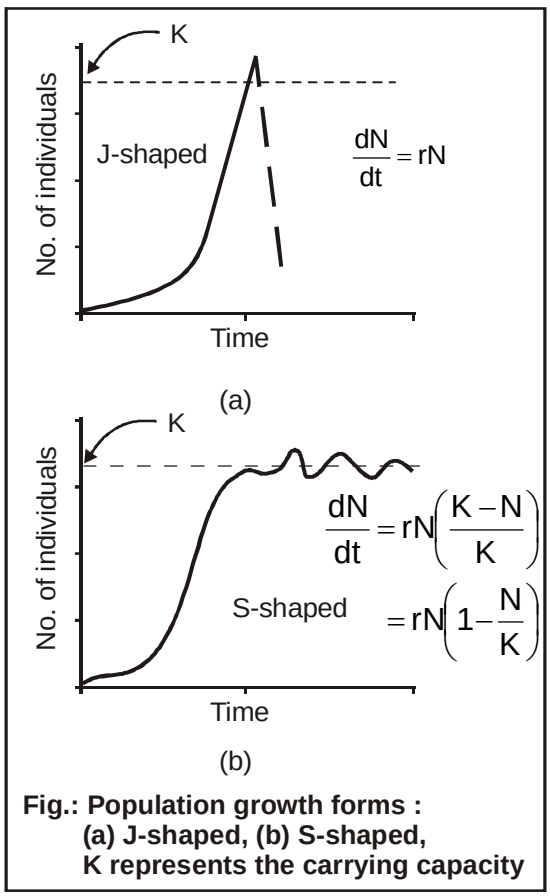


Fig.: Population growth forms : (a) J-shaped, (b) S-shaped, K represents the carrying capacity

Characteristics of Biotic community :

(i) **Species composition -** The kinds of species (Plant and Animals) present in a community represents it's species composition. Species composition are different in different biotic communities even in same community, species composition may be different.

(ii) **Species Dominance / Dominance -** The highest number of organisms of a species present in a community (in terms of number and biomass) is called **dominant species**.

(a) Communities are generally named after their dominant species. For example, forest community with dominance of pine trees is called **Pine forest, grassland community** represents dominance of grasses.

(b) Communities are also named after important environmental factors like **desert community** with dry conditions, **marine community** due to saline conditions of ocean.

(iii) **Physiognomy and Stratification :**

(a) Physiognomy is external appearance or look of a community.

(b) A community is first noticed by it's Physiognomy.

(c) The 'look' or external appearence is the total effect created by the combination of vertical structure and architecture of dominant species of vegetation. For example, high physiognamy of a forest differ from low physiognomy of a grassland.

(d) Several communities may have similar physiognomy, yet they differ sharply on basis of species composition and dominants. For example different forest communities or forest type.

(e) **Stratification-** It represent the vertical layering of vegetation or different layers occupies by different species. The vertical stratification provides physical structure to the plant community, in which many life forms of plants and animals live in.

e.g., stratification in Forest Ecosystem -

Upper most **forest canopy** formed by **large trees** then **understorey tree** layer then **Shrub** layer then lower most **herb** layer.

In a Pond Community upper **surface dwellers** then lower / **bottom dwellers**.

Significance of stratification - Vertical stratification leads increase in number of species and leads to effecient use of resources of a habitat by different types of plants. In aquatic ecosystems, the stratification from surface to bottom is determined by light **penetration, temperature profile** and **oxygen profile.**

(iv) Species Diversity :

(a) More the productive habitat more the diversity of species in a community. For example, **coral reef** and **tropical rain forest** show **high species diversity** while desert community show low species diversity.

(b) The species diversity includes the total number of species present in community and the relative abundence of these species.

(c) Species diversity is the most **important functional property** of a community. (Food chain, Food web)

SUCCESSION

The successive replacement of communities in an area over a period of time is known as succession. Both biotic and abiotic components are involved in successional changes. Succession is a community controlled phenomenon, which results due to action and co-action of living organisms. Physical environment also determines the nature, direction, rate and optimal limit of change during succession. During succession changes occurs in both plant and animal communities.

Type of Succession :

1. **Primary succession -** Occurs in the barren area where there was no vegetation previously, e.g. volcanic lava, esturine soil, mud bank, igoneous rock, sand dunes.
   Note : It requires 1000(s) of years.
2. **Secondary succession :** This type of succession occur where vegetation was present previously but vegetation was destroyed due to natural or artificial causes i.e. fire, flood, sudden changes in climate, land slide.
   Note : This succession is comparatively more rapid, required 50-100 years for grass land and 100-200 years for forest.

Some other type of succession :

(A) On the basis of Replacement :

(i) **Autogenic succession -** During this succession, the community reacts with the environment and changes it. This community is replaced by new community. This is known as autogenic succession.

(ii) Allogenic succession - Community is replaced due to external conditions or forces not by existing vegetation itself. This kind of succession in known as allogenic succession. **e.g.** Fire, Flood.

(B) On the basis of changes in nutritional and energy contents :

(i) Autotrophic succession - This is succession of plants communities.

(ii) Heterotrophic succession - This is succession of animal communities.

Note : Sometimes succession is in retrogressive direction - **e.g.** Forest to grass.

Terms :

- Succession in fresh water → **Hydrosere**
- Succession in salty water → **Halosere**
- Succession in acidic water → **Oxalosere**
- Succession at dry Region → **Xerosere**
- Succession on rocks → **Lithosere**
- Succession on sand → **Psamosere**
- Succession at moistened region → **Mesosere**
- Succession of microbes on decomposed matters → **Serula**

Characteristics :

(A) Continuous change in communities towards a state of stability or climax.

(B) Increases species-diversity, biomass, niche specialization, humus content.

(C) Decreases - net community productivity or annual yield.

(D) Future seral communities can be predicated as it is a directional process.

Community Structure	Seral Stage	Climax
Size of Individual	Small	Large
Ecological Niche	Few	Many
Community organisation	Simple	Complex
Community diversity	Low	High
Community Structure		
Food chain & Food web	Simple	Complex
Effeciency & energy use	Low	High
Nutrient conservation (nutrient cycling & Storage)	Low	High
Heterotrophs	Few	Low
Competition & Predation	Low	High
Net community Productivity	High	Low
r & k - selection	'r'-strategist	k-strategist

Causes of Succession :

1. **Biotic factors -** The action of each seral community (interaction with it's enviroment) makes the less favourable for itself and more favourbale for next seral community in the succession.
2. **Physiographic factors -** These include climatic and other physical factors like soil erosion, soil, landslide, volcanic lava. These all factors makes an area barren.

(a) Plant Formation/Formation ➡ A well developed plant community in any climate is called formation. Ex.: Tropical forest.

(b) Plant Association/Association ➡ A sub unit of formation. A smaller community of plant formation with its two or more dominant species is known as association. A formation has many association.

(c) Consociation ➡ Sub unit of association, means a community with a single dominant species.

Process of Succession

The whole process of succession is actually completed through a number of sequential steps, which follow one another. These steps in sequence are as follows :

1. Nudation –

Formation of bare (nude) areas by natural or artificial causes is called nudation. It is produced through several agencies or natural calamities such as erosion, deposition, wind, water, gravity, slipping of glaciers, fire, lightening, volcanic activity, grazing, diseases and by destructive activities of human beings.

2. Migration –

(a) The seeds, spores or other propagules reach the bare area. This process is known as migration, is generally brought about by air, water and other factors.

(b) The plant structures carried by water are often designated as **disseminules**.

(c) The reproductive structures remaining attached to plant and propagating through the soil are called as **propagules**.

(d) The first arrivals in a bare area are called **pioneers** or **pioneer colonisers**.

3. Ecesis –

(a) After migration the species establish themselves. The process by which the migrants or disseminules establish in a new place is called ecesis.

(b) In plants, after migration, seeds, spores and propagules germinate, seedlings grow and adult start to reproduce.

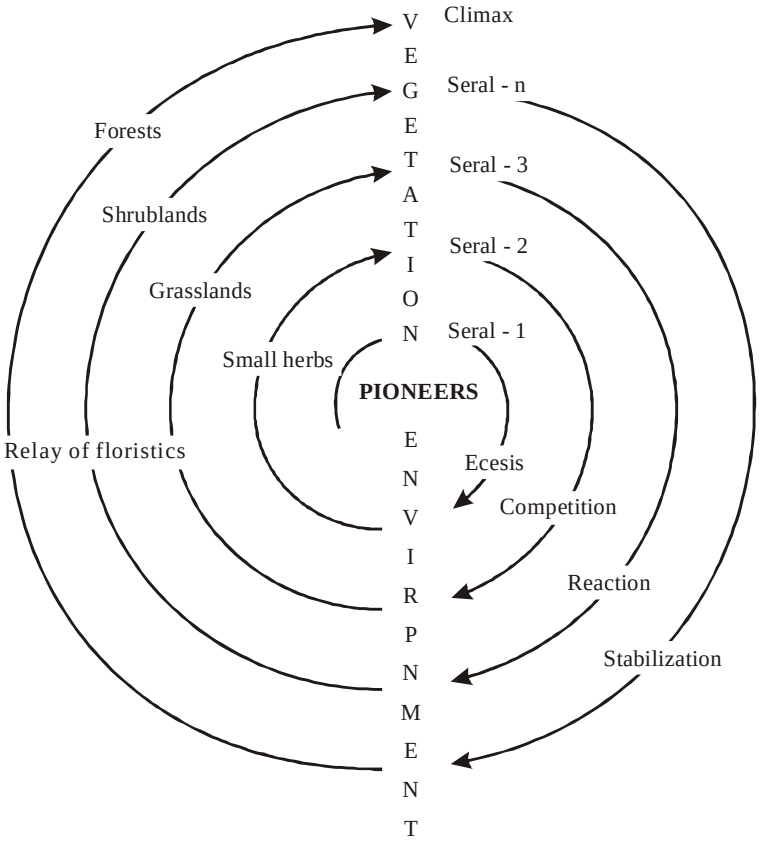
4. Aggregation –

(a) After ecesis as a result of reproduction, the individuals of the species increases in number and they come close to each other. This is known as aggregation.

(b) The three phenomenon i.e. **migration, ecesis** and **aggregation** are sometimes collectively called as **invasion**.

5. Competition and coaction –

(a) After aggregation of a large number of individuals of the species at the limited space, there develops competition. The competition may be for food, space, light or other physical factors. It may occur between individuals of the same species (intraspecific) or different species (interspecific).



(b) Individuals of a species affect each others life in various ways and this is called **coaction**.

6. Reaction –

(a) This is the most important stage in succession. The organisms living in a locality bring about a change in the physical environment and this phenomenon is called as reaction.

(b) As a result of reaction, changes take place in soil, water, light conditions, temperature etc. of the environment. Due to all these the environment is modified, become unsuitable for the existing community which sooner or later is replaced by another community (seral community).

7. Stabilization –

(a) It is the achivement of complete stability of the dominant species.

(b) In this stage the organisms in the community establish a complete harmony with the climate of the area and the community structure remains more or less unchanged. At this stage, there is a perfect equilibrium between abiotic and biotic components of the area.

(c) The final community of dominant species is not replaced by any other group of plants known as **climax community** and the stage as **climax stage**.

IMPORTANT SUCCESSION

(i)Hydrosere :

1.Hydrarch and Hydrosere :

The **ecological succession in water** (pond, lake and saline water) is called as hydrarch and the stages though which it occurs collectively, constitute the hydrosere (in pond or lake) or halosere (in saline water).

The various seral stage of hydrosere are as follows –

(i) Plankton stage : It is the **pioneer stage** of the hydrosere. It consists of a large number of phytoplanktons like **diatoms**, **green algae**, **blue green** algae etc. The phytoplankton are consumed by certain zooplanktons. When planktons die and decompose, they form a very thin layer of humus at the bottom of the pond or lake.

Pioneer community	Seral communities					Climax community
1 Phytoplanity stage	2 Rooted submerged stage	3 Floating stage	4 Read-swamp stage	5 Sedge-meadow stage	6 Woodland stage	7 Forest stage
Blue-green algae, Green algae, Diatoms Bacteria etc.	*Myriophyllum* *Elodea* *Hydrilla* *Potamogeton* *Vallisneria* *Utricularia*	*Nelumbo* *Nymphaea* *Limnanthemum* *Aponogeton* *Trapa* *Monochoria* *Azolla* *Lemna* *Spiodella* *Azolla* *Spirodella* *Wolffia* *Pistia* *Salvinia*	*Scirpus* *Typha* *Sagittaria* *Phragmites*	*Carex* *Juncus* *Cyperus* *Eleocharis*	*Salix* *curmus* *Populus* *Alnus*	*Ulmus* *Acer* *Quercus* Tropical Rain Tropical Deciduous
	General trend of succession →					

(ii) **Submerged stage** – The humus formed by the decomposition of planktons paves way for the arrival of a new community comprising plants eg. ***Hydrilla***, ***Potamogeton***, ***Vallisnaria***, ***Utricularia***, ***Najas***, ***Ceratophyllum*** etc. As a result of decay of these plants more humus is collected at the bottom of the pond or lake.

(iii) **Floating stage**

(a) As more humus and soil is accumulated at the bottom of the pond or lake, it favours introduction of a new community of plants comprising floating forms. There may be plants **rooted in the bottom** soil with floating leaves eg. ***Nymphaea, Nelumbo, Victoria, Trapa, Ranunculus*** *etc*. At places free floating plants also appear eg. ***Azolla, Wolffia, Lemna, Eichhornia, Salvinia, Pistia*** etc.

(b) These plants completely cover the water surface so the submerged plants do not get sunlight and gradually disappear raising the bottom of water body, so the depth of the water is much reduced which disfavours floating plants and thus floating plants also disappear. When these plants decompose, a better substratum is built up.

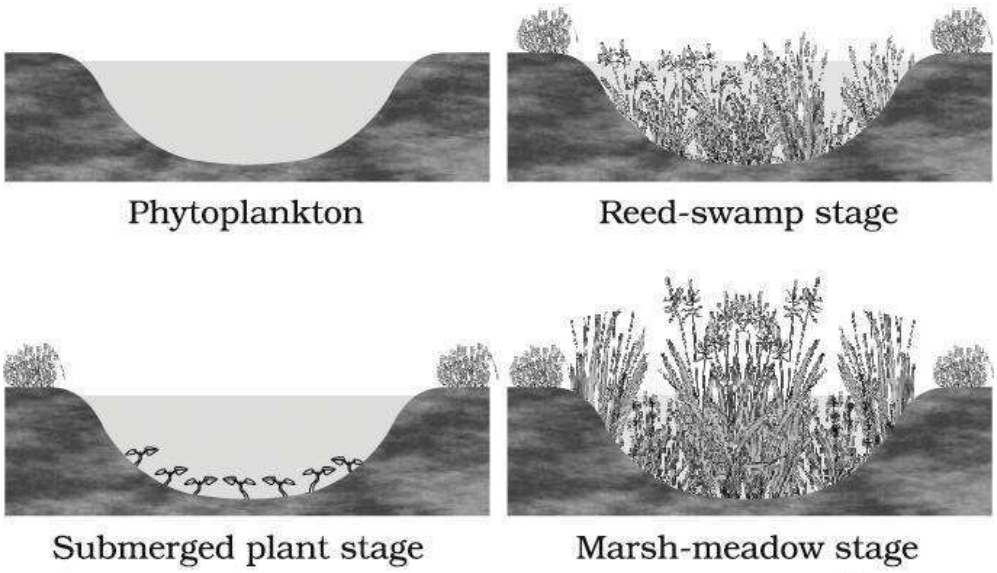
(iv) **Reed swamp stage (Amphibious stage)** – In shallower water **amphibian plants** begin to grow. eg. ***Scirpus, Sagittaria, Typha, Phragmites***. These plants transpire huge quantities of water. They add more silt and humus at the bottom. The water depth is further decreased which favours the next stage.

(v) **Sedge/Marsh meadow stage** – Due to loss of huge amount of water through the amphibious plants accompanied by accumulation of more soil and organic matter, the pond/lake depth reduces further. As a result, a new community invades comprising plants like ***Cymbopogon, Carex*** *(sedge),* ***Cyperus, Juncus***. These plants transpire large quantity of water making the soil too dry for the water loving plants (hydrophytes) to survive. The amount of humus also increases which paves way for the arrival of another plant community.

(vi) **Woodland stage** – **Rhizome bearing shrubs** and **small trees** capable of tolerating excessive light and water logged conditions appear on the edge of sedge/marsh meadow eg. ***Populus*** *(cottonwood),* ***Salix*** *(willow),* ***Cephalanthus, Alnus, Terminalia, Cornus*** *(Bogwood)*

(vii) **Forest stage or climax forest** – This is the final and **climax community.** The woodland community is rapidly invaded by well adapted, self maintaining and uniform plant community consisting of several **woody trees.**

The nature of the **climax** is dependent upon the **climate of the region**. In **tropical regions** with heavy rainfall, there develop **tropical rain forests** but in **temperate regions mixed forests** are formed. They comprise plants like ***Quercus, Acer, Ulmus, Abies, Picea, Taxus*** etc.



Xerarch or Xerosere :

The **ecological succession taking place in a dry area** is called as xerarch. The stages through which it occurs on a bare rock constitute the **lithosere** or on a sand-dune constitute the **psamosere**. Here we will discuss only the lithosere.

The various seral stage of lithosere are as follows :

(i) Crustose lichen stage –

(a) Bare rocks are completely devoid of moisture and nutrients. So in such extremely dry habitats only **crustose lichens** make their foot hold as **pioneers**. The introduction of these plants takes place through the spores or soridia.

(b) Some common crustose lichens are ***Rhizocarpon, Lecanora, Graphis, Rhinodina*** *etc***.** These lichens produce carbonic acid which corrodes the rock forming fine mineral particles (soil particles).

(c) The dead remains of these lichens get mixed with the rock particles. This invites another community to invade upon the rock replacing the previous community.

(d) In tropics, blue green algae are pioneers instead of lichens.

(ii) Foliose lichen stage –

(a) Slowly the foliose lichens begin to colonise upon the rock previously pioneered by crustose lichens. These are leaf like, covering more areas on the rocks. They secrete more acids which enhance soil formation and a thin layer of soil over the rock surface is formed.

(b) The common foliose lichens are ***Parmelia, Umbilicaria, Dermatocarpon*** *etc*. These lichens causes introduction of an other community.

(iii) **Moss stage –** The formation of thin layer of soil on the rocks favours the growth of certain xerophytic mosses like ***Polytrichum, Funaria, Tortula, Barbula, Grimmia*** etc. These erect moss plants accumulate more humus rich soil. Some fruticose lichens like *Cladonia, Usnea* etc. may also grow with the mosses.

(iv) **Annual grass stage –** Annual hardy grasses and herbs invade the humus rich moss dominated rock surface, e.g. ***Aristida, Poa.*** etc. Their roots cause fragmentation of the rock, creating more soil, humus and moisture.

(v) **Perrenial grass stage –** Perrenial grasses invade the annual grass dominated surface, eg. ***Cymbopogon, Heteropogon*** etc. Besides, ferns like ***Adiantum, Asplenium, Actinopteris*** also appear. By further weathering of the rock, more soil is formed. The decomposition of plant material builds up a better layer of substratum that invites yet another plant community to colonise the rock.

(vi) **Shrub stage –** Enough soil is formed in the herbaceous stage (grass stage) which support the growth of woody shrubs, which migrate with the help of seeds etc. from the adjoining areas. eg. ***Fragaria, Rubus, Rhus, Capparis, Zizyphus*** etc. These plants can tolerate bright sunlight. They increase soil and humus content besides moisture.

(vii) **Forest stage or climax forest –** Initially hardy, light demanding small xerophytic trees invade the area. They make the habitat shadier and more moist. The xerophytic trees are gradually dominated by mesophytic trees. The dominant trees of wet temperate area include **conifers, oaks, birches** and **maples**. The warmer areas show dominance of plants like ***Acacia, Prosopis, Balanites, Boswellia*** etc. They represent the climax vegetation which is not replaced.

Pioneer community	Seral communities				Climax community
1 Crustose lichen stage	2 Foliose lichen stage	3 Moss stage	4 Herb stage	5 Shrub stage	6 Forest stage
Rhizocarpon *Rinodina* *Lecanora*	*Parmelia* *Dermato-carpon*	*Polytrichum* *Tortula* *Grimmia*	*Aristida* *Festuca* *Poa*	*Rhus* *Phyto-Carpus*	Mesophytic trees

General trend of succession →

ECOLOGICAL INTERDEPENDENCE AND ECOLOGICAL INTERACTIONS

Ecological Interdependence : Members of biotic community in an area are dependent on one another mainly for **food, space, reproduction** and **protection**. These interaction are important for survival of different species and the community.

(1) **Positive or beneficial interaction -** One or both the interacting species are benefitted but niether is harmed.

(2) **Negative interaction -** One or both interacting species is harmed.

(1) **Positive or Beneficial Interactions :-** It is wide spread phenomenon, it includes → **mutualism**, **commensalism**, **protocooperation**

(A) **Mutualism (+/+) or Symbiosis : (co-evolution)**

Positive interspecific interation in which members of two different species completely depend on each

other for growth and survival, **physcial contact** is present in between both the interacting species. It is obligatory relationship. Both are benifited.

(i) **Mutualism between animal and animal - e.g.** Termites and Flagellates (Trichonympha)

(ii) **Mutualism between plant and animal - e.g.** (a) Zoochlorella and Hydra, (b) Yucca plant folwers and Pronuba insects - Pollination of yucca plant by pronuba (Female yucca moth)

(iii) **Mutualism between plant and becteria - e.g.** legume plant and Rhizobium

(vi) **Mutualism between algae and higher plant - e.g.** Nostoc, Anabaena with **Anthoceros, Azolla** and **coralloid root** of cycas plant.

(v) **Mutualism between algae and fungi - e.g.** 'Lichens', This association is known as Helotism. In this association two organism behaves as a master and slave.

(vi) **Mutualism between fungi and higher plants - e.g.** Mycorrihizal association - *Boletus* in roots of pinus.

(vii) **Fig tree and wasp species.**

In many species of fig trees, the female wasp uses the fruit not only as an **oviosition (egg-laying)** site but uses the developing seeds with in the fruit for nourishing its larval. The wasp pollinates the fig inflorescence while searching for suitable egg-laying sites. In return for the favour of pollination the fig offers the wasp some of its developoing seeds, as food for the developing wasp larvae.

(viii) **Bees and orchid flower.**

The mediterrranean orchid **Ophrys** employs ‘’sexual deceit’’ to get pollination done by a species of bee. One petal of its flower resemblance to the female of the bee in size, colour and markings. The male bee is attaracted to what it perceives as a female, **pseudocopulates** with the flower and during that process is dusted with pollen from the flower, it transfers pollen to it and thus, pollinates the flower.

(B) Proto-cooperation (+/+) - Association in which both organisms are benefited but can live separately. It is a facultative or optional or occuasional association also called as non-obligatory relationship. e.g.

(i) Hermit crab and Sea anemone

(ii) Tick bird (Red-biled or yellow biled) and Rhinoceros

(iii) Crocodile and Bird

(iv) **Scavening -** Association in which one partner called scavenger or saprobiont, eats the dead boides of other animals, which have naturally or killed by another animal. e.g. Jackal, Vulture, Ant, Crow

(C) Commensalism (+ / 0) -

Association between members of two species in which one is benefitted while other is almost unaffected.

(i) **Lianas -** are woody plnats. Their roots are present in soil but their stem use other plant or object for support to get better light. They are found in dense forest. No nutritional relationship. Lianas are the speciality of tropical rain forest. e.g. Bauhinia, Tinospora

(ii) **Epiphytes -** Small plants grow on other plnats in tropical rain forest. They utilise only the space of host plant for light and humidity. e.g. Orchids, Hanging mosses

(iii) **Epizones -** Those animals which depends on plants or other animals.

Sucker fish (Echeneis)	-	Shark
Pilot fish	-	Shark
E. coli becteria	-	Intestine of man
Clown fish	-	Whale
Barnacles	-	Whale
Cattle egret birds	-	Cattle

(2) Negative Interaction (Antagonism)/Detrimental

Two type of negative ineraction are following

(A) Exploitation (B) Amensalism

(A) Exploitation - One species harms the other by making its direct or indirect use for support, shelter or food.It is of three types :

1. Competition 2. Parasitism 3. Predation

1. Competition (–, –) ➡ Interaction in which the fitness of one species is significantly lowers in the presence of another species. According to Darwin the struggle for existence and survival of the fittest in nature, shown that interspecific competition is a potent force in organic evolution.

Cheracteristion of Competition :-

(a) It is generally believed that competition occur when closely related species compete for the same resources that are limiting, but this is not entirely true because totally **unrelated species** could also compete for the same resource e.g. in some shallow South America lakes *flamingoes* and resident fishes compete for their common food.

Resources need not be limiting for competition to occur; in interference competition, the feeding efficiency of one species might be reduced due to the interfering and inhibitory presence of the other species, even if resources (Food and Space) are abundant.

(b) Competition is best defined as a **process in which the fitness of one species** (measured in term of its 'r' the intrinsic rate of increase) **is significantly lower in the presence of another species.**

(c) Strong and persuasive circumstantial evidence does exist, however in some cases. The Abingdon tortoise in Galapagos Island exinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats. This is called **'competitive release'.**

(d) A species whose distribution is restricted to a small geographical area because of the presence of a competitively superior species, is found to expand its distributional range dramatically when the competing species is experimentally removed.

(e) Connell's elegant field experiments showed that on the rocky sea coasts of Scotland, the larger and competitively superior barnacle ***Barlanus*** dominates the intertidal area, and excludes the smaller barnacle ***Chathamalus*** from that zone. In general, herbivores and plants appear to be more adversely affected by competition than carnivores.

(f) **Guase's 'Competitive Exclusion Principle'** states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually. This may be true if resources are limiting but not otherwise. More recent studies do not support such gross generalisation about competition.

(g) While they do not rule out the occurence of interspecific competition in nature, they point out that species facing competition might evovle mechanisms that promote co-existence rather than exclusion.

(h) One such mechanism is **'resource partitioning'.** If two species compete for the same resource, they could avoid competetion by choosing, for instance, different times for feeding or different foraging patterns.

(i) MacArthur showed that five closely related species of warbler living on the same tree were able to compete and co-exist due to behavioural difference in their foraging activities.

2. Parasitism (+ / –) ➡ This association involves individuals of two species of different size in which smaller (Parasite) is benefitted and larger (host) is harmed. The parasite gets nourishment and shelter from host but does not kill the host.

Type of Parasite :

(a) **Ectoparasite** ➡ lives on the body of host

(i) **Ectozooparasite -** Leech on cattle, ticks on dogs, copepods on marine fish and lice, mospquitoes, sandfly live on man

(ii) **Ectophytoparasite -** Amphids, Lac insects, Red cotton bug

(b) **Endoparasites** ➡ live in the body of host

(i) **Tapweorm, Taenia, Ascaris, Entamoeba** ➡ live in intestine of man.

(ii) **Plasmodium** ➡ **live in R.B.C.** of human.

(iii) **Hyper parasitism** ➡ A parasite living on another parasite. e.g. plasmodium on female anopheles mosquito, Bacteriophages on bacteria.

(vi) **Brood parasitism** ➡ Parasitism in which the parasitic bird (cuckoo) lays its eggs in the nest of its **host (crow)** and lets the host incubate them, this relation is known as brood parasitism.

(v) **Holo parasitism** ➡ Parasite which are totally dependent upon the host for their requirement **e.g.** *Rofflesia***, (Total root parasite),** *Cuscuta* **(Total stem parasite)**

(vi) **Hemiparasite** ➡ Parasite which partially depend on the host.

e.g. 1. Viscum – on oak
2. Laranthus – on mango
} both are partial stem parasite.

3. Santualum – partial root parasite.

Note : Arceuthobium is the smallest parasite.

3. Predation (+ / –) : A free living organism which catches and kills another species for food.

1. **Insectivores fungi -** Dactylella, Dactylaria, Arthorobotrys, Feeds upon small insects and protozoans.
2. **Carnivoroes animals -** Lion, snake
3. **Insectivores plants -** Drosera, Utricularia, Nepenthes

Significance of predators :

(a) Predators acting as conduits for energy transfer across tropic levels, they keep prey populations under control The **prickly pear cactus** introduced into Australia in the early 1920's caused havoc by spreading rapidly into millions of hectacres of rangeland. Finally, the invasive cactus was brought under control only after a cactus feeding predator (a moth) from its natural habitat was introduced into the country.

(b) **Pest control** are based on the ability of the predator to regulate prey population. Predator also help in maintaining species diversity in community, when all the **starfish** were removed from an enclosed intertidal area, more than 10 species of invertebrates became extinct within a year because of inerspecific competition.

(c) If a predator is too efficient and overexploits its prey, then the prey might become extinct and the predator will also become extinct due to lack of food. This is reason why predators in nature are 'prudent'. The **Monarch butterfly** is highly distasteful to it's predator birds because of a special chemical presents in its body. The butterfly acquires this chemical during its caterpillar stage by feeding on poisonous weed.

(d) About 25% of all insects are **phytophagous** (feeding on plant parts and plant sap) are predators. Plants have specific adaptations or morphological and chemical defence against herbivores.

(i) Throns - in *Acacia,* Cactus.

(ii) Many plant produce and store chemicals that can make herbivore sick or inhibits feeding or distrupt digestion reproduction or even kill.

(e) **Calotropis** produces highly poisonous cardiac glycosides and that is why you never see any cattle or goats browsing on this plant. A wide variety of chemical substances that we extract from plants on a commercial scale (nicotine, caffeine, quinin, strychnine, opium, etc....,) are produced by them actually as defences against grazers and browsers.

(B) Amensalism (– / 0) : In this interaction one species is inhibited by toxic secretion of another spcies. Inhibitor is neither benefitted nor harmed. There are two type of Amensalism,
1. Antibiosis & 2. Allelopathy.

1. **Antibiosis -** Serection of antibiotics -

(a) **Penicillium fungi secretes penicillin** which inhibits growth of *Staphylococcus* bacteria.

(b) **Chlorella algae secretes bacteriocytes** which not only kill but also inhibit growth of the bacteria.

(c) **Microcystis (BGA) secretes hydroxyl amine**, this causes the death of fishes.

2. **Allelopathy -** Trans cinnamic acid is secreted by *Parthenium* which inhibits the growth of some plants like Cassia tora and Vinca regia. This pnenomenon is known as **allelopathy,** e.g *Sunflower*, *Barley*, *Sorguhm*, *Occimum* also show allelopathy. Chemicals which kill or inhibit the growth of other organism. That chemical known as **Depressants**. e.g. *Parthenium*

Population Interactions		
Species A	**Species B**	**Name of Interaction**
+	+	*Mutualism*
–	–	*Competition*
+	–	*Predation*
+	–	*Parasitism*
+	0	*Commensalism*
–	0	*Amensalism*

SPECIAL POINT

(A) **Sliver oak shows autopathy -** It destroys own seed.

(B) **Allochemics -** Chemicals secreted by a species are knwon as allochemics.

Types of allochemics

1. **Allamon -** Chemicals which repel other enemies is called allamon
e.g. Cuttle fish (Sepia)

2. **Kairmons** - the chemicals secreted by one organism benefits the another organism
e.g. Nematodes in soil → stimulate growth of fungi.

(C) **Cannabalism** ➡ organisms eaten by own species.
e.g. cockroach, termites

EXERCISE – 1

Q.1 Competition for nutrients, food, light and space is more severe between two –
(1) Unrelated species occupying different niches
(2) Unrelated species occupying the same niche
(3) Closely related species occupying different niches
(4) Closely related species occupying the same niche

Q.2 In commensalism –
(1) Both partners are harmed
(2) Both partners are benefited
(3) None of the partners benefited
(4) Weaker partner is benefited

Q.3 Symbiosis means –
(1) Living apart with benefit to one and harm to another partner
(2) Living together with benefit to both partners
(3) Living together with benefit to one partner
(4) Living together without harm

Q.4 When one organism inhibits another organism without a significant gain (OR) Antagonism between two organism through gases or allochemicals is called –
(1) Parasitism (2) Mutalism
(3) Amensalism (4) Commensalism

Q.5 The relationship between the alga *Microcystis* and the surrounding fauna corresponds to –
(1) Exploitation (2) Parasitism
(3) Amensalism (4) Predation

Q.6 A component produced by one organism which inhibit the growth of another organism is–
(1) Antiallergic (2) Anticoagulant
(3) Antibiotic (4) Antiseptic

Q.7 *Mycorrhizae* is a symbiotic association between–
(1) Fungi and roots of higher plants
(2) Algae and roots of gymnosperms
(3) Algae and bryophytes
(4) Algae and fungi

Q.8 Carrot grass/ congress grass (*Parthenium*) exhibit allelopathy by virtue of the production of –
(1) Alkaloids and glycosides
(2) Abscisic acid
(3) Protocaterchuic acid
(4) Hydrocynic acid and transcinnamic acid

Q.9 Mark the hyperparasite –
(1) Bacterio phage (2) Bird
(3) Tape worm (4) Man

Q.10 Occurrence of zoochlorellae in the body wall of Hydra is an example of –
(1) Predation
(2) Mutualism or symbiosis
(3) Commensalism
(4) Food chain involving a parasite

Q.11 Relationship between nitrogen fixing bacteria and a legume plant is described as –
(1) Parasitic (2) Saprophytic
(3) Commensal (4) Mutualistic

Q.12 Zone of transition, presenting a situation of special ecological interest between two types of communities is called as -
(1) Ecad (2) Ecotype
(3) Ecotone (4) None of these

Q.13 The interspecific competition is also called as–
(1) Synnectrosis (2) Allelopathy
(3) Scramble competition
(4) Interference competition

Q.14 The following relationship does not correspond to mutualism –
(1) Mycorrhiza (2) Epiphytism
(3) Zoochory (4) Zoophily

Q.15 The relationship between a climber and the host corresponds to –
(1) Mutualism (2) Parasitism
(3) Neutralism (4) Commensalism

Q.16 The protoco-operation is also called as –
(1) Facultative predation
(2) Facultative parasitism
(3) Non-obligatory mutualism
(4) Non-commensalism

Q.17 When food is obtained by killing of host in which the stronger partner is benefitted and host is damaged such an interaction is said to be –
(1) Competition (2) Antibiosis
(3) Predation (4) Parasitism

Q.18 Secondary succession occurs on –
(1) Burnt lands (2) Humus rich soil
(3) Cut wood lands (4) All of these

Q.19 Plant succession is a .....process –
(1) Unimportant (2) Haphazard
(3) Definite (4) None of these

Q.20 The term succession was coined by –
(1) Hult (2) Tansley
(3) Kormondy (4) Hodges

Q.21 The natural process by which different groups or communities colonize the same area over a period of time in a definite sequence is called–
(1) Succession (2) Adaptation
(3) Biological rhythm (4) Variation

Q.22 In any lithosere the pioneer community is –
(1) Blue green algae (2) Crustose lichen
(3) Foliose lichens (4) Mosses

Q.23 Due to modification of the environment by the plant community itself, when one community is replaced by another suitable community, the succession is called as –
(1) Induced (2) Autogenic
(3) Migration (4) Allogenic

Q.24 Serule is –
(1) Hydrosere
(2) Microbial succession
(3) Biosere
(4) Lithosere

Q.25 In a hydrosere, the submerged stage is followed by –
(1) Sedges (2) Reed-swamps
(3) Floating plants (4) Phytoplanktons

Q.26 Overlapping zone between two biomes is-
(1) Ecotone (2) Ecosphere
(3) Ecosystem (4) Ecotype

Q.27 Which of the biomes exhibit distinct stratification into stories-
(1) Temperate biome
(2) Chapparal biome
(3) Tundra biome
(4) Tropical rainforest biome

Q.28 Which is a predacious fungai
(1) Arthrobotrys (2) Rhizopus
(3) Pyronema (4) Polyporus

Q.29 Congress Grass produce an acid which inhibit growth of other plant is
(1) HCN
(2) Trans cinnamic acid
(3) Oxalic acid
(4) Indole aceteic acid

Q.30 Brood parasitism is shown by
(1) Koel (2) Crow
(3) Koel & Crow both (4) Crocodile

Q.31 Complete the following equation by putting one of the following option respectively. For constant size population : Birth + ... = Death + ...
(1) emigration, immigration,
(2) immigration, emigration
(3) emigration, population density
(4) immigration, population density

Q.32 A total parasite is nutritionally
(1) A photoautotroph
(2) A chemoautotroph
(3) A photoheterotroph
(4) A chemoheterotrophs

Q.33 Which of the following does not show commensalism
(1) Epiphytes growing on a tree
(2) Rhizobium in Soyabean
(3) Small fish surviving on the excrets of large fish
(4) E.coli residing in the intestine of human

Q.34 Which of the following ecological relationship between pairs of organism is different from the other pairs
(1) Fish - Algae (2) Cow - Grass
(3) Fungus - Wheat (4) Giraffe - Shrub

Q.35 An algae is often seen growing on the shell of turtle this type of relationship is called
(1) Mutualism (2) Commensalism
(3) Parasitism (4) Predation

Q.36 Which of the following set of value would result in a population with a grwoth rate of zero
b = birth d = death
i = immigration e = emigration
(1) b = 1000 d = 500 i = 750 e = 1000
(2) b = 1000 d = 500 i = 1000 e = 1000
(3) b = 1000 d = 500 i = 1500 e = 1000
(4) b = 1000 d = 500 i = 500 e = 1000

Q.37 Which of the following is least likely to result in density dependent effects on growth of natural population

(1) Interspecific competition

(2) Parasitism

(3) Disease

(4) Increased rain fall

Q.38 Maximum parental care is present in

(1) Tadpole (2) Primates

(3) Koel (4) Crow

Q.39 Probiosis (Both benifitted) includes-

(1) Mutualism

(2) Proto co-operation

(3) Commensalism

(4) 1 & 2 Both

Q.40 Biological contraol of weeds and pests is largely based on

(1) Pray predator interaction

(2) Host parasite interaction

(3) Antibiosis (4) Allelopathy

Q.41 Which of the following chemical compound help in transmitting the massage to other member of same species -

(1) Hormone (2) Ptyalin

(3) Pheromones (4) None

Q.42 Genetically adaptive population to a particular habitat is

(1) Ecotone (2) Ecotype

(3) Ecosphere (4) Ecology

Q.43 Which one of the following is protective device

(1) Camouflage (2) Competition

(3) Symbiosis (4) Commensalism

Q.44 A smoother crop is which

(1) Does not require much irrigation

(2) Is easier to harvest

(3) Is immune to most of pathogen

(4) Does not allow to grow weed

Q.45 The number of individual of a species in particular habitat remain constant at a given time due to

(1) Man (2) Predator

(3) Parasite (4) Available food

Q.46 What will form a new species

(1) differential reproduction

(2) Inbreeding

(3) Variation (4) None of the above

Q.47 Alturistic behaviour is found in

(1) Spotted dear (2) Honey Bee

(3) Termite (4) All of the above

Q.48 Crow also incubates the eggs of

(1) Pigeon (2) Dove

(3) Koel (4) Weaver bird

Q.49 The population of a place tends to increase when

(1) Predation increases

(2) Emigration occur

(3) Immigration occur

(4) Reproductivity decrease

Q.50 Two different species can not live for long duration in the same niche or habitat. This law is called

(1) Allen's law (2) Gause's law

(3) Jorden's law (4) Weisman's theory

Q.51 Which of the following are characterstic feature of population

(1) Birth rate (2) Death rate

(3) Sex ratio (4) All of the above

Q.52 Inhibitation of growth of plants by release of certain chemicals by higher plants is called

(1) Antibiosis (2) Allelopathy

(3) Predation (4) None of these

Q.53 Species present in only one community is known as

(1) Ubiquitous species (2) Exclusive species

(3) Dominat species (4) None of the above

Q.54 Species which is present in many communities is called

(1) ubiquitous species (2) endemic species

(3) exclusive species (4) dominant species

Q.55 Negative interaction is also known as

(1) Allelopathy (2) Antagonism

(3) Antibiosis (4) Competition

Q.56 Chemical which is secreted by walnut and inhibit growth of apple is

(1) HCN (2) Juglon

(3) Trans cinnemic acid

(4) Walnum

Q.57 Bee dance is a mode of

(1) Mating (2) Grouping

(3) reproduction (4) Communications

Q.58 The carrying capacity of a population mean -

(1) The rate at which the density of individual increase over time

(2) The maximum number of individual which can be supported in a given environment

(3) The proportion of individual which are most responsible for population growth

(4) The minimum number of individual necessary to avoid extinction

Q.59 Which of the following intercation is not a positive interaction

(1) Flower and pollinator

(2) Plant & herbivore

(3) Legume plant and N_2 fixing organism

(4) Lichen

Q.60 The most important factor regulating seasonal migration is

(1) Change in air temperatue

(2) Change in day length

(3) Reduced availability of food

(4) Increased predator pressure

Q.61 The actual rate of growth of population is the difference between the

(1) Number of adult and number of new born

(2) Size last year and size this year

(3) Number of breeding and non breeding individual

(4) Birth rate & Death rate

Q.62 Which equation shows logistic growth

(1) $dN/dt = rN\left(\frac{K-N}{K}\right)$

(2) $dN/dt = rN$

(3) $dN/dt = rN(1+N/K)$ (4) $Nt = N_0e^{rt}$

Q.63 The number of individual in reproductive age is more than prereproductive phase in

(1) Declining population

(2) Stable population

(3) Expanding population

(4) None

Q.64 Which of the following is not an example of predation

(1) Browsing by goats

(2) Killing of deer by lion

(3) Killing of small fish by shark

(4) Ticks on dogs

Q.65 Which equation shows exponetial growth

(1) $dN/dt = -rN$ (2) $dN/dt = rN$

(3) $dN/dt = rN\left(\frac{K-N}{K}\right)$

(4) $dN/dt = rN\left(\frac{K+N}{K}\right)$

Q.66 J shaped curve is formed in

(1) Logistic growth (2) Exponetial growth

(3) Limited growth (4) 2 & 3 Both

Q.67 S shaped growth curve is obtained in

(1) Logistic growth (2) Exponetial growth

(3) Limited growth (4) 1 & 2 Both

Q.68 Among the following a partial parasite is

(1) Bacteria (2) Fungi

(3) Viscum (4) 1 & 2 Both

Q.69 Which of the following counter acts biotic potential

(1) Limitation of food suply

(2) Predation

(3) Competiton

(4) All of the above

Q.70 Parasite can be best explained as an organism which depends on

(1) others for food

(2) others for shelter

(3) others for food & shelter

(4) others for reproduction

Q.71 What is the most important factor for success for population

(1) Natality

(2) Unlimited food

(3) Adaptabiltiy

(4) Interspecific competition

Q.72 Proportion of young individual is heighest in

(1) Declining population

(2) Stable population

(3) 1 & 2 Both

(4) Expanding population

Q.73 When a population reches upto carrying capacity of environment than
(1) Mortality rate = Birth rate
(2) Mortality rate > Birth rate
(3) Mortality rate < Birth rate
(4) None of the above

Q.74 Some frogs are cryptically coloured to aviod
(1) Competition (2) Antibiosis
(3) Predation (4) Amensalism

Q.75 Variety of different life forms in shallow pond constitute
(1) Ecosystem (2) Community
(3) Population (4) Biome

Q.76 Higher root : shoot ratio is found in -
(1) Epiphytes (2) Hydrophytes
(3) Halophytes (4) Psammophytes

Q.77 In xerophytes, longer root system are found because -
(1) Roots grow deeper to absorb water from deep water tables
(2) They give mechanical support to the plant
(3) Low temperature at night encourages root growth
(4) Hight temperature of soils encourages root growth

Q.78 Vegetation of Sunder bans is -
(1) Desert type
(2) Temperate evergreen
(3) Mangrove type
(4) Monsoon type

Q.79 Which of the following are xerophytes ?
(1) Psammophytes (2) Lithophytes
(3) Halophytes (4) All the above

Q.80 Which of the plants have no leaves but green stems -
(1) Hydrophytes (2) Xerophytes
(3) Mesophytes (4)Epiphytes parasites

Q.81 In *Opuntia* the leaves are modified into-
(1) Scales (2) Spines
(3) Stolons (4) Phylloclades

Q.82 Water storage tissue & succulent nature is characteristics of -
(1) Hydrophytes (2) Halophytes
(3) Mesophytes (4) Xerophytes

Q.83 Which group of plants has to face physiological dryness -
(1) Hydrophytes (2) Epiphytes
(3) Lithophytes (4) Halophytes

Q.84 Which type of plants possess aerenchyma like those of hydrophytes; thick leathery leaves with cutinized epidermis & presence of resin & tannin in cortical cells like those of xerophytes and cells with high osmotic pressure like those of succulents -
(1) Desert xerophytes (2) Lithophytes
(3) Succulents (4) Mangroves

Q.85 *Hydrilla* is a or *Vallisneria* and *Hydrilla* are example of –
(1) Floating and anchored
(2) Suspended hydrophyte
(3) Submerged hydrophyte
(4) A free floating hydrophyte

Q.86 Which among the following could be deviod of roots -
(1) Epiphyte (2) Parasite
(3) Hydrophyte (4) Mesophyte

Q.87 In which of the following plants, the metabolism would be hindered if the leaves are coated with wax or vaseline on thier upper surface -
(1) *Trapa* (2) *Vallisneria*
(3) *Hydrilla* (4) *Lotus*

Q.88 Wax coating on leaves is a characteristic of-
(1) Floating hydrophyte
(2) Mesophyte
(3) Xerophyte
(4) submerged hydrophytes

Q.89 Glazed and shining leathery leaf surface and the presence of sclerenchymatous hypodermis in leaves is the characteristic feature of -
(1) Epiphytes (2) Cold xerophytes
(3) Mesophytes (4) Hot xerophytes

Q.90 Plants growing near sea shore will usually have xerophytic characters like thick leaves because-
(1) Light available to the plants is not sufficient
(2) There is plenty of water in the soil
(3) There is too high concentration of salts for the plants to absorb sufficient water from soil
(4) The soil is muddy

Q.91 Mangrove vegetation is found in -
(1) Western Ghats (2) Sunderbans
(3) Kullu valley (4) Dehradun valley

Q.92 A plant that completes its life cycle before the onset of dry conditions fall into which of the following categories -
(1) Short day plants
(2) Mangroves
(3) Drought escaping
(4) Amphibious hydrophyte

Q.93 In general, a plant most likely to survive in areas where temperature is high, relative humidity is low and wind prevalent, would have-
(1) Small and narrow leaves
(2) Large and broad leaves
(3) Large intercellular spaces
(4) Reduced palisade tissue

Q.94 Pneumatophores and viviparous germination are found in -
(1) *Opuntia* (2) *Jussiaea*
(3) *Rhizophora* (4) *Eichhornia*

Q.95 Desert grasses often roll their leaves to -
(1) Check loss of water by transpiration
(2) Protect growing apex
(3) Reduce respiration
(4) Expose to light more chlorenchymatous tissue present near the lower epidermis

Q.96 Presence of lacunate cortex, spicules, sclereids, oil cells and water storage tissue are characteristic of -
(1) Hydrophyte (2) Halophyte
(3) Xerophyte (4) Heliophyte

Q.97 Photosynthetic and respiratory gaseous exchange in hydrophytes occure through -
(1) Lenticels (2) Stomata
(3) Epidermis (4) Hydathodes

Q.98 Root is feebly developed and stem is soft and buoyant in -
(1) Sciophytes (2) Halophytes
(3) Hydrophytes (4) Heliophytes

Q.99 The cells for rolling down of lamina in grasses to reduce transpiration are -
(1) Sunken stomata (2) Subsidiary cells
(3) Bulliform cells (4) Guard cells

Q.100 Which is halophyte of saline soil of Haryana and Rajasthan -
(1) *Salicornia* (2) *Suada*
(3) *Salsola* (4) All of the above

Q.101 Which one of the following sets consists only of xerophytic plants
(1) Subabool, teak, *Eucalyptus*, mango
(2) Banyan, *Acacia*, *Zizyphus*, Teak
(3) Safflower, *Eucalyptus*, *Asparagus*, *Acaci*
(4) *Acacia*, *Prosopis*, *Zizyphus*, *Opuntia*

Q.102 Root cap is absent in
(1) Halophytes (2) Hydrophytes
(3) Mangrooves (4) Mesophytes

Q.103 Which of the following is a hydrophyte-
(1) *Mimosa* (2) *Neptunia oleracea*
(3) *Trapa* (4) *Albizzia julibrissin*

Q.104 Which of the following is amphibious in nature?
(1) *Ranunculus* (2) *Hydrilla*
(3) *Vallisneria* (4) *Trapa*

Q.105 Which of the following is not a water plant or hydrophyte-
(1) *Bladderwort* (2) Water melon
(3) *Vallisneria* (4) *Trapa*

Q.106 Root less insectivorous plants is -
(1) *Dionaea* (2) *Cuscuta*
(3) *Drosera* (4) *Utricularia*

Q.107 Heterophyllous plants are common among -
(1) Free floating hydrophytes
(2) Submerged hydrophytes
(3) Amphibious or emergent rooted hydrophytes
(4) Suspended hydrophytes

Q.108 What type of leaves are present in *Ranunculus aquatilis* -
(1) Simple (2) Heterophyllous
(3) Homophyllous (4) Pinnately compound

Q.109 In true (submerged) hydrophytes stomata are present on -
(1) Upper epidermis
(2) Lower epidermis
(3) Not present on any part
(4) Present on both sides of leaf

Q.110 The vascular plants which are devoid of stomata and hydathodes -
(1) Pteridophytes (2) Gymnosperms
(3) Spermatophytes (4) Hydrophytes

Q.111 Water plants usually have a well developed-
(1) Root system (2) Aerenchyma
(3) Vascular system (4) Stomatal system

Q.112 Swollen petiole of *Eichhornia* is made up of-
(1) Parenchyma (2) Chlorenchyma
(3) Aerenchyma (4) Collenchyma

Q.113 Which hydrophytes have a well developed roots, vascular tissues & stomata -
(1) Submerged types (2) Suspended types
(3) Amphibious types (4) Free floating types

Q.114 Which of the following is an amphibious plant and bear dimorphic leaves-
(1) *Chlorella* (2) *Hydrilla*
(3) *Vallisneria* (4) *Ranunculus*

Q.115 Grasses & many crop plants which possess hydathodes & exhibit guttation are -
(1) Hydrophytes (2) Mesophytes
(3) Xerophytes (4) Halophytes

Q.116 Plants growing in hot climate in nonsaline loose soil are -
(1) Xerophytes (2) Halophytes
(3) Mesophytes (4) Lithophytes

Q.117 In high mountains, there is a lot of moisture and water yet the plants are xerophytes because -
(1) Water turns into snow on mountains
(2) Water runs away due to the presence of slopes and cannot be used by plants
(3) Rocks of mountains cannot absorb water
(4) None of these

Q.118 Desert plants are generally -
(1) Less chlorophyllous (2) Heterophyllous
(3) Herbaceous (4) Succulents

Q.119 Plants growing in xerophytic conditions have
(1) Extensive development of shoot
(2) Extensively developed roots and small & thick leaves
(3) Extensive development of air spaces
(4) Large flowers

Q.120 Cladode, phylloclade & phyllode are the characterstic of -
(1) Mesophytes (2) Xerophytes
(3) Epiphytes (4) Hydrophytes

Q.121 Sunken stomata & multiple epidermis is found in the leaves of -
(1) *Nelumbium* (2) *Nerium*
(3) Neem (4) Maize

Q.122 Reduced leaves, thick cuticle & sunken stomata protected by hairs are the characteristics of -
(1) Xerophytes (2) Mesophytes
(3) Hydrophytes (4) Halophytes

Q.123 The characteristics of water storage tissue is-
(1) Large sized cells
(2) Cell walls thin
(3) Presence of mucilage
(4) Presence of vacuoles

Q.124 Which plant tolerates salinity -
(1) Hydrophte (2) Halophyte
(3) Mesophyte (4) Xerophyte

Q.125 Which group of plants grow in saline situations and face physiological dryness -
(1) Lithophytes (2) Halophytes
(3) Hydrophytes (4) Epiphytes

Q.126 Which of the following is an efficient sand binder of Rajasthan desert -
(1) *Dalbergia latifolia* (2) *Prosopis*
(3) *Tectona grandis* (4) *Cassia fistula*

Q.127 Which of the following are plants of one group-
(1) *Mangifera & Rhizophora*
(2) *Rhizophora & Avicinia*
(3) *Rhizophora & Balanophora*
(4) *Balanophora & Avicinia*

Q.128 Upper part of Sea/aquatic ecosystem contains
(1) Nekton (2) Benthos
(3) Plankton
(4) Plankton and nekton

Q.129 The upper vertical zone of ocean upto the depth of 200 meters is known as-
(1) Aphotic zone (2) Abyssal zone
(3) Photic zone (4) None of these

Q.130 In an aqueous environment, microscopic animals and plants are collectively known as-
(1) Herbivore (2) Commensals
(3) Flora and fauna (4) Plankton

Q.131 Which of the following can be recognised as a major environment in the ocean basin -
(1) Pelagic zone (2) Littoral zone
(3) Benthonic zone (4) All of these

Q.132 Shallow lakes with abundant organic matter are-
(1) Eutrophic (2) Heterotrophic
(3) Oligotrophic (4) Saprotrophic

Q.133 Nutrient enrichment of lakes is called-
(1) Biochemical oxygen demand
(2) Green house effect
(3) Eutrophication
(4) Biomagnification

Q.134 Endemic plants -
(1) Cosmopolitan
(2) Occur in a particular area
(3) Occur at high altitudes
(4) Occur on north pole

Q.135 Ecology name proposed by -
(1) Tansley (2) Reiter
(3) Carl (4) Sukhachev

Q.136 The study of interaction between living organisms and environment is called -
(1) Ecosystem (2) Phytology
(3) Ecosystem (4) Ecology

Q.137 Father of Indian ecology is -
(1) Prof. R Mishra (2) G.S. Puri
(3) S.C. Pandeys (4) Prof. N. Dudgeon

Q.138 Species ecology is -
(1) Autecology (2) Synecology
(3) Palaeo ecology (4) Forest ecology

Q.139 The term Autecology is refers to study of -
(1) Plant community (2) Individual organism
(3) Environment (4) Soil form

Q.140 The science dealing with soil is called -
(1) Pedology (2) Acarology
(3) Geology (4) Palaeantology

Q.141 Water logged soils are -
(1) Physiologically dry
(2) Physiologically wet
(3) With great amount of water
(4) With less amount of water

Q.142 The major source of water to the soil is -
(1) Ground water (2) Capillary water
(3) Precipitation (4) Flood water

Q.143 A soil is said to be fertile when -
(1) It is rich in organic matter
(2) It has capacity to hold water
(3) It has a capacity to hold nutrients
(4) It holds water & all essential nutrients in a definite proportion

Q.144 What is the best pH of the soil for cultivation of plants -
(1) 3.4 – 5.4 (2) 6.5 – 7.5
(3) 4.5 – 8.5 (4) 5.5 – 6.5

Q.145 Forests near equator region are called -
(1) Deciduous
(2) Tropical rain forests
(3) Coniferous forests
(4) Temperate forests

Q.146 Animals of desert are -
(1) Arboreal (2) Fassoiral
(3) Crepuscular (4) Nocturnal

Q.147 Insectivorous plants grow in the soil which is deficient in -
(1) Mg (2) Ca
(3) P (4) N

Q.148 Maximum photosynthesis take place by -
(1) Phytoplankton
(2) Zooplankton
(3) Marsh plants
(4) Woody plants

Q.149 Pneumatophores are found in -
(1) The vegetation which is found in marshy and salin lake
(2) the vegetation which found in saline soil
(3) Xerophytes
(4) Epiphytes

Q.150 In which of the following plant sunken stomata are found -
(1) Nerium (2) Hydrilla
(3) Mango (4) Guava

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	4	2	3	3	3	1	4	1	2	4	3	4	2	4	3	3	4	3	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	2	2	2	3	1	4	1	2	1	2	4	2	3	2	4	4	2	4	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	2	1	4	4	3	4	3	3	2	4	2	2	1	2	2	4	2	2	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	1	1	4	2	2	1	3	4	3	3	4	1	3	2	4	1	3	4	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	4	4	4	3	3	4	3	4	3	2	3	1	3	1	3	3	3	3	4
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	2	3	1	2	4	3	2	3	4	2	3	3	4	2	1	2	4	2	2
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	1	3	2	2	2	2	3	3	4	1	1	3	2	2	4	1	1	2	1
Ques.	141	142	143	144	145	146	147	148	149	150										
Ans.	1	3	4	4	2	2	4	1	1	1										

EXERCISE – 2

Q.1 Ecology take into account
(1) Environmental factors only
(2) Plant adaptaions only
(3) Effect of plants on environment
(4) Relationships between organisms and their enviornment

Q.2 The term ecology was proposed by-
(1) Haeckel (2) Odum
(3) Daubenmire (4) Reiter

Q.3 Who defined ecology as the study of structure and function of nature ?
(1) Haeckel (2) E.P. Odum
(3) R. Misra (4) Taylor

Q.4 Who defined ecology as "The reciprocal relationship of organisms and their environments"?
(1) Misra (2) Haeckel
(3) Odum (4) Lamarck

Q.5 Autecology means the study of -
(1) Effect of temperature on vegetation
(2) Effect of soil on vegetation
(3) Ecology of individual organism
(4) Effect of precipitation on vegetation

Q.6 Synecology is the study of -
(1) Environment (2) Plant community
(3) Individual (4) None

Q.7 The transitional zone where two different communities meet is called -
(1) Niche (2) Ecotone
(3) Ecad (4) Ecotype

Q.8 Science which deals with the management of plants, animals, soil, water and minerals is -
(1) Autecology
(2) Synecology
(3) Phytosociology
(4) Resource ecology

Q.9 What ecological factors are most strong determinants of various biomes –
(1) Soil and wind
(2) Light and wind
(3) Temperature and precipitation
(4) pH and humidity

Q.10 Plants are killed in winter by frost –
(1) Because respiration ceases at such a low temperature
(2) Because there is no transpiration.
(3) Because no photosynthesis takes place at such a low temperature
(4) Because of desiccation and mechanical damage to the tissues

Q.11 Which of the following is direct dominant ecological factor which affects the vegetation of a place
(1) Temperature (2) Altitude
(3) Soil (4) Wind

Q.12 Major characteristics of the vegetation of a locality are controlled –
(1) Mainly by climate
(2) By animals only
(3) By altitude of a place only
(4) By man only

Q.13 Ecological factors work –
(1) Together
(2) In complex combinations
(3) Only indirectly
(4) Singly

Q.14 The hydrologic factor refers to –
(1) Gravitational water
(2) Snow
(3) Water
(4) Atmosphere

Q.15 Most dense layer of atmosphere vulnerable to pollution (OR) Life supporting zone of atmosphere is –
(1) Ionosphere (2) Mesosphere
(3) Troposphere (4) Stratosphere

Q.16 Plant groups growing in zones where high temperature alternates with low temperature are called as –
(1) Mesotherms (2) Megatherms
(3) Hekistotherms (4) Microtherms

Q.17 At what height in atmosphere the concentration of ozone is maximum –
(1) At 25 km (2) At 50 km
(3) At 100 km (4) At 10 km

Q.18 The alpine forests are classed under the plant group called –
(1) Hekistotherms (2) Megatherms
(3) Mesotherms (4) Microtherms

Q.19 Biological rhythms of the majority of organisms are modulated by –
(1) Soil factors (2) Light
(3) Temperature (4) Wind

Q.20 When a plant of hot climate is transferred to colder regions, it gets an injury called –
(1) Thermal death (2) Chilling
(3) Freezing (4) Desiccation

Q.21 'Flag trees' are formed due to –
(1) Erosion and depression
(2) Slat spray
(3) Lodging
(4) Unidirectional winds

Q.22 Which is the least porous soil –
(1) Clay (2) Loam
(3) Sand (4) Peat/Silt

Q.23 In coarse textured soils –
(1) Pore frequency is low
(2) Pore space is narrow
(3) There is no soil air (4) Water retaining capacity is high

Q.24 Which of the following does not occur in loam soil –
(1) Sand (2) Silt
(3) Chalk (4) Sand

Q.25 Soils transported by air are called as –
(1) Residual (2) Colluvial
(3) Eolian (4) Aerial

Q.26 Edaphic factors are concerned with –
(1) Soil and their Characteristics
(2) Rainfall
(3) Grazing by animals
(4) Competition among different species of plants

Q.27 Soil formation is initiated by the phenomenon of –
(1) Pedogenesis (2) Laterization
(3) Weathering (4) Gleization

Q.28 Which soil is best for plant growth –
(1) Clay soil (2) Loamy soil
(3) Sandy soil (4) Gravel

Q.29 The term sub-soil generally refers to –
(1) Horizon - R (2) Horizon - B
(3) Horizon - A (4) Horizon - C

Q.30 Pedology is the study of –
(1) Locomotion of animals
(2) Soil erosion
(3) Soil formation
(4) Rock formation

Q.31 The Biological weathering occurs due to the action of –
(1) Carbon dioxide (2) Oxygen
(3) Alkalies (4) Acids

Q.32 Water logging occurs in –
(1) Clay soil (2) Gravel soil
(3) Sandy soil (4) Loam soil

Q.33 Plants absorb from the soil –
(1) Capillary water
(2) Gravitational water
(3) Both capillary water and gravitational water
(4) Hygroscopic water

Q.34 Water held tightly in the form of a thin film on the surface of soil particle is known as –
(1) Hygroscopic water (2) Gravitational water
(3) Capillary water (4)Run away water

Q.35 The term 'chesard' refers to –
(1) Gravitational water
(2) Capillary water
(3) Water vapour
(4) Run off water

Q.36 Humus is important for plant growth because–
(1) It is partially decomposed
(2) It is derived from leaves
(3) It is made up of dead organic matter
(4) It is rich in nutrients and increases the water holding capacity

Q.37 Plants growing on rocks are called as –
(1) Sciophytes (2) Halophytes
(3) Lithophytes (4) Psychrophytes

Q.38 Storage capacity of the soil is the extent to which it can hold –
(1) Hygroscopic + Bound water
(2) Capillary + Hygroscopic water
(3) Capillary water
(4) Gravitational water

Q.39 Plants growing on sand and gravel are called as –

(1) Psammophytes (2) Psilophytes

(3) Oxylophytes (4) Eremophytes

Q.40 A soil is said to be physiologically dry when–

(1) There is plenty of water in the soil

(2) Concentration of salt is very high in the soil

(3) Light available to plants is not sufficient

(4) Both (1) and (2) together

Q.41 Plants growing on cold soil are called as –

(1) Psychrophytes (2) Psammophytes

(3) Oxylophytes (4) Sciophytes

Q.42 Ecology takes into account -

(1) Effect of plants on environment

(2) Plant adaptation only

(3) Environmental factors only

(4) All the above

Q.43 Who started ecological studies in India ?

(1) Saxton (2) Dudgeon

(3) R. Mishra (4) Agharkar

Q.44 Ecotype is -

(1) Transitional zone

(2) Genetically adapted ecological races of an area

(3) Genetically different individuals with same phenotype

(4) Genetically identical individual with same phenotype

Q.45 A plant or animal form produced in response to a habitat, the adaptations not being heritable is called -

(1) Ecad (2) Ecophene

(3) Life form (4) Ecotype

Q.46 How many horizons are present in a fully developed soil profile –

(1) Five (2) Eleven

(3) Three (4) One

Q.47 Plants growing on burnt soil are called as-

(1) Pyriform (2) Pyrophilous

(3) Hydrophilous (4) Heliophilous

Q.48 The soil containing particles between 0.002–0.02 mm is –

(1) Clay (2) Fine sand

(3) Gravel (4) Silt

Q.49 Soil texture depends upon –

(1) Quantity of microbes

(2) Size of particles

(3) Quantity of humus

(4) Amount of water in soil

Q.50 Which of the following factors cannot be regarded as belonging to a non living environment –

(1) Rainfall

(2) Light

(3) Temperature

(4) Interspecific competition

Q.51 Factors which relate to form and behaviour of the earth's surface are called -

(1) Biotic (2) Edaphic

(3) Topographic (4) Climatic

Q.52 Which of the following habitats would be ideally suited to sciophytes –

(1) Desert

(2) Ponds and lakes

(3) Dry and sunny place

(4) Moist and shady place

Q.53 Laterite soil is rich in –

(1) Mg (2) Ca

(3) Al (4) Fe

Q.54 Flowering is induced if germinating seeds are exposed to –

(1) High temperature

(2) Low temperature

(3) Temperature below freezing

(4) Temperature above 45° C

Q.55 Mark the correct relationship –

(1) Chesard – Ecard = Holard

(2) Holard–Chesard = Ecard

(3) Ecard – Chesard = Holard

(4) Holard + Ecard = Chesard

Q.56 Humus is an example of –

(1) Crystalloids (2) Organic colloids

(3) Soil structure (4) None of them

Q.57 'Solum' includes –

(1) Horizons A and B

(2) Horizons A_2 and B only

(3) Horizon A only

(4) Horizons A_1 and A_2 only

Q.58 A good soil is that which allows –
(1) Rapid percolation of water
(2) Selective percolation of salt
(3) No percolation of water and salt
(4) Slow percolation of water

Q.59 The term 'ecard' refers to –
(1) Unavailable water
(2) Run off water
(3) Total atmosphere precipitation
(4) Available water

Q.60 Percentage of water left in the soil when a plant wilts is known as –
(1) Wilting coefficient
(2) Field capacity
(3) Water retaining power of the soil
(4) Turgidity

Q.61 The soil near the surface is usually darker than the soil about one meter down. This is because the top soil is –
(1) Richer in organic matter
(2) Richer in Ca and Mg
(3) Dry
(4) Young and wet

Q.62 'Chalky soil' is a term used for –
(1) Sandy soil
(2) Carbonate rich soil
(3) Saline soil (4) Clay soil

Q.63 Vegetation of any place is primarily determined by –
(1) Rainfall
(2) Amount of soil water
(3) Soil type
(4) Amount of light

Q.64 Biotic factors are –
(1) All the living organisms which influence other organisms
(2) Factors of atmosphere which affect life
(3) Chemical factors of soil which affect life
(4) Physical factors of soil which affect life

Q.65 The instrument which measures wind velocity is –
(1) Hydrometer (2) Photometer
(3) Lactometer (4) Anemometer

Q.66 Hydrophytes have –
(1) Less mechanical system as well as feebly developed vaculature system
(2) Well developed stomata
(3) Well developed roots
(4) None

Q.67 An aquatic plant with floating leaves –
(1) Have stomata only on upper surface
(2) Have stomata on lower surface
(3) Have stomata on leaf surface
(4) Have stomata

Q.68 In hydrophytes the finely dissected leaves are found generally in –
(1) Emerged plants
(2) Free floating plants
(3) Submerged plants
(4) Rooted floating plants

Q.69 The basis of classification of hydrophyte, mesophyte and xerophyte is –
(1) Tolerance to light
(2) Availability of water
(3) Tolerance to temperature
(4) Tolerance to frost and rain

Q.70 Useful adaptation for hydrophytes is -
(1) Increase in aerenchyma
(2) Decrease in mechanical tissues
(3) Large leaves
(4) Large mechanical tissues

Q.71 The classification of plants in hydrophytes, mesophytes and xerophytes was suggested by-
(1) Warming (2) Odum
(3) Mishra (4) Weaver

Q.72 Heterophylly is common in -
(1) Emergents
(2) Free floating hydrophytes
(3) Submerged hydrophytes
(4) Rooted floating hydrophytes

Q.73 Plants with well developed spongy tissues in its leaves & exhibit temporary wilting in noon hours are -
(1) Halophytes
(2) Floating hydrophytes
(3) Mesophytes
(4) Succulents

Q.74 Plants growing in aerated sand of a river bank are -
(1) Psammophytes
(2) Physical xerophytes
(3) Physiological xerophytes
(4) Mesophytes

Q.75 Vivipary is characteristic feature of –
(1) Halophytes (2) Mesophytes
(3) Xerophytes (4) Hydrophytes

Q.76 Biotic potential refers to
(1) Increase of population under optimum condition
(2) Increase of population under given condition
(3) Increase of population under natural condition
(4) None of the above

Q.77 Specilized roots that penetrates the stem of the host estiblishing relationship with its conducting elements are called
(1) Haustoria (2) Rhizoid
(3) Rhizoplane (4) Rhizopore

Q.78 Which of the following is least likely to be true for ecological succession
(1) The species composition of the community change regularly
(2) The total number of species rises initially than stabilises
(3) The total nonliving material is increases
(4) Total biomass is decline after initial stage

Q.79 The traditional concept of succession includes the idea of an equilibrium states called a climax community. Ecologist now think that there may be no such thing as climax community because
(1) Disturbance is on going in ecosystem
(2) All organism eventually die
(3) Species diversity generally increases
(4) Each succession is different from other

Q.80 An area was cleared for road. Road was not constructed and the land was left to overgrow. The process by which the vegetation reestablished is called
(1) Primary succession
(2) Secondary succession
(3) Tertiary succession
(4) Regenerative succession

Q.81 Long term stability of a community depends on
(1) type of its abiotic component
(2) resource partitioning
(3) Biodiversity
(4) Successio

Q.82 External appearance of community is known as
(1) Stratification (2) Physionomy
(3) Physiognomy (4) Diversity

Q.83 Which of the following is a synthetic character of community
(1) Biomass (2) Diversity
(3) Stratification (4) Value index

Q.84 Which is not a character of climex community
(1) Large size
(2) Mesophytic
(3) Simple food chain
(4) Complex organisation

Q.85 Term ecosystem development to ecological succession was given by
(1) Odum (2) Elements
(3) R.D. Mishra (4) Blackman

Q.86 When the vegetation of any region reaches at climatic climax it is
(1) Lithophytic (2) Xerophytic
(3) Mesophytic (4) Hydrophytic

Q.87 The sequence : BGA $\rightarrow$ crustose lichen $\rightarrow$ foliage lichen $\rightarrow$ masses $\rightarrow$ shrubs $\rightarrow$ dicot plant represent
(1) Phylogenetic trend
(2) Food pyramid
(3) Ecological succession trend
(4) Genetic drift

Q.88 If the vegetation of a place is burnt the first one to appear will be
(1) Mosses (2) Lichen
(3) Liver wort (4) Fern

Q.89 Name the term used to describe a single dominant species that dictate community structure
(1) Pioneer species
(2) Exogenous species
(3) Keystone species
(4) Edge species

Q.90 In succession complexities in structure -
(1) Increase
(2) Decrease
(3) Remain constant
(4) Intially increase than decrease

Q.91 In plant succession when climax is reached the net productivity
(1) Continue to increase
(2) Become half
(3) Become zero
(4) Become 10%

Q.92 Which of the following is the keystone species in tropical rain forest
(1) Fig (2) Pinus
(3) Cycas (4) Fungi

Q.93 Climax community is
(1) Ist stable community
(2) unstable community
(3) Intermediate community
(4) Last stable community

Q.94 Primary succession on rocks starts with
(1) Herbs (2) Animals
(3) Lichen (4) Trees

Q.95 If a piece of land which had a plant community becomes barren due to some external thrust, the succession taking place here is called as
(1) Induced (2) Deflated
(3) Autonomic (4) All the above

Q.96 The direction of succession
(1) Predictable (2) Unpredictable
(3) Haphazard (4) Always changing

Q.97 The ultimate serel community appear in an area as a result of
(1) Ecesis (2) Nudation
(3) Invasion (4) Reaction

Q.98 In a hydrosere the submerged stage is followed by
(1) Phytoplenktons (2) Reed swamp
(3) Sedges (4) Floating plant

Q.99 The pioneer in a hydrosere
(1) Diatoms (2) Sedges
(3) wolffia (4) Lemna

Q.100 According to polyclimax theory the climax stage is controlled by
(1) Eadaphic factor (2) Biotic factor
(3) Topographic factor (4) All of these

Q.101 The invasion of a new community in a bore area is initiated by
(1) Migration (2) Ecesis
(3) Aggregation (4) All

Q.102 The effects of individual of same species upon each other is called as
(1) Reaction (2) Competition
(3) Coaction (4) Ecesis

Q.103 No. of species is more at ecotone, this phenomenon is known as
(1) Ecotone effect (2) Edge effect
(3) Diversity effect (4) All of the above

Q.104 Species which are present at ecotone is known as
(1) Ecotone species (2) Keystone species
(3) Link species (4) Edge species

Q.105 Synecology and plant sociology are the words equivalent to
(1) Community ecology
(2) Population ecology
(3) Gene ecology
(4) Auto ecology

Q.106 Pioneer community is xerosere is
(1) Foliaose lichen (2) Moss
(3) Crustose lichen (4) Fern

Q.107 The invasion of a community in succession involves
(1) Ecesis, aggregation competition
(2) Migration, aggregation and competition
(3) Aggregation, competition and coaction
(4) Migration, ecesis and aggregation

Q.108 Mark the climatic cause for the initiation of succession
(1) Depletion (2) Drought
(3) Deposition (4) Micro-organism

Q.109 The physiographic factor responsible for the initiation of succession in
(1) Erosion (2) Fire
(3) Hail (4) Wind

Q.110 Formation of bare land for initiation of succession is
(1) Migration (2) Ecesis
(3) Nudation (4) Coaction

Q.111 The successive developmental stage in succession is known as

(1) Pioneer (2) Climax

(3) Sere (4) All of the above

Q.112 Increase of population under optimum conditions is termed -

(1) Reproductive ability

(2) Secondary production

(3) Biotic potential

(4) Biomass

Q.113 In a population unrestricted reproductive capacity is called as -

(1) Biotic potential (2) Fertility

(3) Carrying capacity (4) Birth rate

Q.114 What is true for individuals of same species -

(1) Live in same niche

(2) Live in same habitat

(3) Interbreeding

(4) Live in different habitat

Q.115 When the two ecosystems overlap each other the area is called -

(1) Ecotone (2) Niche

(3) Edge effect (4) Ecotypes

Q.116 The community which starts succession at a place is termed -

(1) Climax community

(2) Seral community

(3) Pioneer community

(4) Primary community

Q.117 Earliest settlers on barren lands or the farmers of nature are -

(1) Diatoms (2) Lichens

(3) Moss & grasses (4) Ferns

Q.118 In plant succession last community is called -

(1) Ecotone

(2) Climax community

(3) Seral community

(4) Ecosystem

Q.119 Group of two or more than two plant species is called as -

(1) Plant community (2) Animal ecosystem

(3) Plant ecosystem (4) Ecological niche

Q.120 Plant and animals living in a particular area constitute -

(1) Flora and fauna (2) Community

(3) Ecosystem (4) Ecology

Q.121 Stable plant community formed during succession is called -

(1) Sere community

(2) Climax community

(3) Dominant community

(4) Ecotone

Q.122 Succession in a water body leads to formation of -

(1) Mesophytic vegetation

(2) Xerophytic vegetation

(3) Halophytic vegetation

(4) Epiphytic vegetation

Q.123 Competition for food, light and space is most severe in -

(1) Closely related species growing in the same area (in the same niche)

(2) Closely related species growing in different habitat

(3) Distantly related species growing in the same habitat

(4) Distantly related species growing in different habitat

Q.124 Most successful parasites are those which do not-

(1) grow free

(2) Kill their host

(3) Reproduce sexually

(4) Survive in soil

Q.125 Of the following which is the smallest parasite-

(1) Lemna

(2) Arceuthobium

(3) Spirodella

(4) Wolffia

Q.126 Two different species can not live for long duration in the same niche or habitat. This law is -

(1) Allen's law

(2) Gauss's law

(3) Jorden's principal

(4) Weiseman's theory

Q.127 Capacity to blend with surroundings is called

(1) Hibernation (2) Mimicry

(3) Camouflage (4) Aestivation

Q.128 A behavioural strategy of adaptation called echolocation is found in

(1) Bats

(2) Monarch butterfly

(3) Praying mantis

(4) Arctic tern

Q.129 Natality under actual conditions is called

(1) Biotic potential

(2) Maximum natality

(3) Ecological natality

(4) Reproductive potential

Q.130 An Urn shaped population age pyramid represent

(1) Growing population

(2) Static population

(3) Decling population

(4) Threatened population

Q.131 Ability of an environment to support a population is called its

(1) Biotic potential

(2) Purifying capacity

(3) Carrying capacity

(4) Environmental resistance

Q.132 The equation for J-shaped population growth curve

(1) $\frac{dN}{dt} = rN$

(2) $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$

(3) $N_t = N_0 + B + I - D - E$

(4) $D = \frac{N}{S}$

Q.133 In the equation for S-shaped population growth $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$, r represents

(1) Carrying capacity

(2) Environmental resistance

(3) Biotic potential

(4) Population size

Q.134 Which is not true for J-shaped growth curve?

(1) Exponential phase is prolonged

(2) Population never grows beyond carrying capacity

(3) Population crash occur

(4) Population seldom reaches equilibriumx

Q.135 The exponential increase in insect populations during rains is finally controlled by

(1) Environmental resistance

(2) Reporductive potential

(3) Growth rate

(4) Carrying capacity

Q.136 Which statement is not related to S-shaped populations curve ?

(1) Environmental resistance suddenly become effective

(2) Exponential phase is followed by decline phase

(3) Mass mortality and population crash occurs

(4) Both (1) & (3)

Q.137 The periodic departure and return is known as

(1) Migration (2) Immigration

(3) Emigration (4) Mutation

Q.138 When an animal group is centred around a dominant female, it is called

(1) Patriarchy (2) Matriarchy

(3) Swarm (4) Flock

Q.139 Altruistic behaviour is not found in

(1) White ants (2) Spotted deer

(3) Honey bees (4) Bitch

Q.140 Territory is defended against

(1) Predator

(2) Any intruder

(3) Intruder of another species

(4) Intruder of same species

Q.141 Inability of different organisms to interbreed is called

(1) Streility

(2) Parasitism

(3) Reproductive Isoloation

(4) Monogamy

Q.142 The increased number and density of species in region of ecotone is called

(1) Edge effect

(2) Sympatric speciation

(3) Dominance

(4) Abundance

Q.143 Which of the following association is not an example os symbiosis ?

(1) Lichen (2) Mycorrhiza

(3) Root nodules (4) Epiphytes

Q.144 Which is not an effect of competition ?

(1) Regulation of population size

(2) Generalization of niche

(3) Establishment of social hierarchy

(4) Help in speciation

Q.145 Competitive exclusion principle was given by

(1) J. Grinnel (2) Gause

(3) Lindeman (4) Bates

Q.146 Which of the following shows biologicl antagonism or allellopathy

(1) Amensalis (2) Protocooperation

(3) Competition (4) Parasitism

Q.147 The interaction between two living organism of different species which is beneficial to both but is not obligatory because they can live without each other is known as

(1) Proto-cooperation

(2) Mutualism or symbiosis

(3) Commensalism

(4) Amensalism

Q.148 Find the odd one out

(1) Lianas in tropical rain forest

(2) E. coli in large intestine of man

(3) Pilot fish Remora and shark

(4) Rafflesia on roots of forest tree

Q.149 Find the odd one out

(1) Mating (2) Competition

(3) Aggregation (4) Altruism

Q.150 Toxic chemical against nematode is secreted by

(1) Tagetes (2) Black walnut

(3) Pencillium (4) Grevillea robusta

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	4	2	2	3	2	2	4	3	4	1	1	2	3	3	1	1	1	2	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	1	1	3	3	1	3	2	2	3	4	1	1	1	2	4	3	3	1	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	4	2	2	4	1	2	4	2	4	3	4	4	2	2	2	1	4	1	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	2	1	1	4	1	1	3	2	1	1	1	3	4	1	1	1	4	1	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	3	4	3	1	3	3	4	3	1	1	1	4	3	1	1	4	4	1	4
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	3	2	4	1	3	4	2	1	3	3	3	1	3	1	3	2	2	1	2
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans.	2	1	1	2	2	2	3	1	3	3	3	1	3	2	1	4	1	2	4	4
Ques.	141	142	143	144	145	146	147	148	149	150										
Ans.	3	1	4	2	2	1	1	4	2	1										

EXERCISE – 3 PREVIOUS YEAR'S QUESTION

Q.1 Ethology is the study of - **[UTTARANCHAL 2004]**

(1) Behaviour of animals
(2) Past life of organism
(3) Disease causing pathogens
(4) None of these

Q.2 Humus is - **[UTTRANCHAL 2005]**

(1) Dead and decayed organic matter
(2) Living matter
(3) Fertilizers
(4) Living animal / plants / microbes

Q.3 Name the famous plant ecologist - **[C.G. PMT 2005]**

(1) Jagdish chandra bose
(2) Birbal Shani
(3) Ramdeva Misra
(4) Charles Darwin

Q.4 Correct percentage of CO_2 in atmosphere is - **[C.G. PMT 2005]**

(1) 0.03 % (2) 0.3 %
(3) 1 % (4) 1.1. %

Q.5 In an quatic environment, microscopic animals and plants are collectively known as - **[C.G. PMT 2006]**

(1) Commensals (2) Herbivores
(3) Fauna and Flora (4) Planktons

Q.6 5^{th} June is - **[C.G. PMT 2006]**

(1) World Environment Day
(2) Wold AIDS Day
(3) World Womens Day
(4) Worlds Polio Day

Q.7 Plants developing in dry condition are - **[BIHAR 2004]**

(1) Xerophytes (2) Mesophytes
(3) Lithophytes (4) Hydrophytes

Q.8 Soil carried by gravity is - **[BIHAR 2002]**

(1) Alluvial (2) Colluvial
(3) Elluvial (4) Glacial

Q.9 Velamen tissue is found in - **[BIHAR 2001]**

(1) Mesophytes (2) Epiphytes
(3) Hydrophytes (4) Xerophytes

Q.10 Pneumatophores are characteristic feature of - **[BIHAR 2001]**

(1) Hydrilla (2) Rhizophora
(3) Typha (4) None of these

Q.11 Factors relating to form and behaviour of the earth's surface are called - **[BIHAR 2001]**

(1) Edaphic (2) Topographic
(3) Climatic (4) Biotic

Q.12 Aerenchyma is helpful in plants by - **[BIHAR 2006]**

(1) Providing buoyancy in hydrophytes
(2) Absorption in stilt roots
(3) Giving mechanical strength to plants
(4) Giving flexibility to plants

Q.13 Plants growing in saline soil are called - **[UP CPMT 2002]**

(1) Xerophyte (2) Hydrophyte
(3) Halophyte (4) Heliophyte

Q.14 Which one of the following is well-developed tissue present in hydrophytes? **[UP CPMT 2002]**

(1) Aerenchyma (2) Collenchyma
(3) Stomata (4) Root system

Q.15 Penumetophores are found in - **[RPMT 2000]**

(1) Orchid (2) Piper
(3) Ficus (4) Rhizophora

Q.16 The term Autecology refers to study of - **[RPMT 2000]**

(1) Plant community (2) Individual organism
(3) Environment (4) Soil form

Q.17 Autoecology refers to - **[RPMT 2001]**

(1) Plant ecology
(2) Animal ecology
(3) Ecological study of individual species
(4) Ecological study of group of species, which is grown together

Q.18 Which part of the pond ecosystem does not affect by the temperature - **[RPMT 2001]**

(1) Epilimnion (2) Metalimnion
(3) Hypolimnion (4) All

Q.19 Root cap is absent in - **[RPMT 2002]**

(1) Mesophytes (2) Hydrophytes
(3) Epiphytes (4) Xerophytes

Q.20 Which of the following have sunken stomata - **[RPMT 2002]**

(1) *Nerium* (2) *Mangifera*

(3) *Hydrilla* (4) *Zea mays*

Q.21 Velamen & spongy tissue is found in - **[RPMT 2002]**

(1) Breathing roots (2) Parasitic roots

(3) Tuberous roots (4) Epiphytic roots

Q.22 Root cap is absent in - **[RPMT 2005]**

(1) Lithophytes (2) Xerophytes

(3) Hydrophytes (4) Mesophytes

Q.23 Which of the following is the example of xerophytes - **[RPMT 2005]**

(1) ***Brassica*** (2) ***Cuscuta***

(3) ***Capparis*** (4) ***Hydrilla***

Q.24 The organisms inhabiting a common environment belongs to the same - **[UTTARANCHAL 2004]**

(1) Species (2) Genus

(3) Population (4) Community

Q.25 Insectivorous plants usually survive in - **[JHARKHAND 2005]**

(1) Water rich soil

(2) N_2 deficient soil

(3) N_2 rich soil

(4) Sugar deficient medium

Q.26 Group of two or more than two plants species is called as - **[JHARKHAND 2003]**

(1) Plant community

(2) Animal ecosystem

(3) Plant ecosystem

(4) Ecological niche

Q.27 The two vegetations of ecosystem are separated by - **[UP CPMT 2001]**

(1) Ecotone (2) Ecoline

(3) Ecosytem (4) Ecesis

Q.28 In plant succession last community is called - **[RPMT 2000]**

(1) Ecotone (2) Climax community

(3) Seral community (4) Ecocystem

Q.29 In which one of the following habitats does the diurnal temperature of soil surface vary most ? **[AIPMT 2004]**

(1) Forest (2) Desert

(3) Grassland (4) Shrub land

Q.30 People who have migrated from the planes to an area adjoining Rohtang Pass about six months back : **[AIPMT Pre 2012]**

(1) are not physically fit to play games like football.

(2) suffer from altitude sickness with symptoms like nausea, fatigue, etc.

(3) have the usual RBC count but their haemoglobin has very high binding affinuty to O_2.

(4) have more RBCs and their haemoglobin has a lower binding affinity to O_2.

Q.81 Sacred groves are specially useful in : **[AIPMT Mains 2012]**

(1) generating environmental awareness

(2) preventing soil erosion

(3) year-round flow of water in rivers

(4) conserving rare and threatened species

Q.84 The second stage of hydrosere is occupied by plants like : **[AIPMT Mains 2012]**

(1) *Azolla* (2) *Typha*

(3) *Salix* (4) *Vallisneria*

ANSWER KEY

EXERCISE – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	3	1	4	1	1	2	2	2	2	1	3	1	4	2	3	3	2	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32								
Ans.	4	3	3	4	2	1	1	2	2	4	4	4								

These questions consist of two statements each, printed as "ASSERTION" and "REASON". While answering these Questions you are required to choose any one of the following responses.

(1) If both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.

(2) If both Assertion and Reason are True but Reason is not correct explanation of the Assertion

(3) If Assertion is True but the Reason is False.

(4) If both Assertion and Reason are false.

Q.1 **Assertion :** Drought resistant plants are not true xerophytes.
Reason : Drought resistant plants always have physiological dryness.

Q.2 **Assertion :** In winter and summer season growth of phytoplantkton is low in any lake.
Reason : Amount of nutrients and oxygen is less in lake during summer and winter.

Q.3 **Assertion :** Chemical which repel other animals called allomones.
Reason : These are beneficial substances for others.

Q.4 **Assertion :** In mangrove plants, negatively geotropic roots come out of the mud called pneumatophores.
Reason : Mangrove plants grow in water-logged marshy conditions so there is problem of aeration in roots of these plants.

Q.5 **Assertion :** Loam soils are ideal for vegetation.
Reason : Loam soils have clay but no sand.

Q.6 **Assertion :** Mangroves have breathing roots.
Reason : Soil air is almost negligible in swamps.

Q.7 **Assertion :** Profundal zone of a lake harbours have only heterotrophs.
Reason : Autotrophs fail to grow in deep water due to lack of light.

Q.8 **Assertion :** Ecads appear different.
Reason : They lives in different environmental conditions.

Q.9 **Assertion :** Heliophytes are shade loving plant. They requires poor light intensity.
Reason : They are found in lower level of stratification.

Q.10 **Assertion :** Epiphytes can be absorb atmospheric humidity.
Reason : Velamen tissue presents in thier hanging roots.

Q.11 **Assertion :** Well developed chlorenchyma is present in aquatic plants
Reason : Photosynthetic root are present in **Trapa** plant.

Q.12 **Assertion :** Water holding capacity of the soil depends upon structure of soil.
Reason : Water holding capacity of sandy soil is best.

Q.13 **Assertion :** Human regulated environment is called noosphere.
Reason : Human is the main cause for pollution in our cosystem due to exploitation of natural resources.

Q.14 **Assertion :** Ephiphytes are completely autotrophic plants which grow on other plants.
Reason : Epiphytes are found in Sariska national park.

Q.15 **Assertion :** Psychrophytes are also known as hekistotherms plants.
Reason : Cold soil is physiologically dry habitat.

Q.16 **Assertion :** Photosynthesis process is absent in aphotic zone of ocean.
Reason : Aphotic zone is the deepest zone of ocean without oxygen.

Q.17 **Assertion :** Solar energy is the best pollution free form of energy.
Reason : It can be produced in a nuclear reactor in large amout from a tiny amount.

Q.18 **Assertion :** Planktons are free floating organism on the surfaces of water.
Reason : All Planktons belongs to animal kingdom.

Q.19 **Assertion :** Hygroscopic water is hold by soil colloids.
Reason : It can be utilized by plants.

Q.20 **Assertion :** Undifferentiated and living xylem is found in aquatic plants (suspended).

Reason : Phloem is less developed in aquatic plants.

Q.21 **Assertion :** Drought resistant plant are also known as succulent xerophytes.

Reason : They complete their life cycle during the favourable season.

Q.22 **Assertion :** Soil water available to plant is chresard.

Reason : Capillary water is only form of soil water which is available to plants.

Q.23 **Assertion :** Alluvial soil is a transported soil.

Reason : It is brought through the wind.

Q.24 **Assertion :** Solar energy is conventional energy sources.

Reason : It is widely used.

Q.25 **Assertion :** In Aquatic ecosystem most of the food chain depends on light.

Reason : In aquatic ecosystem parasitic food chain starts from phytoplankton

Q.26 **Assertion :** Home range of different groups can overlap.

Reason : Territory of different groups can not overlap.

Q.27 **Assertion :** Epiphytes are included in phanerophytes.

Reason : The buds are located at much above from surface of earth.

Q.28 **Assertion :** Temperature is gradually decreasing towards the pole.

Reason : Effect to latitude and altitude are almost same for temperature.

Q.29 **Assertion :** Stratosphere is suitable for aviation.

Reason : Moisture content is low and large convection currents are lacking in the stratosphere.

Q.30 **Assertion :** In hydrophytes, photosynthesis takes place through whole plant body.

Reason : Light is the limiting factor for photosynthesis in aquatic plants.

Q.31 **Assertion :** In mutalism both organisms are benefitted.

Reason : Both are benefitted but they are not dependent on each other.

Q.32 **Assertion :** Intraspecific competetion is most sever.

Reason : Organisms of same species have same basic requirements.

Q.33 **Assertion :** In protocoopertion both organism are benefitted.

Reason : Both are benefitted as well dependent on each other.

Q.34 **Assertion :** Due to growth of Penicillium, bacteria become less in soil.

Reason : It shows ammensalism.

Q.35 **Assertion :** All predators are carnivorous.

Reason : They kill and eat the producer.

Q.36 **Assertion :** Biotic potential of any one species is high in maximum favourable conditions.

Reason : Number of species increases in area under favourable conditions.

Q.37 **Assertion :** Mesophytes are climax community in hydrosere.

Reason : No biotic community is stable in ecosystem.

Q.38 **Assertion :** Ecotone have maximum diversity.

Reason : Ecotone is transition zone of two communities.

Q.39 **Assertion :** In population, dominance is subordination behaviour.

Reason : Dominance is a negative interaction in population.

Q.40 **Assertion :** Territory is defended against members of same species.

Reason : It reduces the competetion for the basic need.

Q.41 **Assertion :** Group of African elephants is patriarchy.

Reason : In this group the group leader is male.

Q.42 **Assertion :** In most favourable environmental condition organism have maximum biotic potential.

Reason : Biotic potential is maximum reproduction capacity of organism.

Q.43 **Assertion :** The competition for the basic needs get reduced in territory.

Reason : Territory is defended against members of same species.

Q.44 **Assertion :** Arctic fox and African Jackal are cological equivalent.
Reason : They have same niche in different habitats.

Q.45 **Assertion :** Zone of transition between two type of communities is called ecotone.
Reason : Esturay is an ecotone between marine and fresh water communities.

Q.46 **Assertion :** Interspecific competition are more strongest as compair to Intra specific competition.
Reason : Members of different species have same requirement.

Q.47 **Assertion :** Key-stone species determine the structure of the community.
Reason : These species have great influence on community

Q.48 **Assertion :** Biomass is a analytical character.
Reason : "Growth of plant" is synthetic character which are derieved from biomass.

Q.49 **Assertion :** Ecosystem is made up by biotic and abiotic componants.
Reason : It is the smallest structural and functional.

Q.50 **Assertion :** Biotic community is never stable in nature.
Reason : Climax community is more stable in succession.

ANSWER KEY

EXERCISE – 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	3	1	3	1	1	2	4	1	2	3	2	3	2	3	3	3	3	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	2	3	4	3	2	1	2	1	1	3	1	3	1	3	3	2	1	3	2
Ques.	41	42	43	44	45	46	47	48	49	50										
Ans.	4	2	2	1	2	4	1	2	2	2										

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first allempt	Good / Important questions
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

ECOSYSTEM

INTRODUCTION

(A) A.G.Tansley - The term **"Ecosystem"** coined by A.G. Tansley. According to Tansley Ecosystem is symbol of structure and function of nature.

(B) E.P.Odum - Father of ecosystem ecology. **According to E.P.Odum** Ecosystem is the smallest structural and functional unit of nature or environment.

(C) Karl Mobius - Used term **Biocoenosis** for ecosystem.

(D) Thienmann - Used term **Biosystem** for ecosystem.

(E) Sukhachov - Used term **Biogeocoenosis** for ecology.

(F) Misra - Used term **Ecosom** for ecosystem.

(G) Forbes - Used term **Microsom** for ecosystem.

ECOSYSTEM –

Total living (biotic) and non living (aboitic) componants of the environment present in a particular area is called ecosystem.

Characteristics :

(1) In any ecosystem, communities or living organisms interact with their physical environment in such a way that there is a well defined flow of energy forming clear **trophic** (food) **levels** and **material cycles** within this ecosystem.

(2) Ecosystem is normally an open system because there is a continuous and variable entry and loss of **energy** and **materials**.

(3) An ecosystem may be small like a drop (microsystem) of water and as large as sea or tract of forest.

(4) An ecosystem may be temporary as a fresh water pool or a field or permanent like a forest or sea.

(5) Thus any area of nature that includes living organisms and nonliving substances interacting, so that a **flow of energy** leads to characteristic **trophic structures** and **cycling of materials** makes the ecosystem.

(6) There is an energy source for all living organisms in an ecosystem.

(7) Adequate amount of food and essential nutritional element should be present for living organisms in an ecosystem.

(8) There should be a continuous cyclic flow of energy and materials in form of food chains between organisms and environment.

(9) There are regular changes in the climatic conditions (temperature, humidity, light etc.) in an ecosystem.

(10) Ecosystem is also self maintainable and self regulatory system, it means an ecosystem maintains a balance in between different trophic levels.

(11) Each trophic level control the other trophic level in an ecosystem. If any change take place in any trophic level of ecosystem, the other trophic levels of this ecosystem may react according to it. So ecosystem always remain in equilibrium. This feature of system is known as **Homeostasis.**

(12) A science of self control as (homeostasis) in an ecosystem is called cybernetics.

(13) The boundaries of ecosystem are indistinct and have a overlapping character over each other.

(14) Ecosystem is the smallest structural and functional unit of nature or environment. It is a **self regulatory** and **self sustaining unit.**

TYPE OF ECOSYSTEM

(A) Natural Ecosystem **(B) Artificial Ecosystem**

(A) Natural Ecosystem -

1. **Terrestrial Ecosystem -** eg. forest, grassland, tree, desert ecosystems.
2. **Aquatic Ecosystem -** Aquatic ecosystem is again of two type
   (i) Lentic ecosystem - Stagnant fresh water, lake, pond, swamp.
   (ii) Lotic - Running fresh water ecosystem. eg., rivers

(B) Artificial Ecosystem - Man made ecosystem eg., cropland, Gardens etc.

On the basis of size, type of ecosystem :

(i) Mega ecosystem - Ocean/Sea (ii) Macroecosystem - Forest
(iii) Microecosystem - Pond (iv) Nanoecosystem - Drop of water.

COMPONENTS OF ECOSYSTEM

(A) Abiotic component (B) Biotic component

(A) Abiotic component

(i) Temperature (ii) Light (iii) Soil (iv) Climate
(v) Rainfall etc.

(B) Biotic component

Formed by living things. eg., plants, animals, microbes.

Type of Biotic Components :

1. **Producers -**

(i) All the autotrophs of ecosystem are called producers. They prepare their own food. The green plants are the main producers. In the process of photosynthesis, producers absorb solar energy and convert it into chemical energy so producers are also called **transducers** or **converters.**

(ii) Energy enters into the ecosystem through the producers. The **solar energy** is the only ultimate source of energy in ecosystem. This energy is available for the remaining living organisms. Other example of producers are **Chemoautotrophs** eg. iron bacteria, sulphur bacteria, nitrifying bacteria and phytoplankton.

2. **Consumer -**

All the heterotrophs of the ecosystem are known as consumers. They directly (herbivores) or indirectly (Carnivores) depend on the producers for food.

Type of consumer

(i) Macro consumers (ii) Micro consumers

(i) Macro consumers (Phagotrophs or holozoic) : They digest their food inside the body. ie., first ingestion then digestion. Macro consumers are of following types –

(a) **Primary consumers -** Such living organisms which obtain food directly from producers or plants are known as primary consumers. eg., **herbivores** of ecosystem, Cow, Grazing Cattle, Rabbit. They are also known as **secondary producers** as they synthesize complex materials in the cells, by the digestion of food which is obtained from the plant.

(b) **Secondary consumers or primary cornivores -** Animals which feed upon primary consumers and obtain food. Those cornivores which kill and eat the herbivores, are called **predator**. eg., Dog, Cat, Snake

(i) The organism which completely depends on **dead animals** are not example of predators but they are the **scavangers** or **detrivores**. eg., Vulture, Crow, Fox.

(ii) All predators are carnivores but all carnivores are not predators.

(c) Top Consumers - Those animals which kill other animals and eat them, but they are **not killed** & and **eaten** by other animal in the nature. eg., Lion, Man, Hawk, Peacock.

(ii) Micro Consumers/Decomposers or Saprotrophs/osmotrophs-

Those living organisms which decompose the dead body of producers and consumers are known as decomposer or reducers or transformer or osmotrophs.

Characterstics :

(i) The main decomposers in ecosystem are **bacteria** and **fungi**. In Bacteria and fungi, process of decomposition completely takes place outside the body. They release enzymes from their body on dead remains and decompose it into simpler organic substance and then absorb it so these are called as **osmotrophs (absorptive).**

(ii) Decomposers play a significant role in **mineral cycle.**

(iii) In aquatic system **whale** is **secondary consumer**. It is an example of **filter feeder** because it feeds on plankton.

(iv) **Vulture** is a **scavenger not predator** because it never kills any animal. Vulture is also a decomposer. In Vulture, the break down of the food material takes place inside the body and then released into the soil in the form of waste material and minerals.

(v) **Plant parasites** are known as **primary consumers** while **animals parasites** (E.coli bateria, Entamoeba hisotlitica, liver fluke, tapeworm) are known as **secondary consumers.**

(vi) **All the insectivorous** plants play the **double role** i.e., **producer** as well as **secondary consumer** because they sythesise their own food through photosynthesis and they eat insects simultaneously.

(vii) **Man and peacock** are **omnivores.**

(viii) Organisms which use milk or curd are known as **secondary consumer.**

(ix) **Inorganic material** (CO_2, H_2O, Light), autotrophs **(Producers)** and **decomposers** are **essential** in ecosystem but, **macro consumers** are **non essential.**

STRUCTURE AND FUNCTION OF ECOSYSTEM :

(A) Structure of Ecosystem :

Biotic and abiotic components are physically organized to provide characteristic structure to a ecosystem It is species composition and stratification (lake stratification, forest stratification, ocean stratification).

(1) Another way to represent the structure of ecosystem is through food relationship of producers and consumers constituting the **Standing Crop.**

(2) The nutrients necessary for growth of living organisms, accumulated in biomass and in abiotic componants like soil called **Standing State.**

(B) Function of Ecosystem :

Ecosystem posses a natural tendency to persist, which is due to it's variety of functions (activities under taken to ensure persistance).

For example 1. Leaves carryout photosynthesis, root absorb nutrients from soil, 2. Herbivores utilize plant production and decomposers carryout decompositions and product used by producers. So key aspect of function of ecosystem are -

1. Productivity
2. Decomposition
3. Energy flow
4. Nutrient cycling

1.Productivity :

(i) Primary productivity -

Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in term of weight (g^{-2}) or energy (Kcal m^{-2}). The rate of biomass production is called productivity. It is expressed in term of $g^{-2}yr^{-1}$ or (Kcal m^{-2}) yr^{-1} to compare the productivity of different ecosystem. It can be divided into **GPP** and **NPP**.

(a) Gross primary productivity (G.P.P.) - It is the total amount of energy fixed (organic food) in an ecosystem (in producers) in unit time is called G.P.P. including the organic matter used up in respiration during the measurement period. It is also known as **total (Gross) photosynthesis.** A considerable amount of GPP is utilised by plants in respiration.

(b) Net primary productivity (N.P.P.) - It is the amount of stored organic matter in plant tissues after respiration utilisation.

NPP = GPP – R (R = Respiration + Metabolic activities)

or

GPP = NPP + R

NPP is the available biomass for the consumption of heterotroph.

(ii) Secondary productivity - Secondary productivity is the rate of formation of new organic matter by consumers.

(a) The annual net primary productivity of the whole biosphere is approximately 170 billion tons (dry weight) of the organic matter, productivity of the ocean are only 55 billion tons.

(b) In per unit area maximum productivity found in tropical rain forest.

(c) In water, least productive ecosystem is very deep lakes and highly productive ecosystem is coral reef.

(d) Nitrogen is the limiting factor in ocean and phosphorus is the limiting factor in lake productivity.

(e) In land highest productivity notice in Tropical rain forest (5 kg/msq/year). Lowest productivity is notice in Deserts and tundra.

(f) Most productive Agro-ecosystem is Sugarcane and rice ecosystem (3-4 kg./msq/year).

2.Decomposition :

Decomposition (Formation of Humas) : Decomposers break down comlex organic matter into inorganic substance like carbon dioxide, water and nutrients and the process is called decomposition. Dead plant remains such as leaves, bark, flower and dead remains of animals, including fecal matter, constitute **detritus**, which is the raw material for decomposition. The important steps in the process of decomposition are

1. Fragmentation, 2. Leaching, 3. Catabolism, 4. Humification and 5. Mineralisation.

1. Fragmentation : Detritivores (eg., earthworm) break down detritus into smaller particles. This process is called fragmentation.

2. Leaching : By the process of leaching, water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavilable salts.

3. Catabolism : Bacterial and fungal enzymes degrade detritus into simple inorganic substance. This process is called as catabolism.

4. **Humification :** Humification leads to accumulation of a dark coloured amorphous substance called **humus** that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate. Being colloidal in nature it serves as a reservoir of nutrients.

Types of Humus -

(i) **Mor** (Coarse terxtured humus)- It is raw humus and is formed in acidic soil (PH - 3.8 – 4.0) in which decomposition of litter is slow because it has less number of decomposer organism.

(ii) **Mull –** This is completely decomposed litter. i.e., humus because rate of decomposition is fast due to high PH of soil. (Best PH of the soil 5.5 to 6.5)

5. **Mineralisation :** The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as mineralisation.

Characteristics of Decomposition :

1. It is important to not that all the decomposition steps operate simultaneously on the detrius. Humification and mineralisation occur during decomposition in the soil.
2. It is largely an oxygen-requiring process. The rate of decomposition is controlled by chemical composition of detritus and climatic factors. In a particular climatic condition, decomposition rate is slower if detrius is rich in lignin and chitin and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars.
3. Temperature and soil moisture are the most important climatic factors that regulate decomposition through their effects on the activities of soil microbes. Warm and moist environment favour decomposition where low temperature (< 10ºC) and an anaerobiosis inhibit decomposition resulting in build up of organic materials.
4. Decomposition requires years at very high altitude or lattitudes. Rate of decomposition is low in prolonged dry soil like in tropical desert.
5. The actual rate of decomposition depands on environmental conditions and detritus quality.
6. **Nutrient Immobilisation -** In the process of decomposition, some nutrients get tied up with the biomass of microbes and become temporarily unavailable to other organisms. Such incorporation of nutrients in living microbes (bacteria and fungi) is called nutrient immobilisation**.** This immobilization check or prevents the wash out of nutrients from ecosystem.

3.Energy Flow :

(i) Energy flow is the key function of ecosystem. The storage and expenditure of energy in ecosystem is based on the two basic laws of **thermodynamics.**

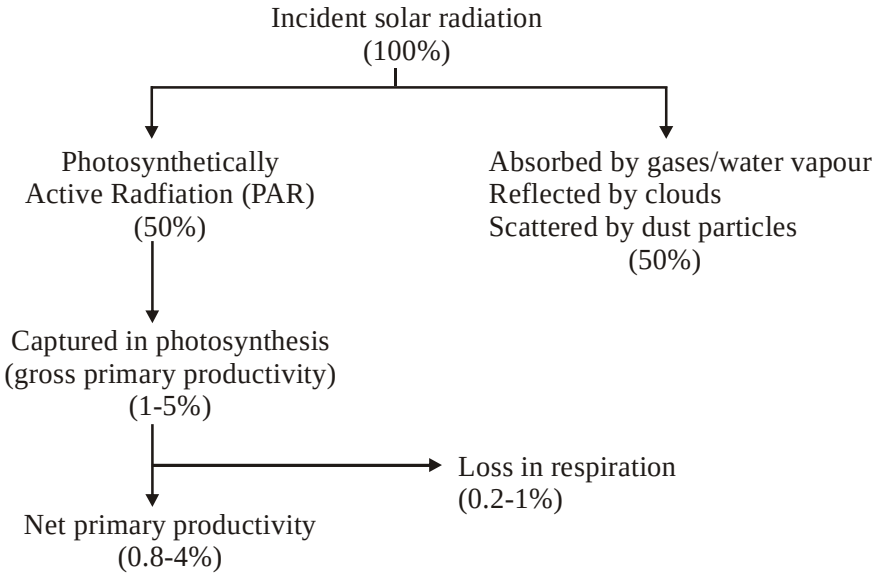
(a) Energy is neither created nor destroyed but only transformed from one state to another state.

(b) The law of entropy - The transfer of food energy from one to another organisms leads to loss of energy as heat due to metabolic activity.

(ii) Energy in food is in concentrated form, heat energy is highly dispersed. It must be understood that all changes in energy forms can be accounted for energy flow in any system.

(iii) It is useful to examine the relationship between incident radiant energy and the energy captured by the producers in the food they menufacture. Only the visible light, or the **photosysnthetically active radiation (PAR),** which carries about 50 percent of the energy of total incident solar radiation, is available to producers for absorption.

(iv) Under favourable environmental conditions, only about 1-5 percent energy of incident radiation or 2-10 percent of PAR is actually captured by the photosynthetic process (gross primary productivity), and the remaining portion is dissipated. Since the simultaneously occuring respiratory processes are energy consuming and use up the part of the photosynthetic gain, the net capture of energy (Net primary productivity) is reduced to only 0.8-4 percent of the incident total radiation, or 1.6-8 percent of PAR. Only the energy captured can be used by other trophic levels.



Food Flow Model :

1. A simplified representation of energy flow through ecosystem has been made in figure presented. Two aspects with respect to energy flow in ecosystem need careful consideration. First, **the energy flows one ways**, i.e., form producers to herbivores to carnivores; it cannot be transferred in the reverse direction.
2. Second, the **amount of energy flow decreases with successive trophic levels.** Producers capture only a small fraction of solar energy flow decreases with successive trophic levels. Producers capture only a small fraction of solar energy (1-5 percent of total solar radiation), and the bulk of unutilised energy is dissipated mostly as heat. Part of the energy capture in gross production their standing crop (respiration) and for providing food to herbivores (herbivory). The unutilised net primary production is ultimately converted to detritus, which serves as energy source to decomposers.
3. Thus, energy actually used by the herbivore trophic level is only a small fraction of the energy captured at the producer level. On an average, in different ecosystems, the herbivore assimilation or productivity approximates 10 percent of gross productivity of producers.
4. The enrgy assimilated by the herbivores is used in respiration and a fraction of unassimilated energy is transferred to decomposers (eg., Faecal matter). The remaining herbivore level energy available at carnivore trophic level is again partitioned leaving a very small fraction to support the next trophic level (top carnivore).
5. The respiration cost also increases sharply along successive higher trophic levels. On an average, respiration in producer consumes about 20 percent of its gross productivity. Herbivores consume about 30 percent of assimilated energy in respiration. The proportion of assimilated energy consumed in respiration rises to about 60 percent in carnivores. Because of this tremendous loss of energy at successive higher trophic levels, the residual energy is decreased to such an extent that no further trophic level can be supported. Therefore, the **length of food chains in an ecosystem** is generally **limited to 3-4 trophic levels.**

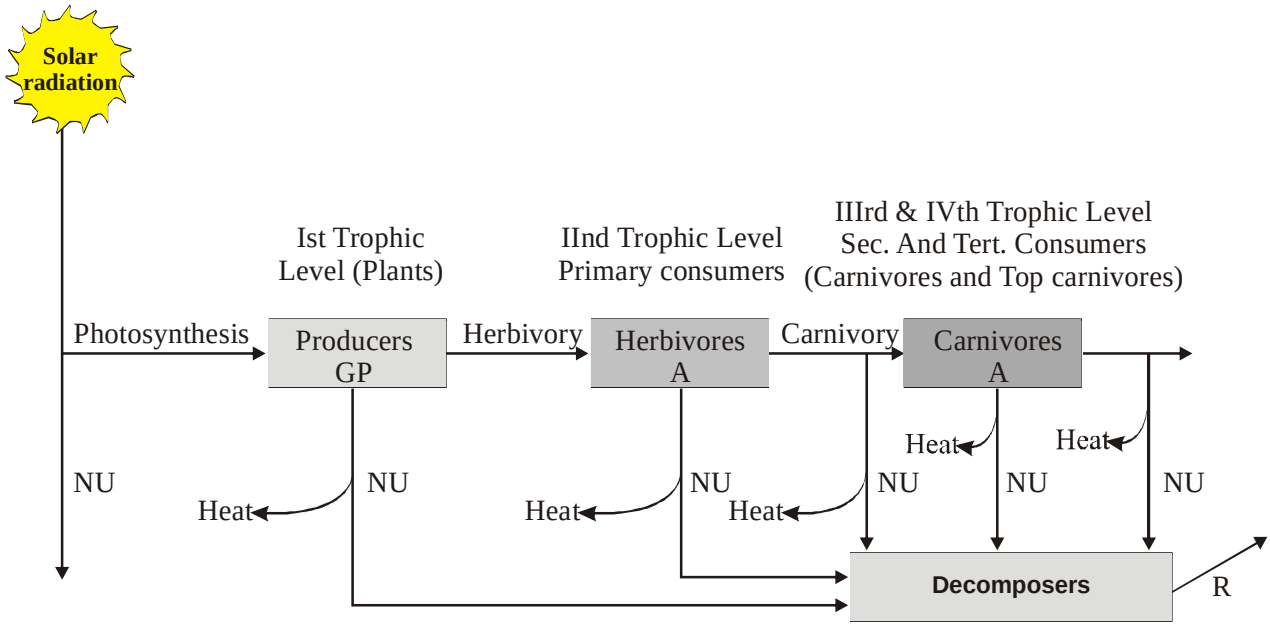


Fig.: A generalized energy flow model of ecosystem : Boxes represent biotic components and the arrows show the pathways of energy transfer; SR-Solar radiation: GP-Gross primary productivity ; A-Assimilation; R-Respiration; NU-Not utilised; NA, Not assimilated

Food Chain :

1. In ecosystem every organism depends on other organism for food material and all organism are (herbivores to carnivores) arranged in a series in which food energy is transferred through repeated eating and being eaten. It is called food chain. In food chain, energy flow is in the form of food.
2. In a food chain, food material or food energy is transfer from one trophic level to next trophic level.
3. Four trophic levels are present in the ecosystem, because level of energy decreases during the flow of energy from one trophic to the another trophic level.

   First trophic level **[T_1]** = Producers

   Second trophic level **[T_2]** = Primary consumers

   Third trophic level **[T_3]** = Secondary consumers

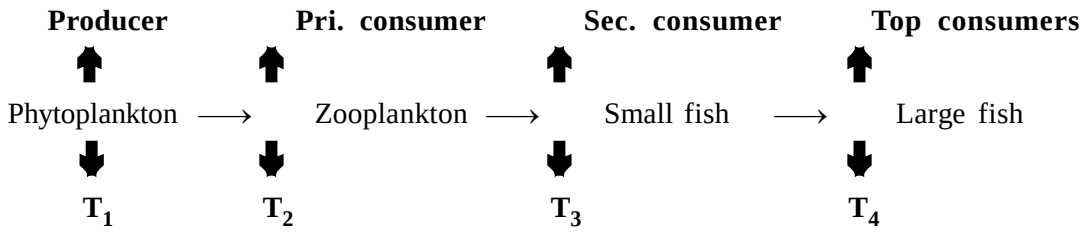
   Fourth trophic level **[T_4]** = Top consumers
4. **Five trophic levels** found in highly complex ecosystem in which tertiary consumer is present in between the secondary consumers and top consumer. Then the fifth trophic level (T_5) is formed by the top consumer.
5. In food chain energy flow is **unidirectional** (preducers to herbivores).
6. Shorter food chains will provide greater energy.
7. Generally the decomposers (Bacteria and Fungi) are not included in the food chain but when included then included as the last trophic level.

Type of Food Chains :

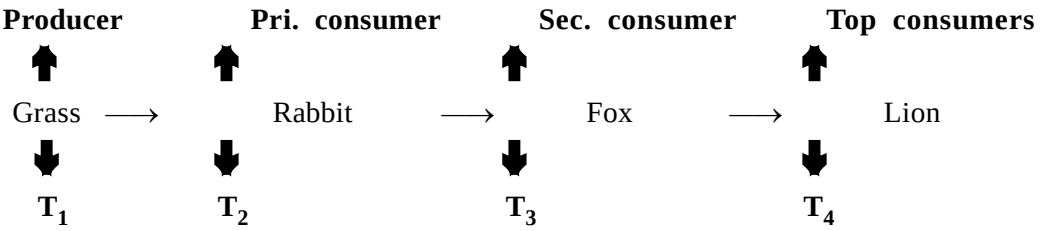
1. **In nature three type of food chain are present-**

(a) **Grazing food chains or Predatory food chain -** Most of food chain in nature are of this type. This food chain begins with Producers (plants) and in successive order it goes from small organism to big organism.

(i) Aquatic ecosystem :



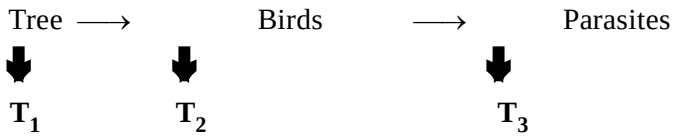
(ii) Grass land ecosystem :



2. Parasitic food chain - This food chain also starts from producers but in successive order it goes from big organism to the smaller organisms.

eg.,

Tree ecosystem



Note : Both above food chains are directly dependent on **solar radiation** (as a primary source of energy) and have **rapid energy flow.**

3. Detritus food chain or Saprophytic food chain - This food chain begins with decomposition of dead organic matter by **decomposers** so it is also known as saprophytic food chain. In this food chain primary consumers are bacteria and fungi.

Dead organic matter → Bacteria, fungi

Note :

(i) In mangrove vegetation this food chain goes up to big organism.

(ii) Dead mangroves leave → Bacteria & fungi → Amphipds, molluscs, crabs, nematodes → small fishes → fish eating birds.

(iii) In detritus food chain **energy flow** is rather very **slow** yet **magnitude of energy is great** because vast number of decomposers are involved.

(iv) It does not depends on **light.**

(v) In an aquatic ecosystem, GFC(Grazing Food Chain) is the major conduit (source) of energy flow. As against this, in a terrestrial ecosystem, a much larger energy flow through the detritus food chain (as it is small) than through the grazing food chain.

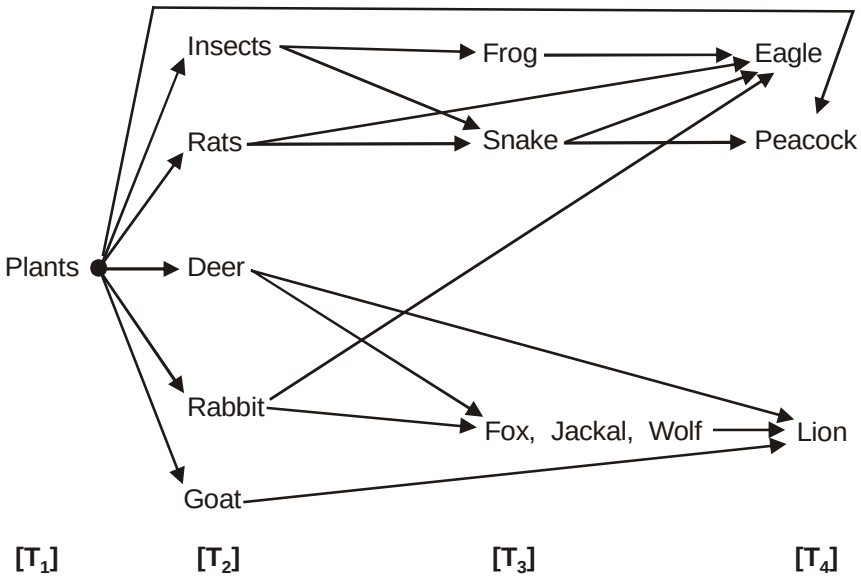
(vi) In Sunderbans, Tigers feed on the fishes and crab in the absence of their natural prey.

Food Web :

1. In big ecosystem many food chains are interlinked together on different trophic levels to form food web. In food web transfer of food energy is unidirectional but from many different alternative pathways.

2. In food web members of a particular trophic level obtain their food according to their choice and taste but that type of facility is not present in food chain. It means they have **more than one option or alternative for getting food.**

3. **As mush as food web is complex that ecosystem is more permanent or stable,** such type of ecosystem is not destroyed naturally and continues for long time. This ecosystme is not affected by loss of any organism of any particular trophic level. **Those ecosystems which have simple food web are not very stable** it means that they can be finished at any time, if there is a change in any particular trophic level.



Pyramids of Ecosystem :

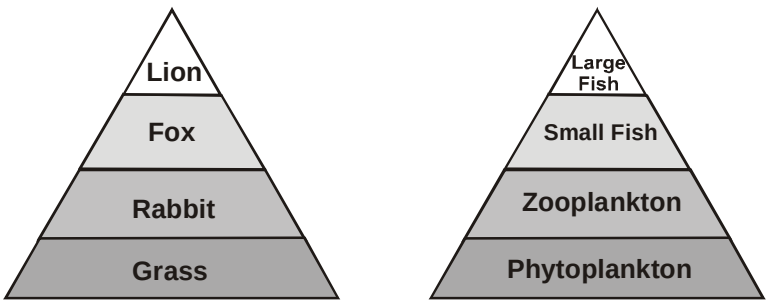
Graphical representation of ecological parameters at different trophic levels and trophic structure in ecosystem is called pyramids. These parameters are **Number**, **Biomass** and **Energy**. First of all, pyramid was formed by **Charis Elton;** So we called it **Eltonian pyramids.**

These Pyramid are of three types

(1) Pyramids of number, (2) Pyramids of energy, (3) Pyramids of biomass.

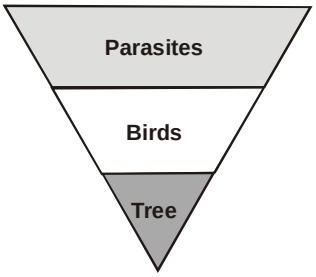
(1) Pyramids of number -

(a) In this type of pyramid the number of individual organism in various trophic level is shown. These pyramid are mostly upright, because number of producers [T_1] is maximum and number of herbivores and carnivores decrease towards apex or at successive trophic levels, such as **Grassland ecosystem** and **aquatic ecosystem.**



Grass land Ecosystem Aquatic Ecosystem

(b) But in a **tree ecosystem** the **pyramid of numbers is inverted.** This is called parasitic ecosystem. Because birds (herbivores) depend on the tree (producer) and parasites (consumer) like bugs, lices depend on birds, therefore with increase in the number of trophic levels, the number of the organisms increase sequentially.



Tree Ecosystem

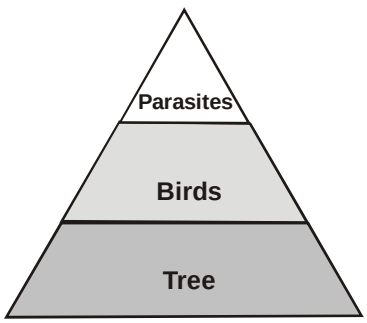
Note :

(i) Maximum number of producers are present in aquatic ecosystem. **The number of organism at any trophic level depends upon the availability of organisms which are used as food** on lower level so **availability of food is main factor.**

(ii) Pyramid of number shows **biotic potential** of a ecosystem. The number of members of any particular species in favourable conditions is called their biotic potential. When the numbers of the members of any species increases over the limit then it is called **population explosion.** Because of this existence of the species comes in danger. Human population is also near this condition at present.

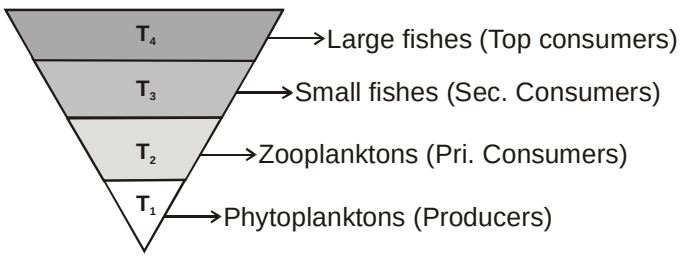
(2) Pyramid of Biomass -

(a) Pyramids of biomass represent the total amount of biomass of each trophic level of ecosystem, mostly these pyramids are also upright (erect) eg., tree ecosystem, forest ecosystem.

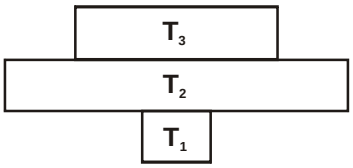


Pyramid of biomass in Tree ecosystem

(b) Pyramid of biomass in **aquatic ecosystem** is **inverted** because in it producers are micro-organism and their biomass is very less.



Note : Pyramid of lake on the basis of biomass-



(3) Pyramids of energy -

(a) It represent amount of energy at different trophic levels, energy pyramids are **always upright or erect** because there is a gradual decrease in energy at successive trophic levels. According to the **10% law of Lindeman,** the 90% part of obtained energy of each organism is utilized in their various metabolic activites and heat and only 10% energy is transferred to the next trophic level. So 90% energy is lost at each trophic level, therefore **top consumers like lion etc. are ecologically weakest** but physically they are strong.

Note : Pyramids of energy represent the **productivity of ecosystem** as well as transfer of production in ecosystem.

Ecosystem	Shape of Pyramid
Pyramid of Number	
Grassland	Uprigint
Forest	Inverted
Aquatic	Upright
Pyramid of Biomass	
Grassland	Upright
Forest	Upright
Aquatic (Lake)	Inverted
Pyramid of Energy	
All ecosystems	Upright

4. Nutrient Cycling / Biogeochemical Cycle :

Bio – Living organism

Geo – Rock, Soil, Water

Chemcial – Material or Nutrients

(a) All the types of material required by ecosystem in addition of energy, are available continuously to ecosystem through recyling. Thus there is a constant exhcange of materials between the living organism and their abiotic environment through the recyling of materials. This phenomenon is called Biogeochemical cycle.

(b) The mineral elements taken up from the enviroment (soil as well as air) by the green plant, (the producers), are again returned to the environment through consumers and decomposers.

(c) The following types of cycles are found in an ecosystem

(i) Gaseous Cycle - C, H, N, O cycle. Reservior is in the atmosphere (air) or in **Hydrosphere**(water).

(ii) Sedimentary cycle - P, S, Ca cycles reservoirs are in earth's crust (lithosphere)

(iii) In these cycles, the bulk material remains in the inactive reservoir on earth crust like sediment of sea or water bodies.

(iv) Nutrient cycles can be conveniently considered under the following three aspects as shown in above figure.

(v) **Input of Nutrients :** Ecosystem receives nutrients form external sources and stores them for further used though biological processes. For example, nutrients in dissolved state are gained from rainfall **(wet deposition)**, or in particular state from dust fall **(dry deposition)**. Symbiotic biological fixation of nitrogen in soil also represents an input. Weathering of soil parent materials, which releases available nutrients from their fixed state, is another example of input.

(vi) **Output of Nutrients :** Nutrients are moved out of an ecosystem and many become input to another ecosystem. For example, considered loss of nutrients like calcium and magnesium (from soil particle) occurs through runoff water, or through soil erosion. Significant amount of nitrogen may be lost in gaseous form by the denitrification process in soil. Harvesting of agricultural crops or transportation of logs from forest, represent nutrient loss from these ecosystems.

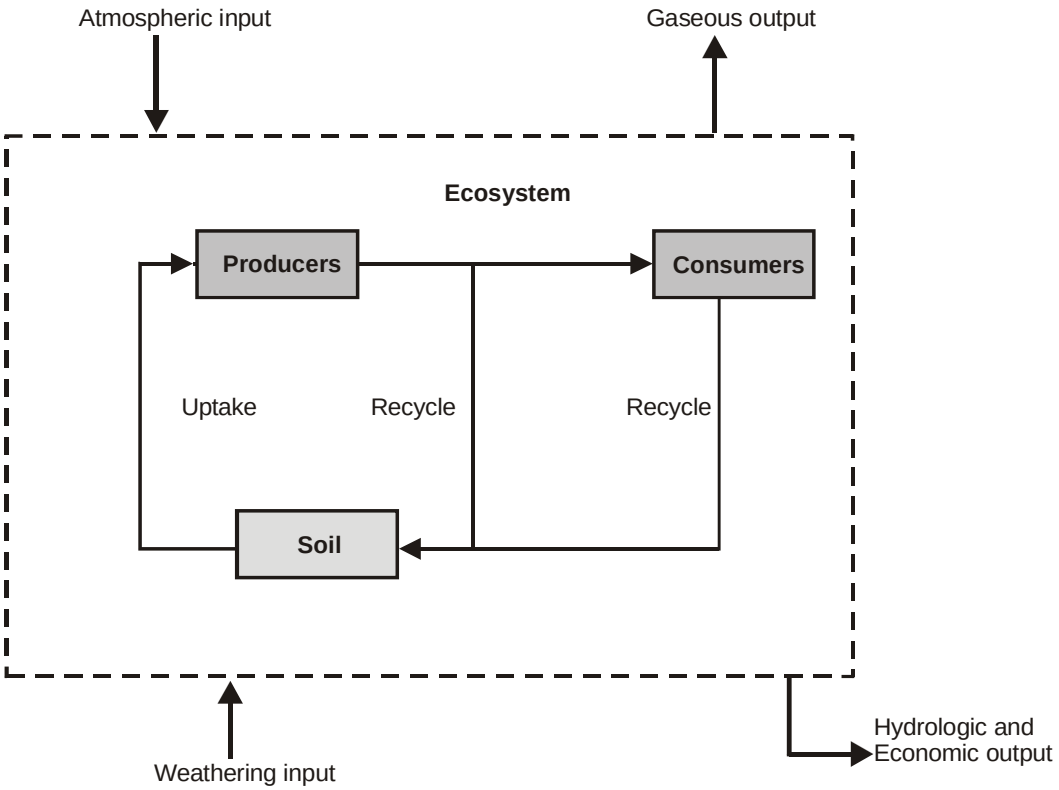


Fig.: A generalised model of ecosystem nutrient cycling : Nutrients are brought in (input), moved out (output), and cycled internally in the ecosystem. Boxes represent ecosystem components and arrows show the pathways of nutrients transfers.

(vi) In an **undisturbed ecosystem**, (ie., an ecosystem in which human activities are absent or nearly so) the **input of nutrients** may approximately **equal the output of nutrients,** rendering the nutrient cycle more or less balanced.

(vii) Generally, the absolute amounts of nutrient moving in (input) and moving out (output) of the ecosystem are much less than the amount of nutrients cycled within (amongst different components) the ecosystem. Sever disturbances in the ecosystem (e.g., Tree felling, insect outbreak, fire, soil erosion, etc.) may make the nutrient cycles unbalanced and the ecosystem unstable. The soil can be lost rapidly by erosion after removal of natural vegetation.

(viii) **Internal Nutrient Cycling :** Plants absorb varying amounts of nutrients from the soil. Due to decomposition of dead organic matter, nutrients are continuously regenerated and strored in soil and available to the plant. A dynamic state exists in soil, with nutrient regeneration and absorption occuring simultaneously.

(ix) The transfer of nutrients form the soil to plants by the process of nutrient absorption is known as **uptake.** The absorbed nutrients are metabolically incorporated in plants during growth. Periodically, nutrients are recycled i.e., brought back to soil through **litter fall** from vegetation, animal remains and faecal matter, etc. The overground, as well as root detritus decompose to regenerate the nutrients.

(x) Eventually, nutrients contained in the detritus on soil surface and within, are regenerated by decomposition in plant-available forms.

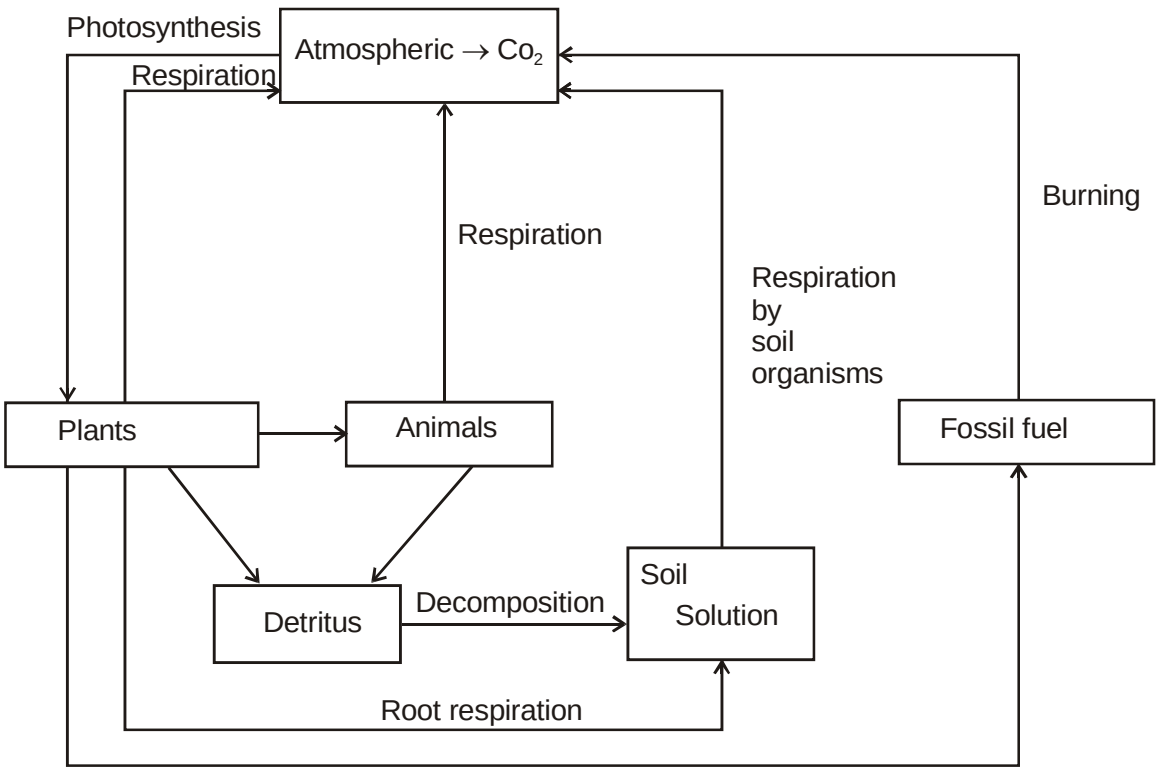
(xi) When the uptake of nutrient exceeds the amount recycled (e.g., as in the case of a young growing forest), a fraction of the uptake is retained in the standing crop. This **retension** of balance nutrients in the standing crop leads to increase in nutrients content of the ecosystem. Thus, in a nutrient cycle:

Retention = Uptake – Recycle.

(xii) Rates of nutrient uptake, recycle and retention vary widely in different ecosystems. A large number of chemical methods are available for determining the amounts of different nutrients per unit weight of biomass of soil. By determining changes in the nutrient concentrations and biomass with time, the nutrient budget of the ecosystems can be computed.

Carbon Cycle :

The main source of carbon is **atmosphere** and in **hydrosphere** it is **rocks of carbonates.** Carbon present in lithosphere in the form of coal and petroleum. The carbon released from them is present in the atmosphere in the form of carbodioxide. The green autotrophs utilize CO_2 from the air to synthesize food materials which is obtained by other organisms as food. Carnivors obtain their organic food from the herbivores. These carbonic matter produce CO_2 through the oxidation or respiration which dissolve in air or water and again utilized by the plants.



Nitrogen Cycle :

Atomsphere is the only source of nitrogen 78% nitrogen is present in atmospheric air. Plants absorb nitrogen in the form of **nitrate** ions mainly.

Nitrogen cycle is completed in following steps

1. Nitrogen fixation -

(a) In this process first of all some bacteria and blue green algae converts atmospheric nitrogen in to nitrogenous, compounds viz ammonia, amino acid or nitrate salts.

e.g.

Bacteria – ***Rhizohbium, Aerorhizobium, Azospirillum***
Frankia, Clostridium, Azotobacter

Blue green algae – ***Oscillatoria, Anabaena, Aulosira, Nostoc*** $\rightarrow$ In flooded rice field in tropics

Note :

(1) Azotobacter is aerobic bacteria

(2) Clostridium is anaerobic bacteria

(3) Symbiotic relationship where the nitrogen fixing bacteria does not penetrate deep into host tissue, known as **associative symbiosis.** Azospirillum with grass paspalum notatum.

2. Nitrification –

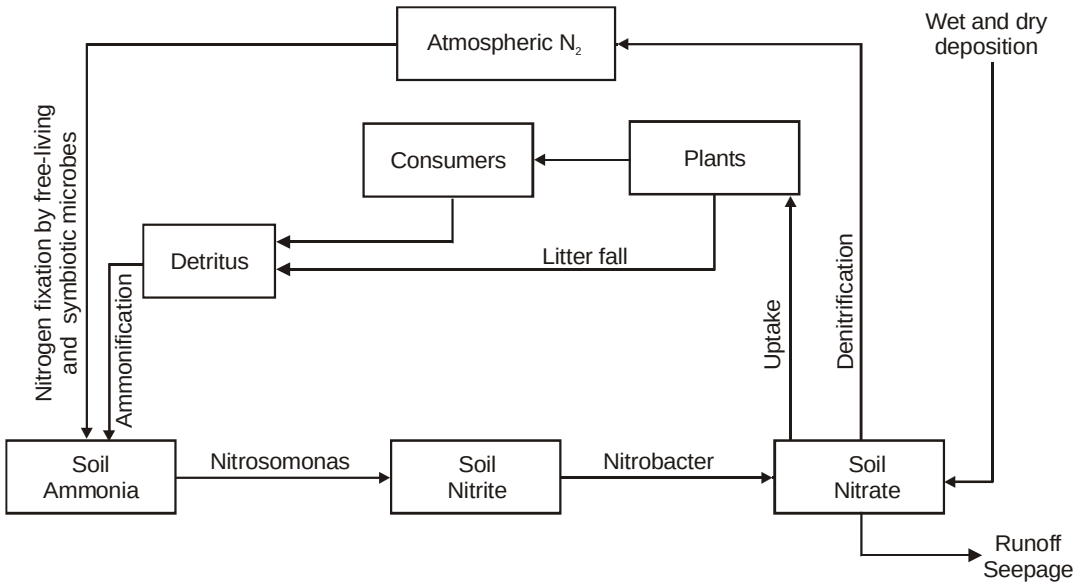
(a) Conversion of ammonia into nitrate is called nitrification.

Nitrification process complete in two steps.

$$NH_3 \xrightarrow{\text{Nitrosomonas}} NO_2^- \xrightarrow{\text{Nitrobacter}} NO_3^-$$

(b) Few quantity of nitrate comes in soil by electrochemical or photochemical process or physical N_2 fixation.

(c) Now few quantity of this nitrate absorb by plants from soil.



3. Nitrogen assimilation –

Plants absorb nitrate from the soil and form protein. When consumers eat these plant proteins is transferred into consumer.

4. **Ammonification –**

   Protein present in litter, is converted into ammonia by some ammonifying bacteria. **e.g.** ***Bacillus vulgaris, Bacillus mycoides, Bacillus ramosus***

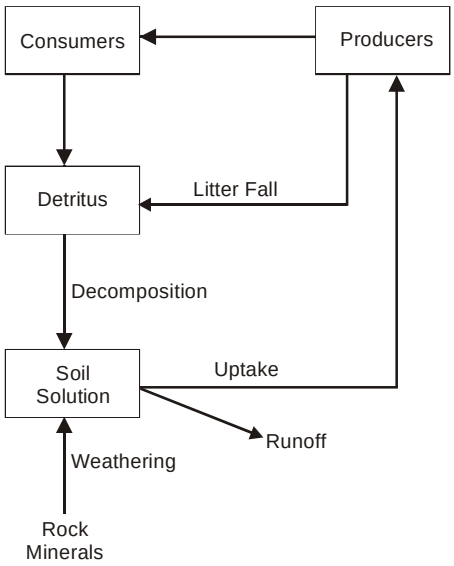
5. **Denitrification –**

   Some quantity of nitrate which is not used by plants is converted into nitrogen by denitrifying bacteria. **e.g.** ***Thiobacillus denitrificans, Pseudomonas denitrificans***

   Note : some nitrate washed out from the ecosystem through seepage.

Phosphorus Cycle

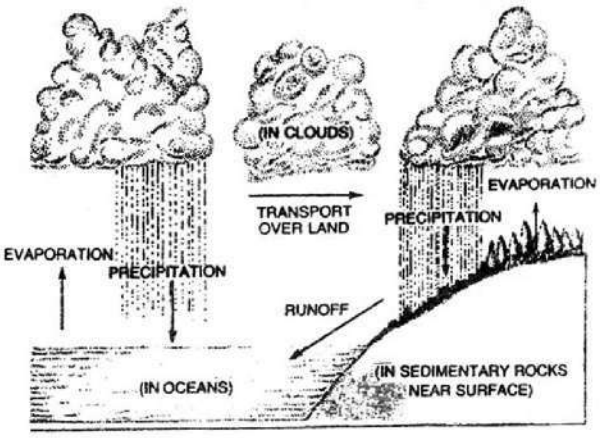
1. Phosphorus is the main constituent of protoplasm, plasma membrane, bones and teeth. Main source of phosphorus is **rocks.** If comes from the weathering of phosphorus containing rock in the soil. Plants absorb this phosphrous from the soil and transfer this phosphate to animals and after the death of animals it is released again into the lithosphere by the action of decmposers.
2. **Sometime** some of the elements like phosphorus and calcium reach into the sea through water, from where they transform into rocks. They separate from the cycle for a long time so it is also known as **sedimentary cycle.**
3. But when these rocks break after sometime then this phosphorus is again made available to the sea plant or sea weeds, which pass into fish and sea birds. The excretory materials of birds on the rocks of sea shore is called **Guano** and and it is a source of phosphorus.
4. **Plants absorb phosphate from the soil in the form of orthophosphate (Po_4^{3-})**
5. Phosphorous cycle differ from nitrogen and carbon cycle in atmospheric input of phosphorous through rainfall is much smaller and gaseous exchange of phosphorous between organism and environment is negligeble, which both are considerable in Nitrogen and Carbon cycle.



Water Cycle :

1. Water is indispensable for life. Sea is the main source of water on earth. Water is always present in the atmosphere in the form of water vapour. Water is also evaporated from other places from where it reaches into the atmosphere. These vapours form clouds in the atmosphere, condensation of water vapour forms clouds, moist, fog and ice at high altitudes. It comes again on he earth in above forms.

2. Water cycle plays a significant role on the earth. Plants and animals receive water or absorb water. Water participates in various metabolic activites of the body of organisms and again it is formed. Water is converted into food through the photosynthesis in plants. Water is also present in protoplasm of all organisms. This water again comes into the atmosphere through transpiration from the plants and evaporation and sweating from the animals. Thus this cycle goes on continuously. The oxygen cycle and hydrogen cycle is also found in the ecosystem as above cycles.



Note :

(i) Water cycle is diectly operated by solar radiation and it is under the control of forests.

(ii) The term ''Cycle'' is used for the movement of matter and the term ''Flow '' is used for the movement of energy.

SPECIAL POINT :

(i) Ecological efficiency - The percentage of energy transferred from one trophic level to the next is called ecological efficiency or food chain efficiency.

$$E.E = \frac{\text{Energy in biomass production at a trophic level}}{\text{Energy in biomass production at previous trophic level}} \times 100$$

(ii) Assimilation efficiency - It is the production of consumed energy that is assimilated.

$$A.E. = \frac{\text{Food energy assimilated}}{\text{Food energy ingested}} \times 100$$

(iii) Net production efficiency -

$$N.P.E. = \frac{\text{Net pri. productivity}}{\text{G.P.P.}} \times 100$$

(iv) Photosynthetic efficiency -

$$P.E. = \frac{\text{G.P.P.}}{\text{Inciden total solar radiation}} \times 100$$

$\Rightarrow$ Detritus —(Environmental Conditions: Fragmentation, Leaching catabolism)→ Humus (Humification) / Co_2, H_2O, Nutrients (Mineralisation)

EXERCISE - 1

Q.1 Eltonian pyramids of numbers are upright in one of the following ecosystem -
(1) Grassland (2) Tree
(3) Pond (4) Both (1) and (3)

Q.2 The type of food chain in which organic matter decomposed is converted into energy rich compounds is called -
(1) Detritus food chain (2) Grazing food chain
(3) Cybernetics (4) None above

Q.3 One of Eltonian pyramids have to be upright always -
(1) Biomass (2) Energy
(3) Number (4) All of these

Q.4 Word 'ecosystem' was coined by -
(1) Elton (2) Tansley
(3) Odum (4) Billing

Q.5 Biotic components include -
(1) producers only
(2) consumers only
(3) producers and consumers only
(4) producers, consumers and decomposers

Q.6 The last organisms of the food chain are generally-
(1) photosynthetic plants
(2) herbivores
(3) carnivores
(4) decomposers

Q.7 In an ecosystem, the population of -
(1) primary producers is larger than primary consumers
(2) secondary consumers is largest
(3) primary consumers out numbers primary producers
(4) primary consumers are least dependent upon primary producers

Q.8 An aquatic ecosystem consists of -
(1) biotic factors
(2) biotic and abiotic factors
(3) consumers only
(4) producers only

Q.9 The best arrangement of an energy system consisting of hawks, snakes, mice and grasses is -
(1) Grass $\rightarrow$ mice $\rightarrow$ snake $\rightarrow$ hawks
(2) Grass $\rightarrow$ snake $\rightarrow$ mice $\rightarrow$ hawks
(3) Grass $\rightarrow$ mice $\rightarrow$ hawks $\rightarrow$ snakes
(4) Mice $\rightarrow$ snake $\rightarrow$ hawks $\rightarrow$ grass

Q.10 If a big fish eats small fish which eats Hydra who in turn eats water fleas ; water fleas in turn eat phytoplankton. In this chain, water fleas will be -
(1) Producers
(2) Primary consumers
(3) Secondary consumers
(4) Top consumer

Q.11 The graphic representation of trophic level is represented by a pyramid. Which of the following pyramid is always a true pyramid unlike the others ?
(1) Pyramid of number
(2) Pyramid of biomass
(3) Pyramid of energy
(4) Both (1) and (3)

Q.12 Which of the following constitutes the structure of an ecosystem ?
(1) Ecological community
(2) Quantity and distribution of abiotic materials
(3) Range of physical conditions
(4) All the above

Q.13 Ecosystem comprises both abiotic and biotic components. Biotic component of an ecosystem consists of -
(1) Producers (2) Consumers
(3) Decomposers (4) All the above

Q.14 Autotrophic organisms (green plants), which capture solar energy to synthesise organic food are called -
(1) Producers (2) Consumers
(3) Decomposers (4) None of the above

Q.15 In a pyramid of numbers representing an ecosystem of a large freshwater pond the number of primary consumers is -

(1) More than the secondary consumers

(2) Less than the secondary consumers

(3) Less than the producers

(4) Less than the tertiary consumers

Q.16 Food chain refers to -

(1) A number of human beings forming a chain for food

(2) The transfer of food energy from producers to consumers

(3) Animals near a source of food

(4) None of the above

Q.17 The sequence of species through which the organic molecules in community pass is called is -

(1) Food web (2) Food chain

(3) Nutrient cycle (4) Pyramid of energy

Q.18 A group of interconnected food chains is called-

(1) Pyramid of energy (2) Food web

(3) Food cycle (4) Complex food chain

Q.19 The energy which is utilized by the living world is primarily -

(1) Heat (2) Electricity

(3) Light (4) Kinetic

Q.20 Energy flow in ecosystem is -

(1) Unidirectional (2) Bidirectional

(3) Multidirectional (4) None of the above

Q.21 The rate at which new tissues are formed in producers is the ecosystem's -

(1) Net primary productivity

(2) Gross primary productivity

(3) Net secondary productivity

(4) Gross secondary productivity

Q.22 How much amount of light is used in the production process by plants ?

(1) 1 to 5% (2) 5% to 10%

(3) 20 to 40% (4) more than 70%

Q.23 The importance of ecosystem maintenance lies in -

(1) Cycling of materials

(2) Flow of energy

(3) Both of the above

(4) None of these

Q.24 The amount of energy, utilized by herbivores from the plants is -

(1) 5 % (2) 10 %

(3) 50 % (4) 90 %

Q.25 The percentage of net primary production of total light intake is -

(1) 10 % (2) 0.8 – 4 %

(3) 10 – 20 % (4) 15 %

Q.26 The flow of materials and energy in an ecosystem is respectively -

(1) Cyclic only (2) Linear only

(3) Linear and cyclic (4) Cyclic and linear

Q.27 Mark the incorrect statement with reference to carbon cycle -

(1) Lime rocks contribute to CO_2 of water

(2) Atmospheric CO_2 gets dissolved in water

(3) CO_2 is returned by combustion of fuel

(4) 75% of total carbon lies in geological component

Q.28 The sulphate rocks are formed in ocean by leaching of -

(1) FeS and Fe_2S_3

(2) Organic sulphates and -SH

(3) Soluble inorganic sulphates

(4) All of these

Q.29 Biogeochemical cycling means -

(1) Cycling of nutrients in an ecosystem

(2) Cycling of water

(3) Cycling of energy in an ecosystem

(4) Cycling of gases between plants and the atmosphere

Q.30 The least productive ecosystem is -

(1) Coastal seas (2) Very deep lakes

(3) Grasslands (4) Moist forests

Q.31 One of the following is sedimentary cycle ?
(1) Carbon (2) Hydrogen
(3) Nitrogen (4) Phosphorus

Q.32 The primary consumers in a pond ecosystem is-
(1) Phytoplankton (2) Zooplankton
(3) Fishes (4) Bacteria

Q.33 The number of primary producers within a specified area would be minimum in -
(1) Grassland (2) Pond ecosystem
(3) Desert (4) Forest ecosystem

Q.34 The river mouth ecosystem is called as -
(1) Estuarine (2) Lotic
(3) Lentic (4) None of these

Q.35 In a natural ecosystem, decomposers include-
(1) Bacteria and fungi (2) Parasitic algae
(3) Macroscopic animals
(4) All the above

Q.36 Which of the following is not true for man made ecosytems ?
(1) They are highly efficient
(2) They lack the diversity of natural ecosystems
(3) They mainly comprise seasonal vegetation or one chosen crop.
(4) Parks and aquaria are not man-made ecosystems.

Q.37 Lotic ecosystem refers to -
(1) Ecosystem of estuary water
(2) Deep marine-water ecosystem
(3) Ecosystem of flowing water
(4) Static-water ecosystem

Q.38 The ecosystem of a pond is referred to as-
(1) Lentic (2) Lotic
(3) Xeric (4) Benthic

Q.39 The correct sequence of components through which energy may pass from initial source, through an ecosystem is -
(1) Sun – autotrophs-heterotrophs– environment – space
(2) Space – environment – heterotrophs – autotrophs – sun
(3) Sun – space – environment – heterotrophs – autotrophs
(4) Sun – space – environment – autotrophs – heterotrophs

Q.40 Which of the following does not contribute directly to the recycling pathways of trophics ?
(1) Bacteria and fungi feeders
(2) Plants
(3) Carnivores (4) Herbivores

Q.41 Efficiency of any ecosystem is best depicted by pyramid of -
(1) Energy (2) Number
(3) Biomass (4) Volume

Q.42 The correct match is -
(1) Producers-act upon the decomposed substances and transform them into different forms of inorganic and organic substances
(2) Consumers-are autotrophic members of ecosystem
(3) Decomposers-feed upon dead decaying living organisms and break them into simpler compounds fit for use of producers
(4) None of these

Q.43 The first trophic level in any kind of food chain is always a green plant because -
(1) Of their wide distribution
(2) They alone have a capacity to fix atmospheric CO_2, in the presence/absence of sunlight
(3) Of their richness in chlorophyll
(4) Of their capacity to convert light energy to chemical energy

Q.44 The creating force of an any ecosystem is-
(1) Organic fuels, carbohydrates
(2) Biomass
(3) Solar energy
(4) Producers

Q.45 When frog eats grasshopper which thrives on green plants, the frog is -
(1) Primary producer (2) Herbivore
(3) Primary carnivore (4) Top consumer

Q.46 The largest ecosystem in the world is contributed by -
(1) Forests (2) Rivers
(3) Oceans (4) Grasslands

Q.47 If the primary producers are absent from any ecosystem which of the following will occur ?
(1) Herbivores will not survive
(2) Carnivores will not survive
(3) Both will be disintegrated because of food absence
(4) No change will take place

Q.48 Grasshopper in grassland is a -
(1) Producer (2) Herbivore
(3) Carnivore (4) None of these

Q.49 The pyramid of number for forest ecosystem is-
(1) Upright (2) Inverted
(3) Both of above (4) None of above

Q.50 They can be put in the category of primary consumers -
(1) Eagles and tigers (2) Fishes and whales
(3) Snakes and frogs (4) insects and cattles

Q.51 The study of fresh water ecology is -
(1) Hydrology (2) Ecology
(3) Limnology (4) Geology

Q.52 The place where fresh water joins the salt water is called as -
(1) Island (2) Lagoon
(3) Beach (4) Estuary

Q.53 The word standing crop in ecosystem refers to-
(1) Living components
(2) Non-living components
(3) Both living and non-living components
(4) None of the above

Q.54 The pyramid of energy in any ecosystem is-
(1) Always upright
(2) May be upright
(3) Always inverted
(4) None of the above

Q.55 Which of the following organisms can convert ammonium or nitrates into amino acids ?
(1) Scavengers
(2) Producers
(3) Primary consumers
(4) Primary detritivores

Q.56 One of the following is a true micro-ecosystem
(1) One litre of water from a pond kept in an air tight flask
(2) One litre of tap water in a flask covered over by cotton plug
(3) Ten litre of boiled pond water covered over by a lid
(4) One litre of pond water closed with a cork having gas exchange tube.

Q.57 The decomposers in an ecosystem constitute the following trophic level -
(1) T_1 (2) T_3
(3) T_5 (4) T_4

Q.58 If all the green plants were to disappear from the earth -
(1) All the animal will die
(2) Only the herbivores will die
(3) Only the carnivores will die
(4) It will not matter to any one because chemosynthetic bacteria will produce food for all

Q.59 The bacteria which attack the dead animals are-
(1) First link of the food chain and are known as primary producers
(2) Second link of the food chain and are herbivorous
(3) Third link of the food chain and are tertiary consumers
(4) The end of the food chain and are decomposers

Q.60 The number of producers and consumers in an ecosystem is mutually controlled by a -
(1) Feed back mechanism
(2) Food chain mechanism
(3) Productivity control
(4) Any of these

Q.61 The non-green plants are as important as the green plants because they -
(1) Cause human disease
(2) Cause diseases of other plants
(3) Are useful in several industries
(4) Bring about decomposition of dead animals and plant remains

Q.62 The ecosystem of earth is known as -

(1) Biome (2) Community

(3) Biosphere (4) Association

Q.63 In any given ecosystem, the number of individuals of a species remain more or less constant over a period of time. This constancy of numbers is maintained by -

(1) Parasites (2) Predators

(3) Human beings (4) Available food

Q.64 The ecosystem exists in a state of 'balance'. Supposing one of the heterotrophs, says the rabbit, multiplies and increases in number suddenly then -

(1) The balance will be permanently upset because the rabbits will eat the grass in the system and die of starvation.

(2) The 'balance' will be restored by an increase in the wolf population

(3) Epidemics will break out in the rabbits and kill all of them

(4) Rabbits will starts eating each other

Q.65 Which of the following terms is not a synonym literally for ecosystem ?

(1) Ecosom (2) Ecosphere

(3) Microcosm (4) Holocoene

Q.66 The amount of living matter present in a component population of a particular trophic level is called as -

(1) Standing crop (2) Standing quality

(3) Both of these (4) Standing state

Q.67 Which of the following is the smallest unit?

(1) Biosphere (2) Ecosphere

(3) Ecosystem (4) Biome

Q.68 The term reducer is applied to -

(1) Decomposers (2) Detrivores

(3) Both of these (4) Heterotrophs

Q.69 In a parasitic food chain which trophic level is represented by bugs and lices ?

(1) T_4 (2) T_3

(3) T_2 (4) T_1

Q.70 The pyramid of number in a forest ecosystem is -

(1) Rhomboidal (2) Upright

(3) Inverted (4) Linear

Q.71 The pyramid of biomass in a parasitic ecosystem is -

(1) Upright (2) Inverted

(3) Linear (4) Rhomboidal

Q.72 The pyramid of biomass in a shallow pond ecosystem is -

(1) Inverted (2) Upright

(3) Rhomboidal (4) Linear

Q.73 The cybernetic of an ecosystem refers to -

(1) Harvest index

(2) A feed back mechanism

(3) Regulation of equilibrium

(4) Reverse energy flow

Q.74 The gross production minus losses respiration in an ecosystem is indicated as-

(1) Net production

(2) Secondary production

(3) Net storage

(4) Net primary production

Q.75 The biotic and abiotic components of the ecosystem are connected through -

(1) Standing quality

(2) Climatic regime

(3) Transducers

(4) Humification and mineralization

Q.76 The rate of storage at consumer level is -

(1) Secondary productivity

(2) Tertiary productivity

(3) Both of these

(4) Net productivity

Q.77 The SO_2 is returned to the atmosphere by-

(1) Metabolism of producers

(2) Metabolism of consumers

(3) Both of these

(4) Combustion of fuel

Q.78 A group of interacting living things and all the environmental factors with which they interact are together called -

(1) Ecosystem (2) Succession

(3) Producers (4) Ecological niche

Q.79 An ecosystem does not normally alter because it is in a state of -

(1) Deficient light

(2) Imbalance

(3) Homeostasis

(4) Deficient components

Q.80 The immediate surroundings of an ecosystem are called -

(1) Macroenvironment (2) Microenvironment

(3) Biosphere (4) Both (1) and (2)

Q.81 Raymond Lindmann (1942) used the term trophic level. Trophic levels are formed by-

(1) Animals only

(2) Plants only

(3) Organisms linked in food chains

(4) Top consumers in food chain

Q.82 Organisms which acquire energy and nutrients by digesting the organic molecules of living organisms are called -

(1) Producers (2) Consumers

(3) Detritivores (4) None of the above

Q.83 Which of the following is the trophic level of man in an ecosystem ?

(1) Omnivore (2) Carnivore

(3) Herbivore (4) Producer

Q.84 The rate at which new tissues are formed in producers is called the primary net productivity of the ecosystem. About how much of the net primary productivity of a terrestrial ecosystem is eaten and digested by herbivores ?

(1) 2 % (2) 10 %

(3) 50 % (4) 85 %

Q.85 Net community productivity (NCP) is the -

(1) Total rate of photosynthesis

(2) Chemical energy left after utilization by plants

(3) Rate of storage of organic matter not used by heterotrophs

(4) Energy wasted by carnivores

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	2	2	4	4	1	2	1	2	3	4	4	1	2	2	2	2	3	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	3	2	2	4	4	3	1	2	4	2	3	1	1	4	3	1	4	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	4	3	3	3	3	2	1	4	3	4	1	1	2	4	3	1	4	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	3	4	2	3	1	3	3	2	1	1	2	3	4	3	1	4	1	3	2
Ques.	81	82	83	84	85															
Ans.	3	2	1	2	3															

EXERCISE - 2

Q.1 A food chain consists of -
(1) Producers, carnivores and decomposers
(2) Producers, herbivores and carnivores
(3) Producers and primary consumers
(4) Producers, consumers and decomposers

Q.2 The herbivores that feed directly on producers are called -
(1) Primary consumers
(2) Secondary consumers
(3) Tertiary consumers
(4) Quarternary consumers

Q.3 Within the ecosystem, energy is transferred from organism to organism in the form of -
(1) Light (2) Heat
(3) Chemicals (4) None of the above

Q.4 The rate at which light energy is converted to chemical energy of organic molecules is the ecosystem's -
(1) Net primary productivity
(2) Net secondary productivity
(3) Gross primary productivity
(4) Gross secondary productivity

Q.5 Producers in an ecosystem are -
(1) Green organisms which fix solar energy by photosynthesis
(2) Aanimals which cause an increase in biomass
(3) Organisms which can be used as manure
(4) Animals in the food chain which produce more energy than they consume

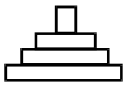
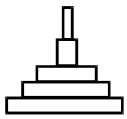
Q.6 The dominant second trophic level in a lake ecosystem is -
(1) Phytoplankton (2) Zooplankton
(3) Benthos (4) Nekton

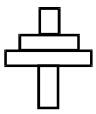
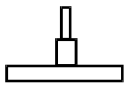
Q.7 Which of the following animals is dominant in desert ecosystem?
(1) Leopard (2) Lizard
(3) Hyla (4) Tiger

Q.8 Pyramid of numbers is upright in which of the ecosystems ?
(1) Pond ecosystem
(2) Tree ecosystem
(3) Grassland ecosystem
(4) None of these

Q.9 The total amount of living material at various levels of a food chain is depicted by -
(1) Pyramid of numbers
(2) Pyramid of energy
(3) Pyramid of biomass
(4) All the above

Q.10 In the diagram, different pyramids are shown. Which one is the pyramid of numbers in a temperate forest ?

(1)  (2) 

(3)  (4) 

Q.11 Which of these is the food chain which runs from larger to smaller organisms ?
(1) Grazing food chain
(2) Predator food chain
(3) Saprophytic food chain
(4) Parasitic food chain

Q.12 The type of food chain in which decomposed organic matter is converted into energy -rich compounds is called -
(1) Cybernetics
(2) Detritus food chain
(3) Grazing food chain
(4) None of these

Q.13 Biological equilibrium is equilibrium amongst-
(1) Consumers and decomposers
(2) Producers and consumers
(3) Producers and decomposers
(4) Producers, consumers and decomposers

Q.14 If we completely remove the decomposers from an ecosystem, the ecosystem functioning will be adversely affected because-
(1) Energy flow will be blocked
(2) Rate of decomposition of other components will be very high
(3) Herbivores will not receive solar energy
(4) Mineral movement will be blocked

Q.15 Zooplankton includes -

(1) Ciliates (2) Flagellates

(3) Small crustaceans (4) All the above

Q.16 Energy and nutrients enter in a community by way of the -

(1) Detritivores (2) Producers

(3) Scavengers (4) Consumers

Q.17 Food webs are 3-D web of interrelations in which several food chains are interlinked. It helps to provide -

(1) Alternate pathways for flow of energy

(2) More variety and quality of food at each trophic level

(3) Stability to ecosystem

(4) All of these

Q.18 Which food chain is directly dependent upon solar radiations -

(1) Grazing (2) Parasitic

(3) Detritus (4) All of these

Q.19 The most productive ecosystem is -

(1) Temperate forest (2) Coral reef

(3) Estuary (4) Sugarcane field

Q.20 All ecosystems have no boundary because-

(1) They require minerals for their functioning

(2) They cannot occur in isolation

(3) The are large in size

(4) They require light from all sources

Q.21 A ecological pyramid, devised by C. Elton 1927; is a graphic diagram that shows relationship between -

(1) Transfer of food through food chains

(2) Organisms

(3) Various trophic levels of a food chain

(4) Populations and communities within an ecosystem

Q.22 The denitrifying bacteria are -

(1) *Micrococcus denitrificans*

(2) *Pseudomonas*

(3) *Thiobacillus*

(4) All of the above

Q.23 In nitrogen cycle, which of the following plays an important role ?

(1) *Rhizopus* (2) *Nitrobacter*

(3) *Mucor* (4) All green algae

Q.24 Denitrification is -

(1) Reduction of NO_2 to ammonia by bacteria in the soil

(2) Conversion of ammonia to amino acids

(3) Conversion of ammonia and nitrates to gaseous nitrogen

(4) Oxidation of ammonia to nitrate

Q.25 Nitrogen cycle involves bacteria capable of changing proteins to ammonia called as -

(1) Bacteria of decay

(2) Denitrifying bacteria

(3) Nitrogen fixing bacteria

(4) Ammonifying bacteria

Q.26 Ruthless exploitation and pollution of the environment has increased the magnitude of waste materials which has disturbed the operations of all important-

(1) Biomes

(2) Ecosystems

(3) Bio-geo-chemical cycles

(4) All of the above

Q.27 Carbon is available to crop plants in the form of-

(1) Amino acids (2) Carbon dioxide

(3) Elemental carbon (4) Carbonates

Q.28 Which of the following contribute to the carbon cycle ?

(1) Photosynthesis

(2) Respiration

(3) Fossil fuel combustion

(4) All of the above

Q.29 Of more immediate concern regarding carbon cycle is -

(1) Output rate of carbon locked in deposits of coal, petroleum and natural gas

(2) Green house gases

(3) Increase in the total mass of carbon in earth's atmosphere by 12-14%

(4) All of the above

Q.30 The organisms which participate most actively in nitrogen cycle in nature are -

(1) Saprophytic angiosperms

(2) Parasitic fungi

(3) Bacteria (4) Legumes

Q.31 Biogeochemical cycles can be traced in -
(1) Ecosystems (2) Biomes
(3) Only water (4) Both (1) and (2)

Q.32 Hydrological cycle comprises of two overlapping cycles -
(1) Surface waters and atstmospheric cycles
(2) Oceanic and fresh water cycles
(3) Ground water and atmospheric cycles
(4) Global and smaller cycles

Q.33 The phosphorus cycle differs from those of carbon and nitrogen as well as those of sulphur, oxygen and hydrogen in that it lacks-
(1) Water (2) Dust particles
(3) Gaesous phase (4) All above

Q.34 Cycling of elements in any ecosystem is called-
(1) Chemical cycle
(2) Geochemical cycle
(3) Biogeochemical cycle
(4) Geological cycle

Q.35 In India, coniferous forests are found in –
(1) Rajasthan
(2) Satpura Hills
(3) Himalayan region
(4) Madhya Pradesh

Q.36 Grassland with scattered trees is called –
(1) Rain forests
(2) Evergreen forest
(3) Savannah
(4) Deciduous forests

Q.37 Life forms are used in the preparation of -
(1) Food chain
(2) Ecological pyramids
(3) Biological spectrum
(4) Quardats & transects

Q.38 In an ecosystem -
(1) Primary producers are more than primary consumers
(2) Primary consumers are larger than primary producers
(3) Secondary consumers are larger than primary producers
(4) Primary consumers are least depend on primary producers

Q.39 Ecosystem term coined by -
(1) Odum (2) Mishra
(3) Reiter (4) Tensley

Q.40 Large ecosystems are called -
(1) Biomes (2) Ecotone
(3) Ecads (4) Biocoenosis

Q.41 "Biocoenosis" name proposed by -
(1) Tensley (2) Reiter
(3) Haeckel (4) Carl Mobius

Q.42 Vultures in an ecosystem are -
(1) Predators (2) Scavangers
(3) Consumers (4) Top carnivores

Q.43 The maximum energy is stored at following tropical level in any ecosystem -
(1) Producers (2) Herbvores
(3) Carnivores (4) Top carnivores

Q.44 The source of energy in an ecosystem is -
(1) Sunlight (2) DNA
(3) ATP (4) RNA

Q.45 Ecosystem may be defined as -
(1) A localized association of several plants and animals
(2) Different communities of plants, animals and microbes together with their physico-chemical environment
(3) Different communities of plants microbes plus their physico-chemical environment
(4) none of the above

Q.46 Ecosytem is -
(1) Any functional unit that includes the whole community in a given area interacting with the abiotic factors
(2) A group of green plants
(3) A group of animals interacting with environment
(4) Man and pets living together

Q.47 In any given ecosystem, number of individuals in a species remains more or less constant over a period of time. This constancy of number is maintained by -
(1) Parasites (2) Predators
(3) Man (4) Available food

Q.48 Who proposed that ecosystem is symbol of structure & function of nature -
(1) Gardener (2) Odum
(3) Tansley (4) Reiter

Q.49 Largest ecosystem of the world are -
(1) Forests (2) Grass lands
(3) Great lakes (4) Oceans

Q.50 Which of the following is a man made artificial ecosystem -
(1) Grassland ecosystem
(2) Forest ecosystem
(3) Ecosystem of artificial lakes & dams
(4) None of these

Q.51 Green plants in a forest ecosystem are -
(1) Suppliers of food & O_2
(2) Consumers of nutritive materials
(3) Consumers of animal proteins
(4) Suppliers of timber

Q.52 Nepenthes (Insectivorous pitcher plant) is -
(1) Producer (2) Consumer
(3) Both 1 & 2 (4) None of these

Q.53 Which one is omnivorous -
(1) Frog (2) Lion
(3) Deer (4) Man

Q.54 Trophic levels are formed by -
(1) Only plants
(2) Only carnivores
(3) Only animals
(4) Organisms linked in food chain

Q.55 In a forest ecosystem green plants are -
(1) Primary producers
(2) Consumers
(3) Primary consumers
(4) Decomposers

Q.56 In an ecosystem the function of the producers is to -
(1) Convert organic compounds into inorganic compounds
(2) Trap solar energy and convert it into chemical energy
(3) Utilize chemical energy
(4) Release energy

Q.57 With regard to ecological food chain, man is a -
(1) Consumer
(2) Producer
(3) Both consumer & producer
(4) decomposer

Q.58 A plant, being eaten by a herbivore which in turn is eaten by a carnivore makes -
(1) Food chain (2) Web of food
(3) Omnivores (4) Interdependence

Q.59 When peacock, eats snake which eats insects depends on green plants, the peacock is -
(1) a primary consumer
(2) a primary decomposer
(3) a final decomposer of plants
(4) the apex of the food pyramid

Q.60 If we completely remove decomposers from from an ecosystem, the ecosystem functioning will be adversely affected because -
(1) Mineral movement will be blocked
(2) Herviores will not receive solar energy
(3) Energy flow will be blocked
(4) Rate of decomposition of other components will be very high

Q.61 Science of self control in an ecosystem is called -
(1) Synecology (2) Autecology
(3) Cybenetics (4) Edaphology

Q.62 Pyramids of energy are -
(1) Always upright (2) Always inverted
(3) Mostly upright (4) Mostly inverted

Q.63 The ecological pyramid of numbers in pond ecosystem is -
(1) Upright (2) inverted
(3) May upright or Inverted
(4) First upright then inversed

Q.64 An ecosystem resists change because it is in a state of -
(1) Homeostasis (2) Regular Illumination
(3) Static Imbalance (4) Food accumilation

Q.65 What is true about any ecosystem -
(1) It is self regulatory
(2) It is self sustained
(3) Top carnivores have climax tropic level position
(4) All

Q.66 The Pyramid of numbers in grassland ecosystem will be -
(1) Up right (2) Inverted
(3) Irregular (4) Linear

Q.67 Pyramid of number is inverted in case of -
(1) Pond ecosystem
(2) Desert ecosystems
(3) Grassland ecosystem
(4) Forest ecosystem

Q.68 Which ecosystem has maximum number of producers in an unit area -
(1) Pond (2) Grassland
(3) Forest (4) Tundra

Q.69 The storage of energy of consumer level is known as -
(1) Grass primary production
(2) Secondary productivity
(3) Net primary productivity
(4) Net productivity

Q.70 Gross primary productivity is -
(1) Rate at which organic molecules are formed in an autotroph
(2) Rate at which organic molecules are used up by an autotroph
(3) Storage of organic molecules in the body of an autotroph
(4) Rate at which organic molecules are transferred to next higher trophic level

Q.71 The flow of materials from non living components to living components and back to the non living components in a more or less cyclic manner is called a -
(1) Gaseous cycle
(2) Sedimentary cycle
(3) Biogeochemical cycle
(4) Hydrologic cycle

Q.72 The plant parts when fully decomposed by microogranism & mixed in the soil is called -
(1) Litter (2) Duff
(3) Mull (4) All

Q.73 Temperate evergreen forests in India found in-
(1) Himalaya (2) W. Bengal
(3) Andman (4) Rajasthan

Q.74 Which biome refers to artic desert -
(1) Tundra (2) Taiga
(3) Savannah (4) Thar desert

Q.75 Which biome is most rich in fauna and flora -
(1) Deciduous forests
(2) Chaparral
(3) Tropical rain forests
(4) Taiga

Q.76 Autumn colouration of leaves appear only in-
(1) Tropical regions
(2) Evergreen plants
(3) Temperate decidous plants
(4) deserts

Q.77 What determines the limits of a biome
(1) Temperature & rain fall
(2) Type of soil & presence of barrier
(3) Altitude & latitude
(4) All the above

Q.78 Which of the biomes axhibit distinct stratification into stories -
(1) Tundra biome
(2) Temperate biome
(3) Tropical rain forest biome
(4) Chapparal biome

Q.79 Veldts of Africa & Pampas of south America are -
(1) Rain forest biomes
(2) Chaparral biomes
(3) Temperate biomes
(4) Grassland biomes

Q.80 All the living organisms and non-living factors of the earth constitute -
(1) Biosphere (2) Community
(3) Biome (4) Association

Q.81 The term biosphere is used for the zone of the earth where life exists -
(1) On the lithospere
(2) In the hydrosphere
(3) In the lithosphere and hydropshere
(4) In the lithosphere, hydrosphere and atmosphere

Q.82 When Biosphere turns into human dominated evironment it is called -
(1) Noosphere (2) Troposphere
(3) Mesophere (4) Man sphere

Q.83 A biosphere is composed of -

(1) Living organisms

(2) Living organisms + Lithosphere

(3) Living organisms + lithosphere + atmosphere

(4) Living organisms + lithosphere + atmosphere + hydrosphere

Q.84 Rhododendron is characteristic vegetation of-

(1) Tropical region (2) Mangrove

(3) Alpine (4) Epiphytes

Q.85 Bacteria are essential in carbon cycle as -

(1) Decomposer (2) Synthesizer

(3) Consumer (4) Pri. Producer

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	3	3	1	2	2	3	3	3	4	2	2	4	4	2	4	1	2	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	4	2	3	4	4	2	4	4	3	4	1	3	3	3	3	3	1	4	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	2	1	1	2	1	4	3	4	3	1	3	4	4	1	2	1	1	4	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	3	1	1	1	4	1	2	1	2	1	3	2	3	1	1	3	3	3	3	4
Ques.	81	82	83	84	85															
Ans.	1	4	1	4	1															

EXERCISE - 3 PREVIOUS YEAR'S QUESTIONS

Q.1 Pond is an example of ..... ecosystem - **[UTTRANCHAL 2005]**

(1) Artifical (2) Natural

(3) Forest (4) Grassland

Q.2 Which of the following is the most productive ecosystem? **[WEST BANGAL JEE 2007]**

(1) Estuary (2) Open sea

(3) Desert (4) Mountain

Q.3 The pyramid of energy in a forest ecosystem is - **[C.G. PMT 2004]**

(1) Always upright

(2) Always inverted

(3) Both upright and inverted

(4) None of the above

Q.4 The importance of ecosystem is - **[C.G. PMT 2004]**

(1) Flow of energy (2) Cycling of materials

(3) Both of the above (4) None of the above

Q.5 Which is the correct path of energy flow in an eco system is - **[C.G. PMT 2004]**

(1) Producers → Carnivores → Herbivores → Decomposers

(2) Producers → Herbivores → Carnivores → Decomposers

(3) Herbivores → Carnivores → Producers → Decomposers

(4) Herbivores → Producers → Carnivores → Decomposers

Q.6 The number of primary producers within a specified area would be maximum in - **[C.G. PMT 2004]**

(1) Grassland ecosystem

(2) Forest ecosystem

(3) Pond ecosystem

(4) Deserts

Q.7 A food chain starts with - **[C.G. PMT 2004]**

(1) Nitrogen fixation organisms

(2) Phtosynthesising organisms

(3) Respiration

(4) Decomposers

Q.8 Nepenthes is a - **[C.G. PMT 2004]**

(1) Primary producer

(2) Consumer

(3) Both primary producer and consumer

(4) None of the above

Q.9 Biological equilibrium is found among the - **[C.G. PMT 2005]**

(1) Producers and consumers

(2) Producers and decomposers

(3) Producers, consumers and decomposers

(4) Producers and light

Q.10 The number of individuals of a species in a particular ecosystem at a given time remains constant due to - **[C.G. PMT 2005]**

(1) Man (2) Parasites

(3) Predators (4) Available food

Q.11 The two components of an ecosystem are - **[C.G. PMT 2005]**

(1) Biotic and abiotic

(2) Plants and animals

(3) Weeds and micro-organism

(4) Plants and light

Q.12 The pyramid of number in a grassland ecosystem is - **[C.G. PMT 2005]**

(1) Linear (2) Upright

(3) Irregular (4) Inverted

Q.13 The cycling of elements in an ecosystem is called- **[C.G. PMT 2006]**

(1) Chemical cycle

(2) Biogeochemical cycle

(3) Geological cycle

(4) Geochemical cycle

Q.14 Which of the following bacteria has potential for nitrogen fixation ? **[C.G. PMT 2006]**

(1) Nitrosomonas (2) Nitrobacter

(3) Nitrosococcus (4) Rhizobium

Q.15 Ecosystem has - **[JHARKHAND 2006]**

(1) Plant and animal

(2) Air and H_2O

(3) Soil and light

(4) Biotic and abiotic component

Q.16 Sal and teak are found in - **[JHARKHAND 2006]**

(1) Tropical rain forest

(2) Tropical deciduous forest

(3) Temperature board leaf forest

(4) Temperature needle leaf forest

Q.17 Decomposers are - **[JHARKHAND 2005]**

(1) Autrophs (2) Hetrotrophs

(3) Organotrophs (4) Autoheterotrophs

Q.18 During food chain the maximum energy is stored in - **[JHARKHAND 2005]**

(1) Producers (2) Decomposers

(3) Herbivores (4) Carnivores

Q.19 In the phosphorus cycle, weathering makes phosphate available first to - **[JHARKHAND 2005]**

(1) Decomposers (2) Consumers

(3) Producers (4) All the above

Q.20 In a food chain, the total amount of living material is depicted by -**[JHARKHAND 2005]**

(1) Pyramid of biomass

(2) Pyramid of energy

(3) Pyramid of number

(4) Trophic levels

Q.21 Nitrates are converted to nitrogen by - **[JHARKHAND 2005]**

(1) Nitrogen fixing bacteria

(2) ammonification bacteria

(3) Denitrifying bacteria

(4) Nitrifying bacteria

Q.22 In pond ecosystem, diatoms represent -

(1) Producers **[JHARKHAND 2004]**

(2) Primary consumers

(3) Secondary consumers

(4) Tertiary consumers

Q.23 Pyramids of biomass in pond ecosystem is - **[BIHAR 2005]**

(1) Inverted (2) Upright

(3) Linear (4) Irregular

Q.24 Lion is kept under in Etoplian pyramid as - **[BIHAR 2004]**

(1) Producer

(2) Primary consumer

(3) Seconary consumer

(4) Tertiary consumer

Q.25 Bacteria and fungi developing on dead decaying organisms are -

(1) Parasites (2) Commensals

(3) Saprophytes (4) Symbionts

Q.26 Phytoplanktons are important biotic comoponent of - **[BIHAR 2001]**

(1) Grassland (2) Pond ecosystem

(3) Forest ecosystem (4) None of these

Q.27 Which ecological pyramid can never occur in an inverted form ? **[BIHAR 2001]**

(1) Pyramid of number

(2) Pyramid of biomass

(3) Pyramid of energy

(4) Pyramid of species richess

Q.28 Peacock eats a snake and snake eats insect while insect eats green plant, then position of peacock is - **[UP CPMT 2002]**

(1) Primary producer

(2) Secondary producer

(3) Decomposer

(4) Top at the apex of food pyramid

Q.29 Source of energy in an ecosystem is - **[UP CPMT 2002]**

(1) Sun

(2) ATP

(3) Sugar made by plant

(4) Green plant

Q.30 Legume plants are important for atmosphere because they - **[UP CPMT 2002]**

(1) Help in NO_2 fixation

(2) Do not help in NO_2 fixation

(3) Incrase soil fertility

(4) All of these

Q.31 Tropical dense forest are due to - **[UP CPMT 2002]**

(1) Low rainfall and low temperature

(2) High rainfall and low temperature

(3) Low rainfall and high temperatrue

(4) High rainfall and high temperature

Q.32 Energy enters in food chain- **[UP CPMT 2003]**

(1) by producer
(2) by primary consumers
(3) by secondary consumers
(4) by tertiary consumers

Q.33 In an ecosystem - **[RPMT - 2000]**

(1) Primary producers are more than primary consumers
(2) Primary consumers are larger than primary producers
(3) Secondary consumers are larger than primary producers
(4) Primary consumers are least depend on primary producers

Q.34 In Which type of the forest, humus is formed by the dry and dead leaves - **[RPMT - 2001]**

(1) Coniferous forest (2) Decidous forest
(3) Tundra forest (4) Alpine

Q.35 A pond is a - **[RPMT - 2002]**

(1) Biome
(2) Natural ecosystem
(3) Artifical ecosystem
(4) Community of plants & animals

Q.36 The importance of ecosystem lies in - **[RPMT 2003]**

(1) Energy flow
(2) Cycling of materials
(3) Both (4) None

Q.37 Concept of Ecological pyramid was given by- **[RPMT - 2004]**

(1) Odum (2) Elton
(3) Darwin (4) Reiter

Q.38 Stratification is found in - **[RPMT - 2004]**

(1) Tundra (2) Tropical forest
(3) Deciduous forest (4) Desert

Q.39 Driving force of ecosystem is - **[RPMT - 2004]**

(1) Producers
(2) Plants with Carbohydrate
(3) Biomass
(4) Solar energy

Q.40 Ecosystem creates - **[RPMT - 2005]**

(1) Food chain (2) Food web
(3) Any of the two (4) None

Q.41 Ecosystem term coined by - **[RPMT - 2005]**

(1) P. Maheshwari (2) Tansley
(3) R. Mishra (4) P. Odum

Q.42 The importance of ecosystem lies in - **[CPMT 80]**

(1) Flow of energy (2) Cycling of materials
(3) Both the above (4) None of the above

Q.43 A pond is a - **[RPMT 2002]**

(1) Biome
(2) Natural ecosystem
(3) Artificial ecosystem
(4) Community of plants & animals

Q.44 Which biotic components mainly help in recycling of minerals - **[CPMT 80]**

(1) Producers (2) Consumers
(3) Decomposers (4) All the above

Q.45 Path of energy flow in a n ecosystem is - **[MPPMT 2002]**

(1) Herbivorous $\rightarrow$ producer $\rightarrow$ carnivorous $\rightarrow$ decomposer
(2) Herviorous $\rightarrow$ carnivorous $\rightarrow$ producer $\rightarrow$ decomposer
(3) Producer $\rightarrow$ carnivorous $\rightarrow$ herbivorous $\rightarrow$ decomposer
(4) Producer $\rightarrow$ herbivorous $\rightarrow$ carnivorous $\rightarrow$ decomposer

Q.46 The number of primary producers in a specified area would be maximum in - **[RPMT 85, CPMT 86, MP PMT 85, 95]**

(1) Pond ecosystem
(2) Grassland ecosystem
(3) Forest ecosystem
(4) Desert ecosystem

Q.47 Carbon cycle includes (the following is a logical sequence) - **[CPMT 79]**

(1) Producer – consumer – decomposer
(2) Decomposer – consumer – producer
(3) Producer – decomposer – consumer
(4) Consumer – producer – decomposer

Q.48 The bulk of nitrogen in nature is fixed by - **[CPMT 82]**

(1) Lightening

(2) Chemical industries

(3) Denitrifying bacteria

(4) Symbiotic bacteria

Q.49 Hydrological cycle is controlled by - **[RPMT 85]**

(1) Grasslands (2) Forests

(3) Planktons (4) Epiphytes

Q.50 In india the temperate evergreen type of vegetation is found mostly in - **[CPMT 76]**

(1) Western Himalayas above 3,500 Meter

(2) Estern and western Himalayas less than 3,500 Meter

(3) Rajasthan and South Punjab

(4) Western ghats and Assam

Q.51 Savannahs are - **[MPPMT 2002]**

(1) Tropical rain forest

(2) Desert

(3) Grassland with scattered trees

(4) Dense forest with close canopy

Q.52 Biosphere refers to - **[MP PMT 80]**

(1) Plants of the world

(2) Special plants

(3) Area occupied by living beings

(4) Plants of a particular area

Q.53 ***Acacia***, ***Prosopis*** and ***Caparis*** belongs to - **[AIPMT-1998]**

(1) Deciduous forest (2) Tropical forest

(3) Thorn forest (4) Evergreen forest

Q.54 Total amount of energy trapped by green plants in food is called - **[AIPMT-1998]**

(1) Gross primary production

(2) Net primary production

(3) Standing crop

(4) Standing state

Q.55 In which biome a new plant may adapt soon - **[AIPMT-1998]**

(1) Tropical rain forest

(2) Desert

(3) Mangrove (4) Sea island

Q.56 Percentage energy transferred to higher trophic level in food chain is - **[AIPMT-1999]**

(1) 1 % (2) 10 %

(3) 90 % (4) 100 %

Q.57 Which is the reason for highest biomass in aquatic ecosystem - **[AIPMT-2000]**

(1) Nano plankton, blue green algae, green algae

(2) Sea grass, and slime molds

(3) Benthonic and brown algae

(4) Diatoms

Q.58 Which of the following is a correct pair - **[AIPMT-2002]**

(1) Cuscuta - parasite

(2) Dischidia - insectivorous

(3) Opuntia - predator

(4) Capsella - hydrophyte

Q.59 Bamboo plant is growing in a far forest then what will be the tropic level of it - **[AIPMT-2002]**

(1) First trophic level (T_1)

(2) Second trophic level (T_2)

(3) Third trophic level (T_3)

(4) Fourth trophic level (T_4)

Q.60 Which of the following is expected to have the highest value ($gm/m^2/yr$) in a grassland ecoystem- **[AIPMT-2004]**

(1) Tertiary production

(2) Gross production (GP)

(3) Net production (NP)

(4) Secondary production

Q.61 An ecosystem which can be easily damaged but can recover after some time if damaging effect stops will having - **[AIPMT-2004]**

(1) High stability and low resilience

(2) Low stability and low resilience

(3) High stability and high resilience

(4) Low stability and high resilience

Q.62 Which one of the following pairs is mismatched- **[AIPMT-2005]**

(1) Savanna - acacia trees

(2) Coniferous forest - evergreen trees

(3) Tundra - permafrost

(4) Prairies - epiphytes

Q.63 Which one of the following is ***not*** used for construction of ecological pyramids ?
[AIPMT-2005]
(1) Rate of energy flow
(2) Fresh weight
(3) Dry weight
(4) Number of individuals

Q.64 Which one of the following ecosystem types has the highest annual net primary productivity-
[AIPMT-2007]
(1) Temperate deciduous forest
(2) Tropical rain forest
(3) Tropical deciduous forest
(4) Temperate evergreen forest

Q.65 Quercus species are the dominant component in-
[AIPMT-2008]
(1) Scrub forests
(2) Tropical rain forests
(3) Temperatre deciduous forests
(4) Alpine forests

Q.66 Consider the following statements concenrning food chain - **[AIPMT-2008]**
(a) Removal of 80 % tigers from an area resulted in greatly increased growth of vegetation
(b) Removal of most of the carnivores resulted in an increased population of deers
(c) The length of food chains is generally limited to 3-4 trophic levels due to energy loss
(d) The length offood chains may very from 2 to 8 trophic levels
Which two of the above statements are correct ?
(1) a, c (2) a, b
(3) b, c (4) c, d

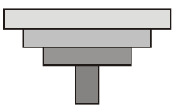
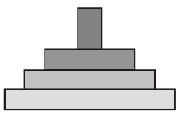
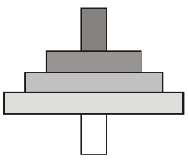
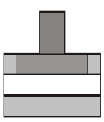
Q.67 The slow rate of decomposition of fallen logs in nature is due to their - **[AIPMT-2003]**
(1) Anaerobic environment around them
(2) L:ow cellulose content
(3) Low moisture content
(4) Poor nitrogen content

Q.68 Which one of the following types of organisms occupy more than one trophic level in a pond ecosystem ? **[AIPMT-2009]**
(1) Frog (2) Phytoplankton
(3) Fish (4) Zooplankton

Q.69 Study the four statements (1-4) given below and select the two correct once out of them-
[AIPMT Pre 2010]
(A) A lion eating a deer and a sparrow feeding on grain are ecologically similar in being consumers
(B) Predator star fish helps in maintaining species diversity of some invertebrates
(C) Predators ultimately lead to the extinction of prey species
(D) Production of chemicals such as nicotine, strychnine by the plants are metabolic disorders
The two correct statements are :
(1) A and D (2) A and B
(3) B and C (4) C and D

Q.70 The biomass available for consumption by the herbivores and the decomposers is called-
[AIPMT Pre 2010]
(1) Net primary productivity
(2) Secondary productivity
(3) Standing crop
(4) Gross primary productivity

Q.71 Which one of the following is one of the characteristics of a biological community?
[AIPMT Pre 2010]
(1) Stratification (2) Natality
(3) Mortality (4) Sex-ratio

Q.72 Which of the following representations shows the pyramid of numbers in a forest ecosystem?
[AIPMT Mains 2010]
(1) 
(2) 
(3) 
(4) 

Q.73 Identify the possible link "A" in the following food chain :
Plant $\rightarrow$ insect $\rightarrow$ frog $\rightarrow$ "A" $\rightarrow$ Eagle
[AIPMT Pre 2012]
(1) Wolf (2) Cobra
(3) Parrot (4) Rabbit

Q.74 In an area where DDT had been used extensively, the population of birds declined significantly because : **[AIPMT Pre 2012]**

(1) earthworms in the area got eradicated

(2) cobras were feeding exclusively on birds

(3) many of the birds eggs laid, did not hatch

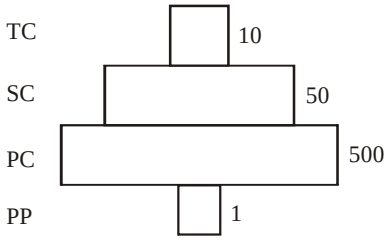
(4) birds stopped laying eggs

Q.75 The upright pyramid of number is absent in : **[AIPMT Pre 2012]**

(1) Forest (2) Lake

(3) Grassland (4) Pond

Q.76 Given below is an imaginary pyramid of numbers. What could be one of the possibilities about certain organisms at some of the different levels ? **[AIPMT Pre 2012]**



(1) Level PP is "phytoplanktons" in sea and "Whale" on top level TC

(2) Level one PP is "pipal trees" and the level SC is "sheep"

(3) Level PC is "rats" and level SC is "cats".

(4) Level PC is "insects" and levels SC is "small insectivorous birds".

Q.77 Which one of the following is not a functional unit of an ecosystem ? **[AIPMT Pre 2012]**

(1) Decomposition (2) Productivity

(3) Stratification (4) Energy flow

Q.78 Which one of the following is not a gaseous biogeochemical cycle in ecosystem ? **[AIPMT Pre 2012]**

(1) Phosphorus cycle (2) Nitrogen cycle

(3) Carbon cycle (4) Sulphur cycle

Q.79 The rate of formation of new organic matter by rabbit in a grassland, is called : **[AIPMT Mains 2012]**

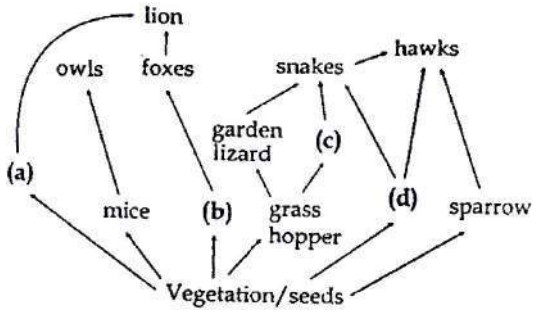
(1) Net productivity

(2) Secondary productivity

(3) Net primary productivity

(4) Gross primary productivity

Q.80 Identify the likely organisms (a), (b), (c) and (d) in the food web shown below : **[AIPMT Mains 2012]**



Options :

	(a)	(b)	(c)	(d)
(1)	deer	rabbit	frog	rat
(2)	dog	squirrel	bat	deer
(3)	rat	dog	tortoise	crow
(4)	squirrel	cat	rat	pigeon

ANSWER KEY

EXERCISE – 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	1	1	3	2	3	2	3	1	4	1	2	2	4	4	2	2	1	3	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	1	1	4	3	2	3	4	1	3	4	1	1	2	2	3	2	2	4	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	3	2	3	4	1	1	4	2	2	4	3	3	1	1	2	3	1	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	4	2	2	3	3	3	3	2	1	1	2	2	3	1	4	3	1	2	1

These questions consist of two statements each, printed as "ASSERTION" and "REASON". While answering these Questions you are required to choose any one of the following responses.

(1) If both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.

(2) If both Assertion and Reason are True but Reason is not correct explanation of the Assertion

(3) If Assertion is True but the Reason is False.

(4) If both Assertion and Reason are false.

Q.1 **Assertion :** The pyramid of biomass indicates the decrease in biomass in successive trophic levels.

Reason : In tree ecosystem pryamid of biomass is inverted.

Q.2 **Assertion :** Each ecosystem has two types of biotic components autorophs and heterotrophs.

Reason : Autrotrophs sysnthesize food materials while heterotrophs utilize and resynthesize it.

Q.3 **Assertion :** Detritus food chain depends upon light energy

Reason : In this food chain food starts with producers.

Q.4 **Assertion :** Tundra biome is most delicate fragile biome

Reason : Trees and shrubs are densly distributed in this biome.

Q.5 **Assertion :** In ecological pyramids, producers always occupy the base.

Reason : Pyramids of number and biomas are mostly upright but pyramid of energy always inverted.

Q.6 **Assertion :** Energy flow in ecosystem is bidirectional.

Reason : Amount of energy increase with each and every trophic levels.

Q.7 **Assertion :** Biotic and abiotic components constitute ecosystem.

Reason : Sun is the ultimate source of energy in ecosystem.

Q.8 **Assertion :** Predators directly depend on producers for food.

Reason : Tertiary consumers are green plants.

Q.9 **Assertion :** In predation, one organism is killed by other organism and used as food

Reason : In this type of association predator lives on interest.

Q.10 **Assertion :** In ecosystem, the function of producers is to convert organic compounds to inorganic compounds.

Reason : Consumers are directly dependent on solar energy.

Q.11 **Assertion :** Biosphere consist of hydrosphere, lithosphere and atmosphere.

Reason : Biosphere is formed of only nonliving matter.

Q.12 **Assertion :** Crop field is a natural ecosystem.

Reason : Complex food chain is found in this ecosystem.

Q.13 **Assertion :** Agroecosystem is man made and stable ecosystem.

Reason : it can be maintained by biological control.

Q.14 **Assertion :** Pyramid of biomass in aquatic ecosystem is inverted.

Reason : Number of phytoplanktons are maximum in aquatic ecosystem.

Q.15 **Assertion :** Lion is a ecologically weakest animal.

Reason : 90% energy is lost. When it transfered from one trophic level to another trophic level.

Q.16 **Assertion :** Earth is a closed system for minearl cycle.

Reason : Mineral cycle is take place between abiotic and biotic component of earth .

Q.17 **Assertion :** Pyramid of energy is always upright.

Reason : There is a gradual decrease in energy at successive trophic levels.

Q.18 **Assertion :** Ecological efficiency always decrease.

Reason : The percentage energy transferred one to another trophic level always increases.

Q.19 **Assertion :** In ecosystem energy flow is always unidirectional.

Reason : In food web energy flow from different pathway.

Q.20 **Assertion :** According to Lindeman in food chain only 90% of enegy transferred from one to next trophic level.

Reason : 10% energy is lost at each trophic level due to respirations & heat.

Q.21 **Assertion :** Those ecosystem which have complex food web are more stable.

Reason : In complex food web every organism have more than one option for getting food.

Q.22 **Assertion :** Decomposers play a significant role in mineral cycle.

Reason : Decomposers are not included in the food chain.

Q.23 **Assertion :** In ecosystem energy cycle runs between producers and consumers.

Reason : Energy goes to producers through decomposer.

Q.24 **Assertion :** Vulture is decomposer.

Reason : Vulture is scavenger not predator.

Q.25 **Assertion :** All predators are carnivores.

Reason : All carnivores are not predators.

Q.26 **Assertion :** Tundra biome is located above 60ºN latitude on polar ice.

Reason : Coniferous forests occur in this biome.

Q.27 **Assertion :** Consumers are not much essential for the formation of ecosystem.

Reason : Producers and reducers can maintain a balance in ecosystem.

Q.28 **Assertion :** Total amount of energy fixed in an producer is gross primary productivity.

Reason : It is the amount of storage organic matter in producer including respiratory untilsation.

Q.29 **Assertion :** Artifical ecosystem are mostly temporary.

Reason : They require energy from external environment.

Q.30 **Assertion :** Heliophytes are mainly occurs in Tundra region.

Reason : Maximum light intensity occurs in Tundra region.

Q.31 **Assertion :** Ecologically, animals are consumers.

Reason : Living organism are classified as followings Producers, Consumers, Decomposers.

Q.32 Mr. X is eating curd/yoghurt. For this food intake in a food chain he should be considered as occupying-

(1) First trophic level

(2) Second trophic level

(3) Third tropic level

(4) Fourth trophic level

Q.33 The Great Barrier Reef along the east coast of Australia can be categorized as -

(1) Population (2) Community

(3) Ecosystem (4) Biome

Q.34 Which one of the following correctly represents an organism and its ecological niche?

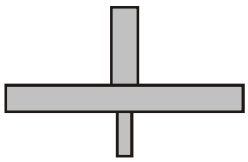
(1) ***Vallisneria*** and pond

(2) Desert locust ***(Schistocerca)*** and desert

(3) Plant lice (aphids) and leaf

(4) Vultures and dense forest

Q.35 Given below is one of the types of ecological pyramids. This type represents -



(1) Pyramid of numbers in a grassland

(2) Pyramid of biomass in a fallow land

(3) Pyramid of biomass in a lake

(4) Energy pyramid in a spring

Q.36 Which one of the following is correct matching of a plant, its habit and the forest type where it normally occurs?

(1) ***Prosopis***, tree, scrub

(2) ***Saccharum***, grass, forest

(3) ***Shorea robusta***, herb, tropical rain forest

(4) ***Acacia catechu***, tree, coniferous forest

ANSWER KEY

EXERCISE – 4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	4	3	3	4	2	4	3	4	3	4	4	2	1	1	1	4	2	4
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
Ans.	1	2	4	2	2	3	1	1	1	4	2	3	3	1	3	1				

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first allempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

BIODIVERSITY AND CONSERVATION

BIODIVERSITY

Term given by **Edward Wilson.** Combined diversity at all the levels of biological organization called Biidiversity. The biodiversity can be studied at three levels.

(1) Genetic diversity

(2) Species diversity

(3) Community and Ecosystem diversity

(1) Genetic diversity :

(a) A species show high diversity at **gene level** over it's distributional range. For ex. Medicinal plant ***Rauwolfia Vomitoria*** growing in himalayan range show diversity in synthesis of chemical **reserpine** in concentraction and potential.

(b) India has 50,000 genetically different spacies of rice and 1000 varieties of mangos.

(c) Each species, varying from bacteria to higher plants and animals, stores an immense amount of genetic infromation. For example, the number of genes is about 450-700 in Mycoplasma, 4000 in Escherichia coli, 13000 in Drosophila melanogaster, 32000-50000 in Oryza sativa and 35000 to 45000 in Homo sapiens.

(d) Genetic diversity refers to the variation of genes within species; the differences could be in allels (different variants of same genes), in entire genes (the traits determining particular characteristics) or in chromosomal structures.

(e) The genetic diversity enables a population to adapt to its environment and respond to natural selection. If a species has more genetic diversity, it can adapt better to the changed environmental conditions.

(f) Lower genetic diversity in a species leads to uniformity, as in the case of large monocultures of genetically similar crop plants. This has advantage when increased crop production is a consideration, but can be a problem when an insect or a fungal disease attacks the field and posses a threat to the whole crop.

(g) The amount of genetic variation is the basis of **speciation** (evolution of new species). It has a key role in the maintenance of diversity at species and community levels. The total genetic diversity of a community will be greater if there are many species, as compared to a situation where there are only a few species. Genetic diversity within a species often increases with environmental variability.

(2) Species diversity :

(a) Diversity at species level.

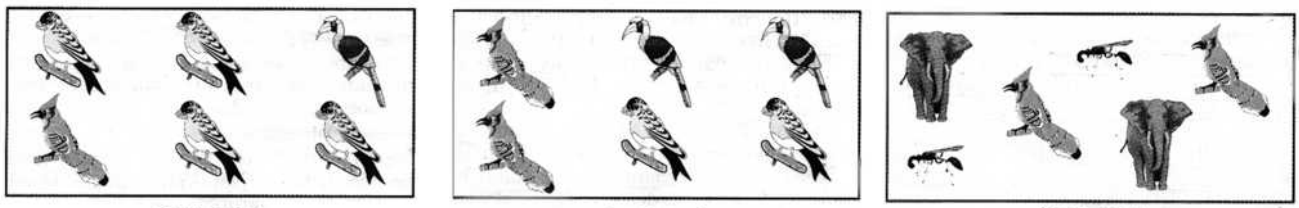
Ex.: Western Ghat have greater species diversity of amphibians than Eastern Ghat.

(b) Species are distinct units of diversity, each playing a specific role in an ecosystem. Therefore, loss of species has consequences for the ecosystem as a whole.

(c) Species diversity refer to the variety of species within a region. Simplest measure of species diversity is **species richness**, i.e., the number of species per unit area. The number of species increases per unit area of the site.

(d) Generally, greater the species richness, greater is the species diversity. However, number of individuals among the species may also vary, resulting into differences in **evenness** or **equitability** and **consequently** in diversity.

(e) Suppose, we are having three sample areas. In the sample area-I, there are three spacies of birds. Two species are represented by one individual each, while the third species has four individuals. In the sample area-2 that has the same three spacies, each spacies is represented by two individuals. This sample area show greater evenness, and there are equal chances for a species being represented in a sample. The sample area-2 will be considered more diverse than the first. In the sample area-3 the species are represented by an insect, a mammal and a birds. This sample area is most diverse as it comparises taxonomically unrelated species. In this example, we find equal number of spacies but varying number of individuals per species. In nature, both the number and kind of species, as well as the number of individuals per species vary, leading to greater diversity.



(3) Community and Ecosystem diversity :

Diversity at ecosystem and community level called Community and diversity. Ex. India have diverse kind of ecosystem like desert, rain forests, mangrovs, coral reefs, wetlands, estuaries and alpine meadows, than the Norway.

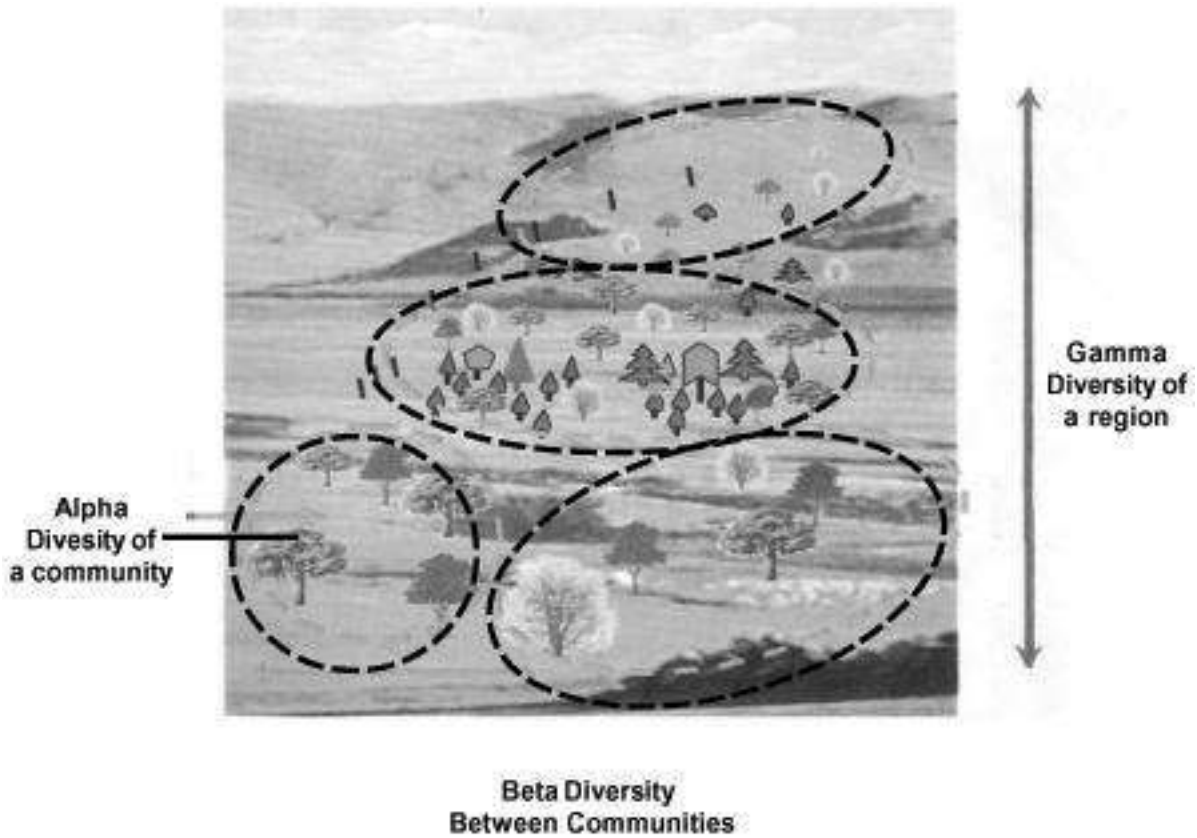


Fig.: Three perspectives of diversity : alpha, beta and gamma diversity.

(a) Diversity : Diversity at the level of community and ecosystem has three perspectives. **Alpha diversity** (within-community diversity) refers to the diversity of organisms sharing the same community/habitat.

(b) β-Diversity : A combination of species richness and equitability/evenness is used to represent diversity within a community or habitat. Species frequently change when habitat or community changes. The rate of replacement of specis along a gradient of habitats or communities is called **beta diversity** (between - community diversity). There are differences in species composition of communities along environmental gradients, eg., altitudinal gradient, moisture gradient, etc.

Higher the heterogenecity in the habitats in a region or greater the dissimilarity between communities, **higher is the beta diversity.**

(c) γ-Diversity : Diversity of the habitats over the total landscape or geographical area is called **gamma diversity.**

Ecosystem diversity describes the number of niches, trophic levels and various ecological processes that sustain energy flow, food webs and the recycling of nutrients. It has a focus on various biotic interactions and the role and function of keytone species. Studies in temperate grasslands have shown that **diverse communities** are functionally **more productive** and **stable** even under environmental stresses such as prolonged dry conditions.

Magnitude of Biodiversity in world and India

(a) According to IUCN (2010) the total number of species of plants and animals described so far are about **1.5 million**.

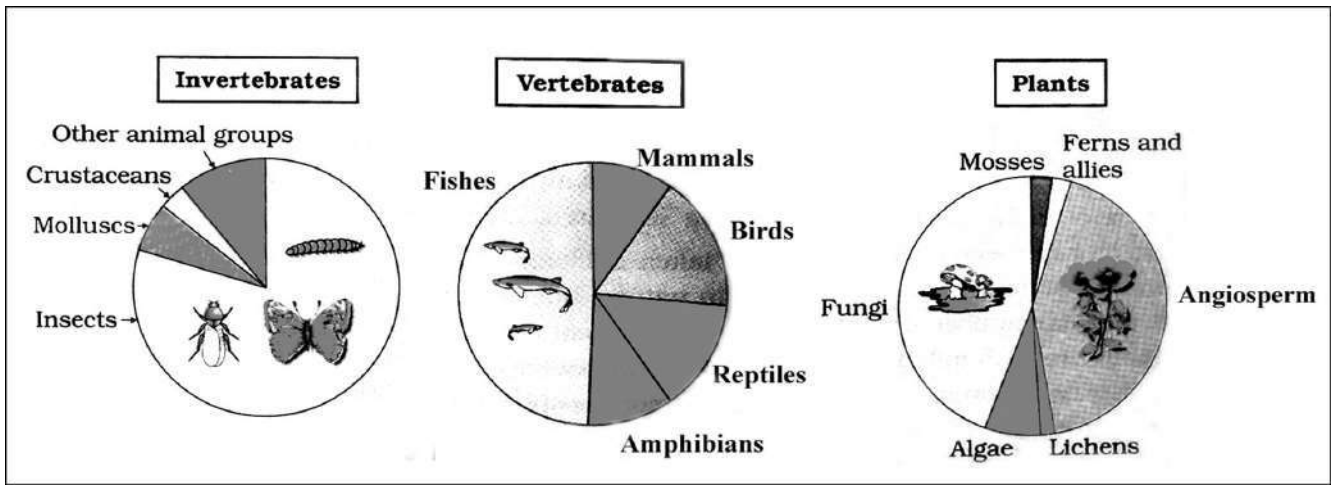
(b) According **Robert May** global species diversity is about 7 million.

(c) According to knowledge of earth's biodiversity-

70% of all species is of **animals.**

22% of all **plants species** (Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms)

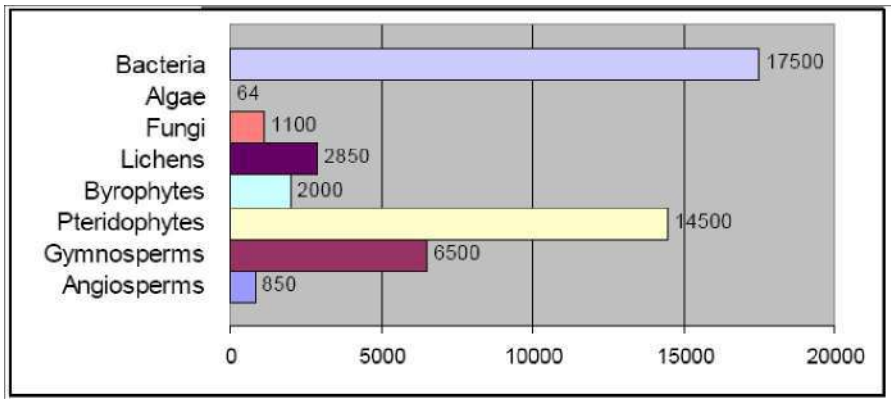
(d) Among animals, **insects** are **most species rich** (number of species) constituting **70% of total animal species**. ie., from every 10 animals, 7 are insects



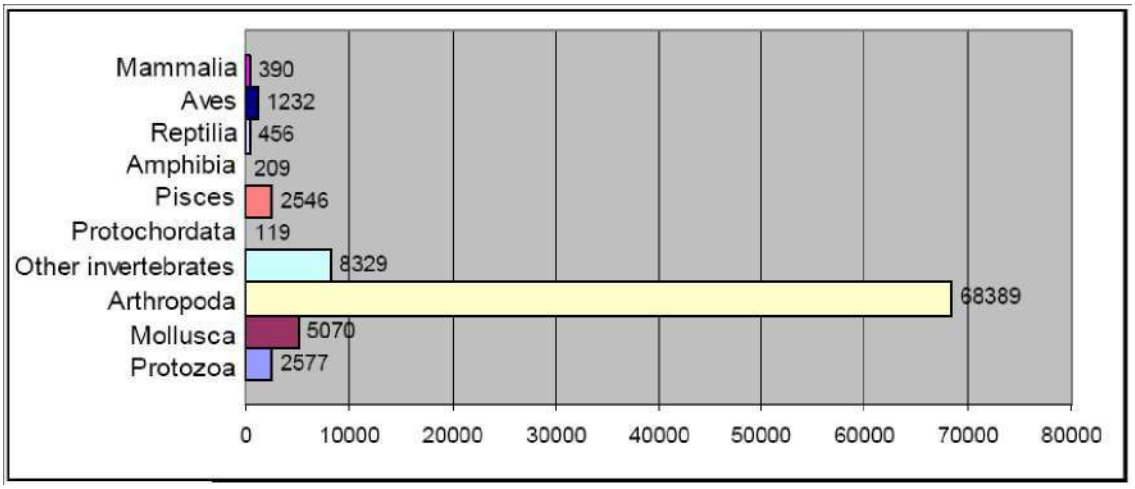
(e) Prokaryotes are not counted in global biodiversity as the number of prokaryotic species in not known, conventional toxonic methods are not suitable for them and many species are not cultrable under laboratory conditions.

- **India** share **2.1% of world land** area but **share global species diversity is 8.1%** which make India **one of the 12 mega diversity countries** of world. **India** has **45000 species of plants** and twice number of species of animals and many more yet to be identified and discovered.

- According to Robert Mays global estimates, only 22% of the total species have been recorded so far. Applying this proportion to India more than 1,00,000 plant and 3,00,000 animal species yet to be discovered and described.



Plants



Animals

Fig.: Number of plant and animal species in different groups reorded in India

Group	Number of species
Higher Plants	2,70,000
Algae	40,000
Fungi	72,000
Bacteria (including cyanobacteria)	4,000
Viruses	1,550
Mammals	4,650
Birds	9,700
Reptiles	7,150
Fish	26,959
Amphibians	4,780
Insects	10,25,000
Crustanceans	43,000
Molluscs	70,000
Nematodes and worms	25,000
Protozoa	40,000
Others	1,10,000

Approximate Numbers of Species which have been Described and Identified from all over the World

(a) India has **10 biogeographical regions** among them **Deccan Peninsula** has the **most extensive coverage of landmass (42%).**

(b) The **most biodiversity rich zone** are **Western Ghat** and **North East Himalaya** account for 4% and 5.2% of geographical area respectively.

(c) Each biogeographical area have several habitats, biotic communities and ecosystem .

(d) A large number of species (both plants and animals) are present in these zone which are endemic (exclusive to India).

(e) About **33% of flowering plants** are **endemic to India**.

(f) Among animals, out of recorded vertebrates, **53% - Fresh water fishes, 60% Amphibians, 36% Reptiles, 10% mammalian fuana** are **endemic to India** which are mainly distributed in North - East, Western Ghats and Nicobar Islands.

(g) A very high number of Amphibian species are endemic to western ghat.

(h) Biological diversity in ecosystems like deep oceans, wetlands, lakes and habitats like tree canopy and soil of tropical rain forest in India yet to be explored.

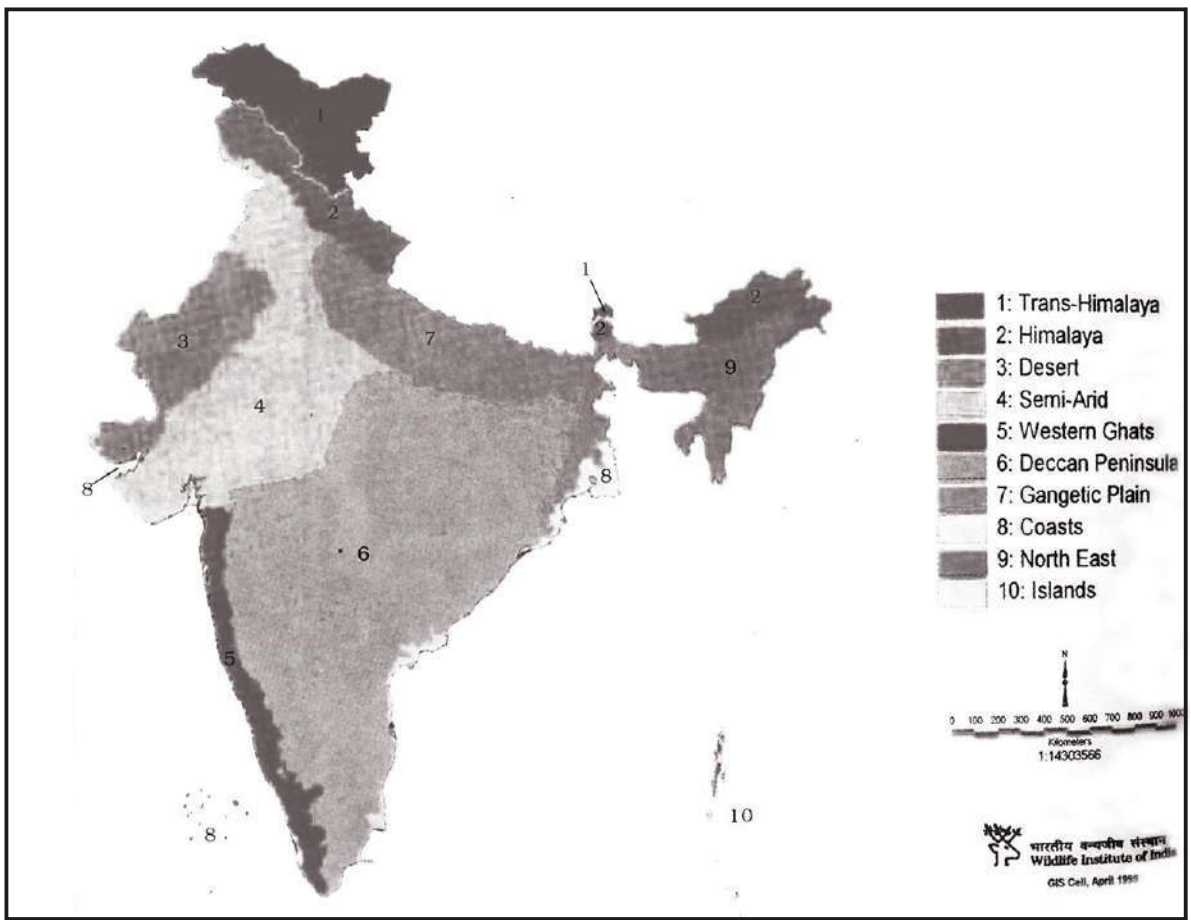


Fig.: Biogeographical regions of India.

Gradients / Pattern of Biodiverity :

(A) The pattern of biodiversity is decided by latitudes (Distance from equator), altitude (Height from sea level.

(a) As we move from high to low latitudes ie., from poles to the equator the biological diversity increases. ie., equator towards the pole for example, Tropics (latitudinal range of 23.5ºN to 23.5ºS) harbour more species

than temperate or polar areas. Colombia located near equator has about 1400 species of birds while Newyork at 41ºN has 105 species and greenland at 71ºN only 56 species and Greenland at 71°N only 56 species of birds.

(b) **India** located in tropical latitude has more than **1200 species of birds.**

(c) A forest in tropical region like Equator has 10 times more species of vascular plants than temperate region like midwest of USA.

(d) The largly **tropical Amazonian rain forest** in South America has **greatest biodiversity on earth.** It home to more than **40,000 species of plants, 3000 fishes, 1,300 birds, 427 mammals, 427 Amphibians, 378 reptiles and more than 1,25,000 invertebrates.**

(e) Tropics have very high biodiversity due to -

(i) Speciation (Formation of new species) is the function of time and unlike temperate regions which are subjected to frequent glaciations in past the tropical latitudes have remained undisturbed for millions of years. so have long evolutionary time for species diversification.

(ii) Tropical environment unlike temperate one are less seasonal, relatively more constant and predictable which promotes niche specialisation and leads to greater species diversity.

(iii) There is more solar energy available in tropics, which contributes to higher productivity and indirectly contribute to greater diversity.

(f) **Decrease in species at altitudes,** from **lower to higher altitude** on a mountain.

(g) **1000 m increase in altitude** results in **temperature drop of about 6.5ºC.** This drop in temperature and great seasonal variability at higher altitude are a major factor that reduce biodiversity.

(h) The **latitudinal** and **altitudinal gradients** of species **divesrity** are two master gradients.

(i) Also **more complex** and **heterogenous the physical envrironment, more complex and diverse** will be the **flora** and **fauna**.

Latitude and types of forest in world and India :

(a) In Northern hemisphere as we moves from equator north world to arctic region consecutive belts of coniferous.

Tropical rain forest	:	0 – 20º N
Tropical deciduous forest	:	20 – 40º N
Temperate deciduous / Temperate broad leaf forest	:	– 40 – 60º N
Temperate coniferous/ temperate needle leaf forest or Alpines	:	– 50 – 60º N
Tundra biome	:	60º N

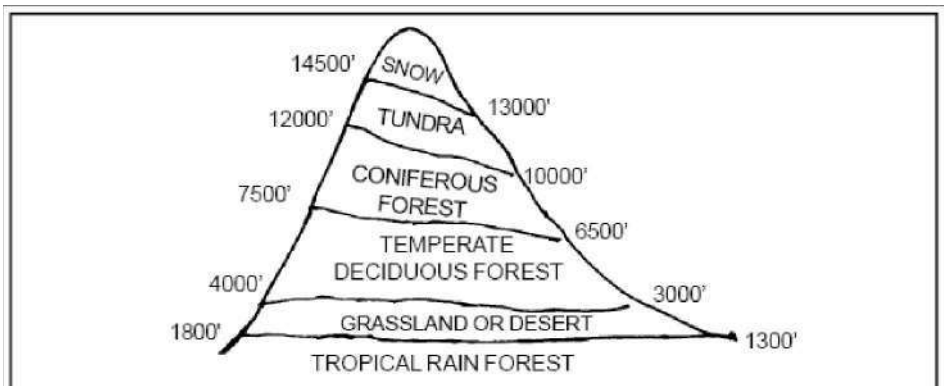
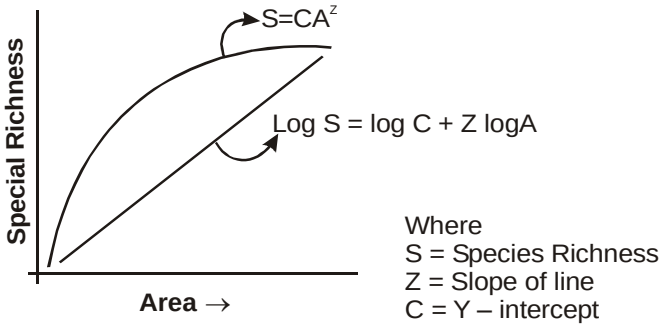


Fig. Different types of vegetation with increasing altitude on mountains (Altitudinal Zonation)

(B) Species Area Relationship

(i) German naturalist and geographer **Alexander Von Hemboldt** observed that within a region, species richness increased with increasing explored area, but only upto a limit.



(ii) Generally the value of Z-line is in range of 0.1 to 0.2 regard less of taxonomic group or region.

BIODIVERSITY CONSERVATION :

Uses of Biodiversity :

(A) Narrowly utilitarian

(B) Broadly Utilitarian / Ecosystem Services

(C) Ethical / Aesthetic and Cultural Benifits

(A) Narrowly utilitarian :

(a) As source of food, medicin, pharmaceutical drugs, fibers, rubber and timber.

(b) As source of food and improved varities. The biodiversity used in modern agriculture in three ways-

(i) As a source of new crops.

(ii) As a source of material for breeding improved varieties.

(iii) As a source of new biodegradable pesticides.

(c) Less than **20 plant species** are cultivated to **produce about 85% of world food. Wheat, Corn** and **Rice** are **three major carbohydrate crops** yield nearly 2/3 of food sustaning the human population.

(d) The commercialy domestiated species are cross breed with their wild relatives to improve their fruits.

(e) Genes of wild species are used to introduce new properties like **disease resistance** and **high yield**. for Example, **rice grown in Asia** is protected from four main disease by genes received from a single wild rice species (***oryza nivara***) **from India.**

(f) Drugs and Medicines - Biodiversity is rich source of substance with medicinal value.

Morphine - From *papaver sominiferum*

Quinine - From Cinchona

Taxol - From bark of yew tree (**Taxus *brevifolia***, *T.baccata*)

(g) 25% of drugs are derived from 120 species of plants.

(h) Botanochemicals - Plant chemicals used in preparation of synthetic products.

(B) Broadly Utilitarian :

(a) Diversity is essental for the maintenance and sustainable utilization of goods and services of ecosystem or individual species. The ecosystem services are -

(i) Gaseous exchange - **Amazon forest** is estimated to produce through photosynthesis. **20% of total oxygen of earth atmosphere.** So these forest are considerd as **"Lungs of Earth".**

(ii) Pollination by bees, bumblebees, birds, bats, ants and various insects.

(iii) Climate control by forest and oceanic ecosystem (Hydrological Cycles)

(iv) Natural pest control.

(v) Protection of soil

(vi) Conservation and purification of water.

(vii) Nutrient cycling.

(b) These ecosystem services have been valued in range of 16 to 54 trillion (10^{12}) (average 34 Trillion) US dollars per year. Robert Constanza and his colleagues recently tried to put price tag on nature's life support services, which is about 33 trillian US dollar on an average. Out of total cost of various ecosystem services the **soil formation accounts for - 50%, Recreation & nutrient cycling - < 10%, Climate regulation - 10%, Habitat for wild life - 6%.**

(C) Ethical / Aesthetic and Cultural Benifits -

(a) Ecotourism.

(b) Bird Watching

(c) Wild life

(d) Pet keeping, **Gardening**.

(e) Cultural and religious beliefs - like in India *Ocimum Sactum* (Tulsi), *Ficus religiosa* (Pipal), **Prosopis Cineanaria (Khejri)** and many more plants and animals like Rat (Lord Ganesha), Lion (Jai mata di), Owl (Laxmi ji), Swan (Saraswati ji), Peacock (Kartikaya ji) Snakes (Shiv Ji) are considered as scared and worshiped.

(g) The plants and animals are symbol of our cultural heritage and national pride.

(h) Philosophically and spiritually we need to realize that every species has an intrinsic value, even if it may not be of current or any economic value to us. It is our moral duty to care for their well being and pass on our biological legacy in good order of future generation. as we Indians belives in : **''सर्वेभवन्तु सुखिनः सर्वेःसन्तुः निरामया''**

Importance of species diversity to the Ecosystem :

(a) The number of species in a community is important for a ecosystem. It is belives that **communities with more species are more stable and with less species are less stable.**

(b) A stable community mean-

(i) Not show to much variation in productivity year to year.

(ii) It must be resistant to occasional disturbances (Natural or Man made).

(iii) It must be resistant to invasion by alien species.

(c) How these attributes are linked to species richness in a community?

According to David Tilman's by the long term ecosystem experiment using outdoor plots concluded that plots with more species shows less year to year variation in total biomass and increased diversity contributed to higher productivity.

(d) Rich biodiversity is not only essential for ecosystem health, but also necessory for survival of human race on this planet.

(e) How a species extinctintion anywhere on this planet affect the human race is explained by Stanford ecologist paul **Ehrlich** by **Rivet Popper Hypothesis.**

(f) He compare **aeroplane** as **ecosystem** joined togather by thousends of **rivets** as **species**. If passenger travelling in it starts popping a rivet to take home (causing species to become extinct) if may not affect flight safety (proper functioning of ecosystem) initially, but as more or more rivets are removed, the plane become dangerously weak over a period of time.

(g) The removal of rivat of fan is more dangerous than seat or wind rivets. The rivet of fan means dominant species of ecosystem.

LOSS OF BIODIVERSITY/THREATS TO BIODIVERSITY :

The loss in biodiversity in an region may leads to-

(a) Decline in plant production.

(b) Lowered the resistance to environmental changes like draught.

(c) Change the ecosystem processing like plant productivity, water use, pest and disease cycle.

Cause of biodiversity loss :

(a) Habitat loss and Fagmentation.

(b) Over exploitation

(c) Introduction of exotic species/ Alien species.

(d) Co-extinction

(a) Habitat loss and Fragmentation : This is the most important cause driving animals and plants to extinction. The most dramatic example of habitat loss come from torpical rian forests. Once covering more than 14 percent of the earth's land surface, these rain forests now over no more than 6 percent. they are being destroyed fast. By the time you finish reading this chapter, 1000 more hectares of rain forest would have been lost.

(i) The **Amazon rain forest** (It is so huge that it is called the **'Lungs of the planet'.**) harbouring probably millions of species is being cut and cleared for cultivating soya beans or for conversation to grassland for raising beef cattle.

(ii) Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species. When large habitats are broken up into small fragments due to various human activities, mammals and birds requiring large territories and certain animals with migratory habits are badly affected, leading to population declines.

(b) Over-exploitation : Human have always depended on nature for **food** and **shelter**, but when **'need'** turns to **'greed'**, it leads to over-exploitation of natural resources. Many species extinctions in the last 500 years (**Stellr's sea cow, passenger pigeon**) were due to exploitation by humans. Presently many marine fish populations around the world are over harvested, endangering the continued existence of some commercially important species.

(c) Alien species invasions : When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species.

(i) The **Nile perch introduced into Lake Victoria** in **east Africa** led eventually to the extinction of an ecologically unique assemblage of more than 200 species of **cichlid fish** in lake. You must be familiar with the environmental damage caused and threat posed to our native species by **invasive weed species** like **carrot grass (*Parthenium*)**, **Lantana** and **water hyacinth *(Eicchornia*).**

(ii) The recent illegal introduction of the **Africa Catfish *Clarias gariepinus*** for aquaculture purposes is posing a threat to the indigenous **catfishes** in our rivers.

(d) Co-extinctions : When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct even the assemblage of parasites also meets the same fate.

Another example is the case of a coevolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

Type of Extinction of Species :

(a) Extinction is a natural process. Species have disappeared and new ones have evolved to take their places over the long geological history of the earth. It is useful to distinguished three types of extinction processes.

Natural Extinction : With the change in environmental conditions, some species diappear and others, which are more adapted to changed conditions, take their place. This loss of species which occured in the geological past at a very slow rate, is called **natural** or **background extinction.**

Mass extinction : There have been saveral periods in the earth's geological history when large number of species become extinct because of catastrophes. Mass extinctions occured in millions of years.

Anthropogenic extinction : An increasing number of species are disappearing from the face of the earth due to human activities. This man-made mass extinction represents a very severe depletion of biodiversity, particularly because it is occuring within a short period of time.

(b) The **World Conservation Monitoring Centre** has recorde that **533 animal species** (Mostly **vertebrates**) and **384 plant species** (Mostly **flowering plants**) have **become extinct since the year 1600.** More species have gone extinct from the islands than from the mainland or the oceans.

(c) The current rate of extinction is 1000 to 10000 time higher than the background rate of **extinction.** Some interesting observations about the current loss of species are :

(i) From ten high diversity localities in **tropical forests** covering 300,000 km^2, some 17,000 **endemic plant species** and **350,000 endemic animal species could be lost in near future.**

(ii) The **tropical forests alone are losing** roughly **14,000-40,000 species per year** (or 2-5 species per hour)

(iii) The **earth** may lose up to 50% of the species by the end of the 21^{st} century, if the current rate of loss continues.

Susceptibility to Extinction : The characteristics of species particularly susceptible to extinction are : **large body size (Bengal tiger, Lion and Elephant); small population size** and **low reproductive rate (Blue whale and Giant panda). Feeding at high tropic levels in the food chain** (Bengal tiger and Bald eagle), **fixed migratory routes** and **habitat (Blue whale and Whooping crane)** and **localised** and **narrow range of distribution (woodland caribou; many island species)** also make the species susceptibel to extinction.

The IUCN Red List Categoris :

(A) The IUCN Red List (which is started in **1963**) is a catalogue of taxa that are **facing the risk of exctinction.** It is important to understand that the Red List aims to impart information about the urgency and scale of conservation problems to the public and policy makers. The uses of the Red List are -

(i) Developing awarness about the importance of threatened biodiversity;

(ii) Identification and documentation of endangered species;

(iii) Providing a global index of the decline of biodiversity;

(iv) Defining conservation priorities at the local level and guiding conservation action.

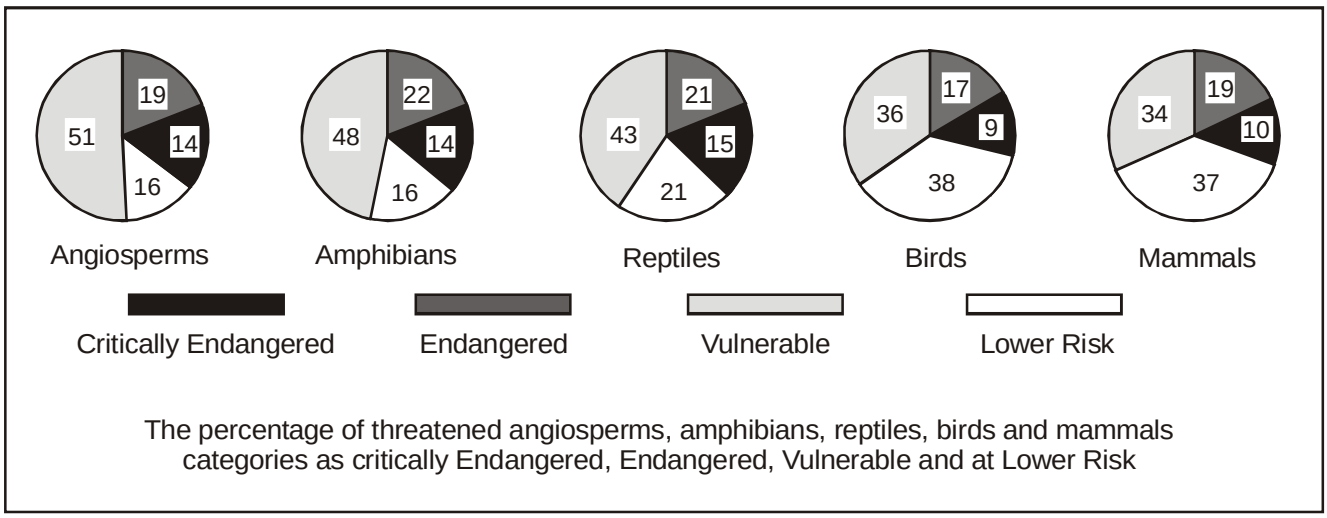
(B) The **World Conservation Union** (formerly known as International Union for the Conservation of Nature and Natural Resource, **IUCN**) has recognised **eight Red List Categories of species**; ***Extinct, Extinct in the wild, Critically endangered, Endangered, Vulnerable, Lower Risk, Data Deficient*** and ***Not Evaluated.*** These categories are difined in Table below.

Red List Category	Definition
Extinct	A taxon is Extinct when there is no reasonable doubt that the last individual has died.
Extinct in the wild	A taxon is Extinct in the wild when exhaustive surveys, in known and/or expected habitats, have failed to record an individual.
Critically Endangered	A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	A taxon is Endangered when it is not Critically Endangered, but facing a very high risk of extinction in the wild in the near future.
Vulnerable	A taxon is Vulnerable when it is not Critically Endangered or Endangered, but facing a high risk of extinction in the wild in the medium term future.
Lower Risk	A taxon is Lower risk when it has been evaluated and does not satisfy the criteria for Critically Endangered, Endangered or Vulnerable.
Data Deficient	A taxon is Data Deficient when there is inadequate information to make a direct or indirect, assessment of its risk of extinction.
Not Evaluated	A taxon is Not Evaluated when it has not yet been assessed against the above criteria.

(C) Threatened (T) : The term is used in context with conservation of the species which are in any one of the above 3 categores (E, V, R).

Threatened = Endagered + Vulnerable + Rare

1. **Endangered (E) :** Those species which are in the immediate danger of extinction and whose survival is unlikely whose number have been reduced to a critical level, if the casual factors continue to be operating.
2. **Vulnerable (V) :** The species likely to move into the endangered category in the near future if the casual factors continue to operate. Their population is still abundant but are under threat throughout their range.
3. **Rare (R) :** These are species with small population in the world. These are not at present endangerd and vulnerable, but are at risk due to their less number. These species are usually **localised within restricted geographical areas** or **habitals.**

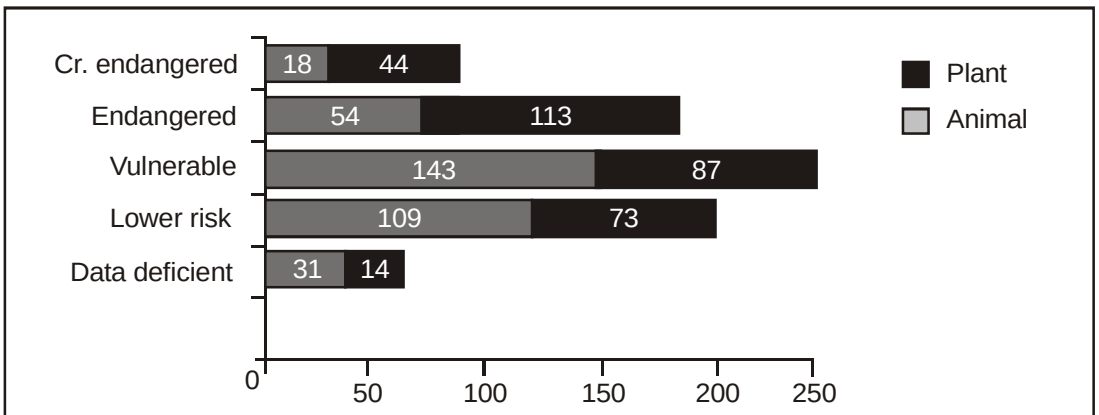


The percentage of threatened angiosperms, amphibians, reptiles, birds and mammals categories as critically Endangered, Endangered, Vulnerable and at Lower Risk

(D) The **IUCN Red List (2004)** documents the extinction of **784 species (including 338 vertebrates, 359 invertebrates and 87 plants)** in the last 500 years. Some examples of recent extinctions include the **dodo (Mauritius), quagga (Africa), thylacine (Australia), Steller's Sea Cow (Russia)** and **three subspecies (Bali, Javan, Caspian) of tiger.** The **last twenty years** alone have witnessed the **disappearance of 27 species.** Careful analysis of records shows that extinctions across taxa are not random; some groups like amphibians appear to be more vulnerable to extinction. Adding to the grim scenario of extinctions is the fact that **more than 15,500 species** world-wide are facing the threat of extinction.

(E) Presently, **12 per cent of all bird species, 23 per cent of all mammal species, 32 per cent of all amphibian species** and **31per cent of all gymnosperm species** in the world **face the threat of extinction.**From a study of the history of life on earth through fossil records, we learn that large-scale loss of species like the one we are currently witnessing have also happened earlier, even before humans appeared on the scene.

(F) During the long period (> 3 billion years) since the origin and diversification of life on earth there were **five episodes of mass extinction of species.** How is the **'Sixth Extinction' presently in progress** different from the previous episodes? The difference is in the rates; the current species extinction rates are estimated to be 100 to 1,000 times faster than in the pre-human times and our activities are responsible for the faster rates. Ecologists warn that if the present trends continue, nearly half of all the species on earth might be wiped out within the next 100 years.



The number of plant and animal species of various threat categories in India

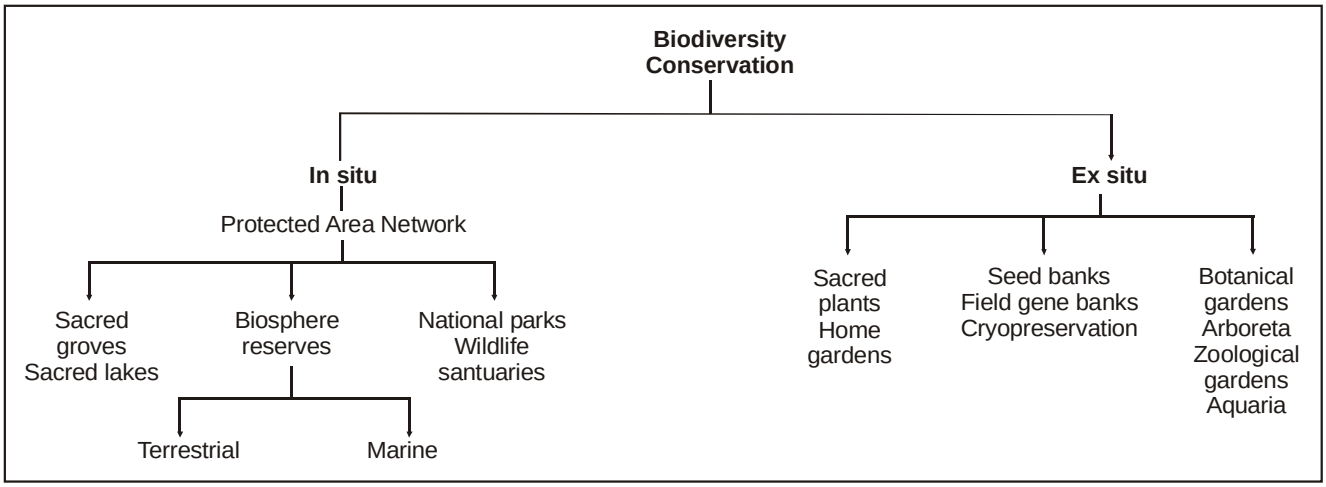
Some Important Examples of Threatened species in India

Category	Plants	Animals
(1) Critically endengered	Barberis nilghiriensis	Sus salvanius (Pigmyhog)
(2) Endangered	Bentinckia nicobarica	Ailurus fulgens (Red panda)
(3) Vulnerable	Cupressus cashmeriana	Antelope cervicapra (Black buck)

Note : Rauwolfia serpentiana (medicinal plant) is **endangered.**

BIODIVERSITY CONSERVATION :

It is of two types **In situ (On site)** and **Ex situ (Off site)** conservation.



In situ Conservation Strategies :

The in situ strategies emphasise protection of total ecosystems.The in Situ approach includes protection of a group of typical ecosystems through a network of protected areas.

(1) Protected Areas : These are areas of land and/or sea, especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources. These are managed throught leagal or other effective means. Examples of protected areas are **National Parks** and **Wildlife Sancturies**. The **earliest national parks**, the **Yellowstone in USA** and the **Royal** near **Sydney, Australia.**

Many similar areas throughout the world now protect rare species or wilderness areas. **World Conservation Monitoring Centre** has recognised 37,000 protected areas around the world. As of **September 2002, India has 581 protected areas** (**89 National Parks** and **492 Wildlife Santuries**), **covering 4.7% of the land** surface, as against 10% internationally suggested norm. The **Jim Corbett National Park** was the **first National Park established in India.**

Some of the main benefits of protected areas are :

(i) Maintaining viable populations of all native species and subspecies.

(ii) Maintaining the number and distribution of communities and habitats and conserving the genetic diveristy of all the present species.

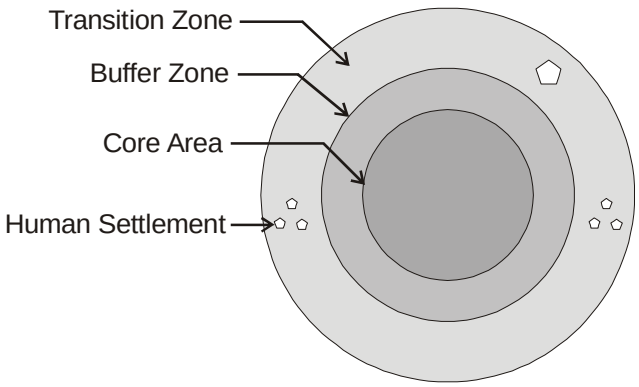
(iii) Preventing human caused introductions of alien spacies; and

(iv) Making it possible for species/habitats to shift in response to environmental changes.

(2) Biosphere Reserves : Biosphere reserves are special category of protected areas of land and/or coastal environments, where in **people are an integral component** of the system. These are representative examples of natural biomes and contain unique biological communities. The **concept of Biosphere Reserve was launched in 1975** as a part of **UNESCO's Man and Biosphere Programme (MAB)**, dealing with the conservation of ecosystems and the genetic resources contained therein. Till **May 2002**, there were **408 biosphere reserves** located in **94 countries**. There are **13 biosphere reserves** in **India** and are shown in figure below.

Diagram III : Showing the Biosphere Reserves in India

In India, Biosphere Reserve are also notified as **National Parks**. A Biosphere Reserve consists of **core, buffer** and **transition zones**. The **natural** or **core zone** comprises an **undisturbed** and **legally protected ecosystem.** The **buffer zone** surrounds the core area, and is managed to accomodate a greater variety of **resource use strategies** and **research** and **educational activities.**



The zonation in a terrestrial Biosphere Reserve

The **transition zone,** the outermost part of the Biosphere Reserve, is an **area of active cooperation between reserve management** and the **local people,** wherein activities like **settlements, cropping, forestry** and **recreation** and **other economic** uses continue in harmony with conservation goals. The main fucntions of biosphere reserves are :

(i) **Conservation :** To ensure the conservation of landscapes, ecosystems, encourages traditional resource use.

(ii) **Development :** To promote economic development which is culturally, socially and ecologically sustainable.

(iii) **Scientific research, monitoring and education :** The aim is to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.

(3) **Sacred forests and sacred lakes :** A **traditional strategy** for the protection of biodiversity has been in practice in **India** and some other Asian countries in the form of **sacred forests.** These are forest patches of varying dimensions protected by tribal communities due to religious sanctity accorded to them.

The sacred forests represent islands of **pristine forests** (most undistributed forest without any human impact) and have been free from all disturbances; though these are frequently surrounded by highly degraded landscapes.

In India, sacred forests are located in several part, eg., **Karnataka. Maharashtra, Kerala, Meghalaya etc.,** and are **serving as refugia** for a number of rare, endangered and endemic taxa. Similarly, several water bodies (eg., **Khecheopalri lake in Sikkim**) have been declared sacred by the people, leading to protection of aquatic flora and fauna.

Ex-situ Conservation Strategies :

(A) The ex-situ conservation strategies include **botanical gardens, zoos, conservation stands** and **gene, pollen, seed, seedling, tissue culture** and **DNA banks**. Seed gene banks are the easiest way to store germplasm of wild and cultivated plants at low temperature in cold rooms. Preservation of genetic resources is carried out in field gene banks under normal growing conditions.

(B) In vitro conservation, especially by **cryopreservation** in **liquid nitrogen** at a **temperature of –196ºC,** is particularly useful for conserving vegetatively propagated crops like potato. Cryopreservation is the storage of material at ultra-low temperature either by very rapid cooling and simultaneous dehydration at low temperature (used for tissue culture). The material can be stored for a long period of time in compact, low maintenance refrigeration units.

(C) Conservation of biological diversity in botanical gardens is already in practice. There are more than **1500 botanical gardens** and **arbsoreta** (botanical gardens where specific tree and shrub species are cultivated) in the world **containing more than 80,000 species.** Many of these now have seed banks, tissue culture facilities and other ex situ technologies. Similarly, there are more than **800 professionally managed zoos around the world** with **about 3,000 species of mammals, birds, reptiles** and **amphibians.** Many of these zoos have well developed **captive breeding programmes.**

(D) The conservation of wild relative of crops plants and the off-site conservation of crop varieties or cultures of micro-organisms privdes breeders and genetic engineers with a ready source of genetic material. Plants and animals conserved in botanical gardens, aroboreta, zoos and aquaria can be **used to restore degraded land, reintroduce species into wild** and **restock depleted populations.**

Hot Spots of Biodiversity :

(A) Biodiversity is not uniformly distributed across the geographical regions of the earth. Certain regions of the world are mega diversity zones where a very large number of species are found. For example, **India accounts for only 2.4% of the land area of the world,** but it **contributes approximately 8% species to the global diversity.**

(B) **Norman Mayers** developed the **hot spots concept** in **1988** to designate priority areas **for in situ conservation.** the hot spots are the plant and animal life on earth. The key criteria for determining a hot spote are :

(i) **Number of endemic species**,ie., the species which are found nowhere else, and

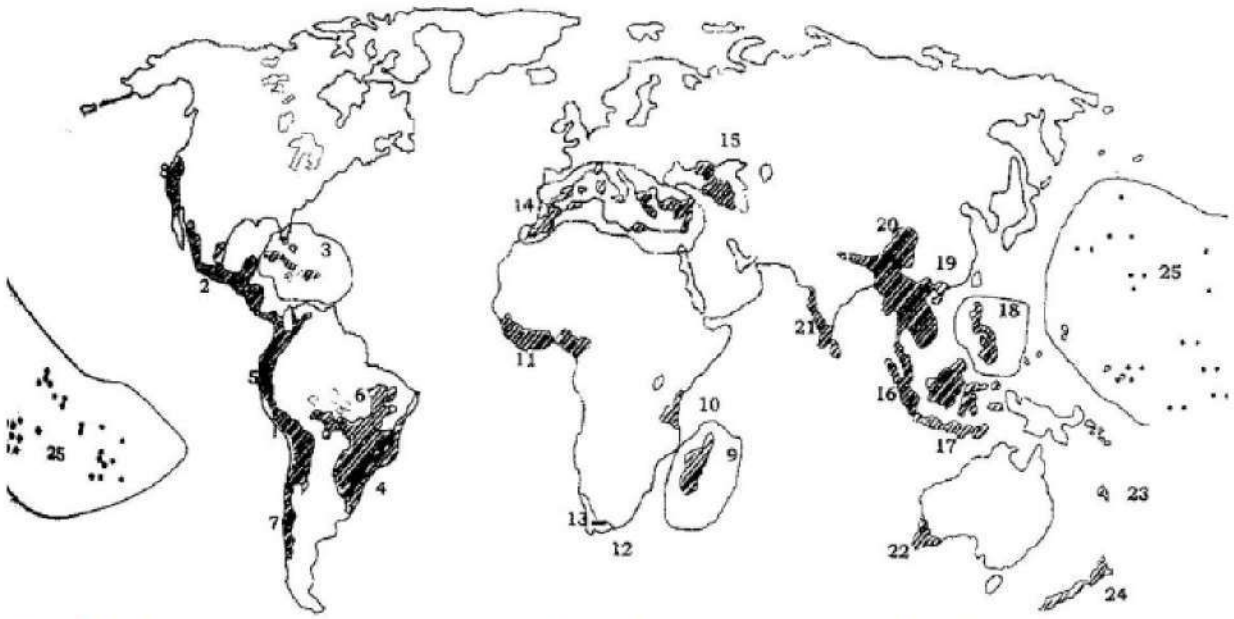
(ii) **Degree of threat**, which is measured in terms of habitat loss.

(C) **Twenty five terrestrial hot spots** for conservation of biodiversity have been identified worldwide. These hot spots together, now cover **1.4% of the earth's land area**. **Tropical forests** appear in **15 hot spots, Mediterranean** type **zones in 5**, and **9 hot spots** are completely made up of **islands**. As many as **16 hot spots** are in the **tropics**. About **20% of the human population** lives in the **hot-spot regions**. **Now total number of hot spots are 34.**

(D) Among the **34 hot spots of the world**, two (**Western Ghats and Eastern Himalayas**) are **found in India,** and these extend into the neighbouring countries also.Srilanka and **Indo-Burma** These areas are rich in flowering plants, also in **reptiles, amphibians, swallow-tailed butterflies and some mammals;** and also show a high degree of endemism.

(E) The eastern Himalayan hot spot exteds to the **north-eastern India** and **Bhutan**. the temperate forests are found at altitudes of 1780 to 3500 meters. Many deep and semi-isolated valleys found in this region are exceptionally rich in endemic plant species. Besides being an active centre of evolution and rich diversity of flowering plants, the numerous primitive angiosperm families (eg., ***Magnoliaceae*** and ***Winteraceae***) and primitive genera of plants, like ***Magnolia*** and ***Betula*** are found in **Eastern Himalaya.**

(F) The **Western Ghat** region lies parallel to the western coast of Indian peninsula for almost 1600 km, in **Maharashtra**, **Karnataka**, **Tamil Nadu** and **Kerala**. The forests at low elevation **(500m above means sea level)** are mostly **evergreen**, while those found at **500-1500 meter height** are generally **semi-evergreen forests.** The **Agasthyamalai hills,** the **Silent Valley** and the **new Amambalam Reserve**, are the **two main centres of diversity**.



1. Tropical Andes, 2. Mesoamerica, 3. Caribbean, 4. Brazils's Atlantic Forests, 5. Choco/Darien/Western Ecuador, 6. Brazil's Cerrado, 7. Central Chile, 8. California Floristic Province, 9. Madagascar, 10. Eastern Arc & Coastal Forests of Tanzania/Kenya, 11. West African Forests, 12. Cape Floristic Province, 13. Succulent Karoo, 14. Mediterranean Basin, 15. Caucasus, 16 Sundland, 17. WAllacea, 18. Phillippines, 19. Indo-Burma, 20. South-Central China, 21. Western Ghats/Sri Lanka, 22. Southwest Australia, 23. New Caledonia, 24. New Zealand, 25. Polynesia/Micronesia.

Fig. The terrestrial biodiversity hot spots.

International Efforts for Conserving Biodiversity :

(A) The **Earth Summit held in 1992** at **Rio de Janeiro** result into a **Convention on Biodiversity,** which came into force on **29 December, 1993.** The convention on has three key objectives:

(i) Conservation of biological diversity.

(ii) Sustainable use of biodiversity and

(iii) Fair and equitable sharing of benefits arising out of the utilisation of genetic resources.

The **World Conservation Union** and the **World Wide Fund for Nature (WWF)** support projects worldwide to promote conservation and appropriate development of **Biosphere Reserve.**

Biodiversity Conservation in India :

(B) Indian region has contributed significantly to the global biodiversity. India is a homeland of **167 cultivated species** and **320 wild relatives of crop plants**. It is the centre of diversity of animal species **(zebu, mithun, chicken, water, buffalo, camel); crop plants (rice, sugarcane, banana, jackfruit, cucurbits), edible diascoreas, alocasia, colocasia; spices and condiments (cardamom, black paper, ginger, turmeric);** and bamboos, brassicas, and tree cotton. **India** also represents a **secondary centre of domestication for some animals (horse, goat, sheep, cattle, yak and donkey)** and **plants (tobacco, potato and maize).**

(C) **In situ conservation** of biodiversity is being carried out through **Biosphere Reserves, National Parks, Wild Life Sancturies** and other **protected** areas by the **Ministry of Environment and Forests.**

(D) The **joint forest management systems** involve **forest departments** and **local communities.** This enables the tribles the tribal people and local communities to have access to non-wood forest products, and at the same time protect the forest resources.

(E) The **National Bureau of Plant, Animal and Fish Genetic Resources** has a number of programmes to collect and **conserve the germplasm of plants and animals in seed gene banks**, and **field gene banks** for in *vitro* conservation.

(F) Botanical and Zoological gardens have large collections of plant and animal species in different climatic regions of India.

(G) The land races and diverse food and medicinal plants are also being conserved successfully by the tribal people and women working individually, or with various non-governmental agencies. The women particularly have an important role in the conservation of agrobiodiversity.

(H) In India, a programme is underway to develop a system of community registers of local informal innovations related to the genetic resource, as well as natural resource management in general.

SPECIAL POINTS

(A) India is divided into 10 Biogeographical regions.

(i) Trans - Himalaya	(ii) Himalaya	(iii) Desert
(iv) Semi - Arid	(v) Western ghats	(vI) deccan peninsula
(viii) Gangetic plain	(viii) Coasts	(ix) North east
(x) Islands		

Note : Deccan peninsula has maxmum coverage of teh Indian land mass (42%), western ghats 4% and north-east 5.2%

(B) **Endemic Flowering Species of India -** 33% of flowering plants recorded in India are endemic.

(C) **Endemic fauna (Animals Species) of India -** Out of the recorded vertebrates, 60% amphibians, 53% fresh water fish, 36% reptiles and 10% mammalian.

(D) Maximum endemic amphibian species are found in western ghats.

(E) From ten high-diversity localities in tropical forest some 17,000 endemic plant species and 350,000 endemic animal species could be lost in near future.

(F) The tropical forests alone are losing roughly 14,000 - 40,000 speices per year (or 2-5 species per hour).

(G) The earth may lose up to 50 percent of the species by the end of the 21st century.

(H) According to IUCN (2004), total number of plant and animal species on the earth is 1.5 million.

(I) According to Robert May global species diversity is about 7 millioin.

(J) More than 70 percent of all species recorded are animals, while plants comprise no more than 22%

(K) Out of 10 animals on this planet 7 are insects.

(L) Indian share of the global spcies diversity is about 8.1 percent.

(M) Some examples of recent extinction include the **dodo (Mauritius), quagga (Africa), thylacine (Australia), stellars' sea cow (Russia)** and three subspecies (Bali, Javan, Caspian) of **tigers**.

(N) According to IUCN Red list (2004), 784 species were extinct in the last 500 year.

(O) The Amazon rain forest is so huge that is called **''Lungs of the Planet''.**

(P) **Biodiversity Day 22th May.**

(Q) **Year 2010** is declared as Biodiversity Conservation year by UNO.

THEREATENED ANIMALS OF INDIA :

T = Threatened, **R** = Rare ; **E** = Endangered ; **V** = Vulnerable

MAMMALS

1.	Macaca silenus (L.)	Lion-Tailed Macaque.	E
2.	Loris tardigradus (L.)	Slender Loris	T
3.	Hylobates hoolock (Harlan)	Hoolock Gibbon	E
4.	**Panthera tigris** (L.)	**Tiger**	T
5.	Panthera leo persica (Meyer)	Asiatic Lion	T
6.	Panthera Pardus (L.)	Leopard or Panther	T
7.	Felis bengalensis Kerr	Leopard Cat	V
8.	Felis temmincki : V	Horsfield Golder Cat	E
9.	Felis manual Pallas	Pallas's Cat	R
10.	Felis silverstris ornate Gray	Indian Desert Cat	R,E
11.	**Canis lupus** (L.)	**Wolf**	E
12.	Vulpes bengalensis (shaw)	Indian Fox	T
13.	Ailurus fulgens F.Cuvier	Red Panda	E
14.	Manis crassicaudata Gray	The Indian Pangolin	T
15.	**Elephas maximum** (L.)	**Asian Elephant**	E
16.	**Rhinoceros unicornis** (L.)	The great **one-horned Rhinoceros**	E
17.	**Asinus hemionus** khur (L.)	**Asiatic wild ass**	E
18.	Bos mutus (Przewalski)-	Wild Yak	R
19.	Bubalus bubalis (L.)	Wild Buffalo	E
20.	**Cervus elaphus hanglu** Wagner	**Hangul** or **Kashmir Stag**	E

21.	Antelope cervicarpra (L.)	Black buck	V
22.	Maschus moschiferus L.	Musk Deer	E
23.	**Gazella Dorcas** (L.)	**Chinkara**	V

BIRDS

1.	**Choriotis nigriceps** (Vigors)	**Great Indian Busted**	E
2.	Grus leucogeranus Pallas	Siberian Crane	T
3.	Grus nigricollis Przeyalski	Blacknecked Crane	E

REPTILES

1.	Chelonia mydas (L.)	Green Sea Turtle	T
2.	Gavialis gangeticus (Gmelin)	Gharial	R,T
3.	Crocodylus porosus Schneider	Estuarine Crocodile	T
4.	Crocodylus palustris (Lesson)	Mugger	T
5.	Varanus bengalensis (Daudin)	Common Indian Monitor	E
6.	Varanus griseus Monitor	Indian Desert Monitor	T
7.	Python molurus *(L.)	Indian Rock Python	E
8.	Python reticulatus (Scheider)	Reticulated Python	E

AMPHIBIANS

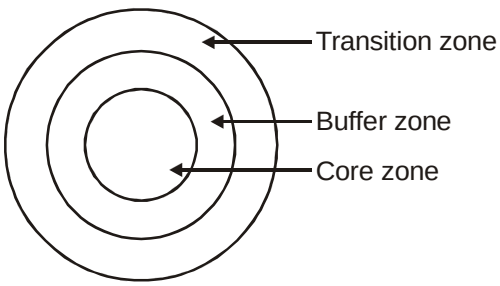
1.	Tylototriton verrucosus Anderson	Himalyan	R

BIOSPHERE RESERVES :

It is a specified protected area in which multiple use of the land is permited.

There are 3 zones of Biosphere Reserve.

1. **Core Zone :** It lies at the centre where no human activity is allowed.
2. **The Buffer zone :** Where limited human activity is allosed.
3. **Manipulating zone or Transition zone :** Where a large number of human activites would go on.



Note : 408 Biosphere reserves are located in **94 countries.** In **India** following **14 sites** have been identified as potential biosphere reserves together with their locations :

	Biosphere Reserve	**State(s)**
1.	Nanda Devi	Uttranchal
2.	Nokrek	Maghalaya
3.	Manas	Assam
4.	Dibru Saikhowa	Assam

5.	Dehang Debang	Arunachal Pradesh
6.	Sunderban	West Bengal
7.	Gulf of Mannar	Tamil Nadu
8.	Nigiri	Kerala, Karnataka and Tamil Nadu
9.	Great Nicobar	Andaman and Nicobar
10.	Simlipal	Orissa
11.	Kanchanjunga	Sikkim
12.	Pachmarhi	Madhya Pradesh
13.	Agasthyamalai	Kerala
14.	Achankamar	Madhya pradesh, Chattisgarh

NATIONAL PARKS AND MAIN SANCTUARIES IN INDIA :

National Parks :

In national parks both plants and animals are protected. There are **90 National Parks** (in 2004) which occupy about **4.7% of the country's total geographical area.**

Sanctuaries -

The are **448 wildlife Sanctuaries** (as on Sept. 2004) which occupy about **3.2% of the country's total geographical area.**

ANDAMAN AND NICOBAR ISLANDS

1. Marine National Park
2. North Button Island National Park (Andaman)
3. Saddle Peak National Park (Andaman)
4. South Button Island National Park (Andaman)
5. Narcondum Sancutrary (Bay of Bengal)
6. North Reef Island Sanctuary (Bay of Bengal)
7. South Sentinel Island Sanctuary (Bay of Bengal)

ANDHRA PRADESH

1. Coringa Sanctuary (East Godavari)
2. Nagarijunasagar Srisailam Sanctuary (Guntur, Kurnool) [Largest tiger reserve]
3. Pakhal Sanctuary (Warangal)
4. Papikonda Sanctuary (East and West Goddavari)

ARUNACHAL PRADESH

1. Namdapha National Park
2. Pakhui Sanctuary

ASSAM

1. **Kaziranga National Park** (Sibsagar and Nowgong)
2. **Manas National Park** (Barpeta)
3. Garampani Sanctuary

JHARKHAND

1. Palamau National Park (Dalton Ganj)

CHANDIGARH

1. Sukhna Sanctuary

DELHI

1. Indira Priyadarshini Sanctuary

GOA

1. Cotigao Sanctuary

GUJARAT

1. **Gir National Park** (Junagarh)
2. Nalsarovar Sanctuary (Ahmedabad)

HARYANA

1. Bhindawas Sanctuary
2. Chotala Sanctuary
3. Sultanpur Sanctuary (Gurgaon)

HIMACHAL PRADESH

1. Great Himalayan National Park
2. Pin Valley National Park
3. Manali Sanctuary (Manali)

JAMMU AND KASHMIR

1. **Dachigam National Park** (Srinagar)
2. Salim Ali National Park
3. Karakoram Sanctuary

KARNATAKA

1. Bandipur National Park (Mysore)
2. Ghataprabha Sanctuary (Belgaun)

KERALA

1. Periyar National Park (Idukki)
2. **Silent Valley National Park** (Palghat)
3. Idikki Sanctuary (Idikki)

MADHYA PRADESH

1. **Bandhavagarh National Park** (Shadol)
2. Fossil National Park
3. **Kanha National Park** (Mandla and Balaghat)
4. **Panna National Park** (Panna)
5. Ghatigao-Great Indian Bustard Sanctuary
6. Singhori Sanctuary

MAHARASHTRA

1. Chandoli Sanctuary
2. Chaprala Sanctuary
3. Great Indian Bustard Sanctuary

4. Nagzira Sanctuary
5. Tansa Sanctuary

MEGHALAYA

1. Balphakram National Park
2. Nokrek National Park

MIZORAM

1. Dampa Sanctuary

NAGALAND

1. Fakim Sanctuary

ORISSA

1. Balukhand Sanctuary

PUNJAB

1. Harike Lake Sanctuary

RAJASTHAN

1. **Desert National Park** (Jaisalmer and Barmer)
2. **Keoladeo Ghana National Park** (Bharatpur)
3. **Ranthambore National Park**
   (Sawai Madhopur)
4. **Sariska National Park** (Alwar)
5. Sariska Sanctuary (Alwar)

SIKKIM

1. **Kanchanjunga National Park** (Gangtok)
2. Van Vihar Sanctuary

TAMIL NADU

1. Guindy National Park (Madras)
2. Marine National Park (Gulf of Mannar)

TRIPURA

1. Trishna Sanctuary

UTTRANCHAL AND U.P.

1. **Corbett National Park** (Nainital) (Uttaranchal)
2. Dudhwa National Park (Lakhimpur Kheri) U.P.
3. **Nanda Devi National Park** (Chamoli) (U.P.)
4. **Valley of Flowers National Park (**Chamoli)
5. National Chambal Sanctuary

WEST BENGAL

1. **Sunderban National Park** (24-Parganas)
2. Jaldapara Sanctuary (Jalpaiguri)
3. Senchal Sanctuary

SOME IMPORTANT NATIONAL PARKS OF INDIA :

Sr. No.	Name and Location	Area in Sq. Km.	Important Animals Found
1	Kaziranga National Park District Sibsagar (Assam)	430	**Rhinoceros,** elephant, wild buffalo, bison, tiger, leopard, sloth, bear, sambhar, swamp deer, barking deer, wild bear, gibbon, python and birds like pelican, stork and ringtailed fishing eagles. This is a famous National Park of famous one-horned rhinocero
2	Sundarbans (Tiger Reserve) 24-Pargana(West Bengal)	2585	**Tiger,** wild boar, deer, gangetic dophin, estuarine crocodile.
3	Hazaribagh National Park Hazaribagh Jharkhand	186	**Tiger,** leopard, hyaena, wild bear, gaur, sambhar, nilgai, chital, sloth, bear, peafowl
4	Corbett National Park District Nainital (Uttaranchal)	525	**Tiger,** elephat, panther, sloth bear, wild bear, nilgai, sambhar, chital, crocodile, python, king cobra, peafowl, partridge. This is the first National Park of India which is famous for tigers.
5	Gir National Park District Jungarh (Gujarat)	1412	**Asiatic lion,** panther, stripped hyaena, sambhar, nilgai, chital, 4-horned antelope, chinkara, wild bear, langur, python, crocodile, green pigeon, partridge. This National park is famous for the Asiatic loins.
6	Kanha National Park Mandla and Balaghat (M.P.)	940	**Tiger, panther, chital, chinkara,** barking deer, blue bull, **four horned deer,** langur, wild bear, black buck, nilgai, wild dog, sloth bear, sambhar, crocodile, grey horn bill, egret, pea-fowl.
7	Tandoba National Park Chandrapur (Maharashtra)	116	**Tiger** sambhar, sloth bear, bison, chital, chinkara, barking deer, blue bull, four horned deer, langur, pea-gowl, crocodile.
8	Bandipur National Park District Mysore (Karnataka)	874	**Elephant, tiger, leopard,** sloth bear, wild dog,chital, panther, barking deer, langur, porcupine, gaur, sambhar, malabar squirrel, green pigoen
9	Desert National Park Jaisalmer (Rajasthan)	3000	**Great Indian Bustard, Black buck,** chinara.

SOME IMPORTANT SANCUTARIES OF INDIA :

	Name of Location	Area in sq.km.	Important Animals
1.	Keoladeo Ghana Bird Sanctuary Bharatpur (Rajasthan) Famous for birds	29	**Siberian crane,** egrets, herons spoon bill etc.
2.	Annamalai Sanctuary Coimbatore (Tamil Nadu)	958	**Tiger, elephant,** gaur, spotted deer, wild dog, south bear, sambhar, panther.

3.	Jaldapara Sanctuary Madarihat (West Bengal)	1155	**Rhino, elephant, tiger,** leopard, deer, sambhar, and different kinds of birds.
4.	Sultanpur Lake Bird Sanctuary Gurgaon (Haryana)	12	**Crane, sarus, spotbill, duck, drake, green pigeon,** wild bear, crocodile, python.
5.	Bir Moti Bagh Wildlife Sanctuary Patiala (Punjab)	8.3	Nilgai, **wild boar, hog deer,** black buck, blue jackal, peafowl, partidge, sparrow, myna, pigeon, dove
6.	Shikari Devi Sanctuary Mandi (Himachal Pradesh)	213	**Black bear, snow leopard, flying fox,** barking deer, musk deer, chakor, partridge
7.	Dachigam Sanctuary Srinagar (Jammu and Kashmir)	89	**Hangul or Kashmir stag, musk deer,** snow leopard, black bear, brown bear
8.	Mudumalai Wildlife Sanctuary Nilgiri (Tamil Nadu)	520	**Elephant, gaur, sambhar, chital, barking deer,** mouse deer, **four horned antelope,** langur, gaint squirrel, flying squirrel, wild dog, wild cat, civet, sloth bear, porcupine, python, rat, snake, monitor lizard, flying lizard.
9.	Nagarjuna Sagar Sanctuary Guntur Kamool and Nalgonda (Andhra Pradesh)	3,568	**Tiger, panther,** wild bear, chital, nilgai, sambar, black buck, fox, jackal, wolf, crocodile.
10.	Periyar Sanctuary (Kerala)	777	**Elephats,** gaur, **leopard,** sloth bear, sambhar, bison, black langur, hornbill, egret. It is famous for elephants
11.	Chilka Lake Brid Sanctuary Balagaon (Orissa) (Largest brackish water lagoon in Asia)	900	An oasis of bir is like **water fowls, ducks, cranes,** Golder plovers, sand pipers, flamingoes
12.	Manas Wildlife Sanctuary Kamrup (Assam)		**Tiger, panther,** rhino, gaur, wild buffalo, sambhar, swamp deer, golden langur, wild dog wild bear.

INFORMATION RELATED TO NATIONAL PARKS AND SANCTUARIES :

India's Famous Tiger Reserve -

(a) Jim Corbett National Park - Nainital (Uttaranchal)
(b) Dudhwa National Park - Lakhimpur Kheri (U.P.)
(c) Kanha National Park - Mandala and Balghat (Madhya Pradesh)
(d) Indrawati National Park - (Chattishgarh)
(e) Simli National Park - (Orissa)

Some Special Animals -

(a) **Asiatic wild ass - (Endangered) -** Found in runn of Kutch and Pakistan
(b) **Red Panda - (Endangered) -** Found in Kanchanjunga (Sikkim)
(c) **Hangul - Kashmir Stag (Endangered) -** Found in Dachigam (Sri-Nagar - Jammu and Kashmir)
(d) **Siberian Crane - (Endangered) -** Found in Keoladeo (Ghana) National Park

(e) **The Great Indian Bustard** is a huge ground bird with a long and long bare legs. It is an inhabitant of the semi-arid areas of Rajasthan, Gujarat and Maharashtra. Hunting for its flesh has reduced its population to over 800. It is a highly endangered bird.

(f) **''Ex-situ conservation''** is the protection of wild life in zoos and botanical gardens. Other e.g., of Ex-situ conservation are gene banks, germ plasm bank, seed bank. **''In situ coservation''** is the protection of species (wild life) in thier natural habitat or National parks.

1. **The world's first National Park (America) -** Yellow stone National Park
2. **India's first National Park -** Jim Corbett National Park - Nainital (Uttaranchal)
3. **Smallest tiger reserve in India -** Ranthambore National Park - Sawaimadhopur (Rajasthan). It is famous for Asiatic wild ass.
4. **Largest Tiger reserve in India -** Nagarjuna Sagar Saisailum Sanctuary - Guntoor - Andhra Pradesh.
5. **Nandan-Kanan zoo is known for -** White tiger.

   Note : Tahr and Sunderbans (W. Benal) is also famous for tigers.
6. **Periyar wild life Sanctuary (kerala) -** Famous for elephant and ohters.
7. **Valley of flower National Park -** It is situated at Chamoli-Garhwal (Uttaranchal)
8. **Flamingoes** are protected in Chilka lake Balagaon (Orissa)
9. **Rachel carson written a book ''Silent Spring'' -** concerned with awareness about "Nature conservation and Enviroment" - 1962.

   Note : In it was mentioned the effect of DDT on birds. The population of Lady bird bettle declined.
10. **The black buck** is one of the most graceful antelopes native of India. The male possesses a pair of spirally twisted horns. Once abundant in several parts of India. Its population had come untill the enforcement of the wild life (Protection) Act.

SOME IMPORTANT INFORMATIONS :

1. (i) **Natinal Forest Policy revised in - 1988.**

(ii) **Biodiversity act of India** was passed by the Parliament in the **year-2002.**

(iii) **Forest Act-1927.**

2. **Wild life protection act 1972 (Revised in 1991) :**

Objectives :

(1) Restriction and Prohibition on hunting of animals.

(2) Protection of specified plants.

(3) Setting up and managing Sanctuaries and National parks.

(4) Empowering zoo authority.

(5) Control of trade and commerce of wildlife.

3. **Chipko Movement** was born in **March-1973** at **Gopeshwar in Chamoli district.** The movement had two leaders - **Sundarlal Bahuguna** of **Silyara** in **Tehri and Chandi Prasad Bhatt of Gopeshwar.**

Appiko Movement - Similar type movement Appiko movement was under taken by **Poundurang hegde** in **south in 1983.**

SPECIAL WILDLIFE PROJECTS IN INDIA :

Project tiger - Running since 1 April 1973 - Central Government.

The Gir Lion Sanctuary Project - Running since 1972-Central Govt. and Gujrat Govt.

Himalayan Musk Deer Project - U.P. Govt. IUCN and Central Govt.

The Manipur Brow - Antlered Deer Project - Running since 1977

Project Hangul - Since 1970 - J. & K. Govt. IUCN, WWF.

Crocodile Bredding Project - Since 1975 UNDP, Central Govt.

Project Elephant - Recently started.

ABOUT WILDLIFE :

Red Data Book : This book contains a record of **animals and plants** which are known be in danger. This Book is maintained by the IUCN (International Union of Conservation of Nature and Natural Resources).

Green Data Book : A book containing a list of rare plants in a protected area like Botanical gardens.

Silent Valley : It is tropical evergreen forest in Kerela (Palghat) declared as National Reserve Forest. It is called silent valley because there is no noise in the forest during night, even that of cicadas, as they are not found there. It is related to conservation of forest.

Butterfly Park : India's first and only butterfly park was established in 1992 near **Gangtok (Sikkim)**

ENVIRONMENTAL POLLUTION, ISSUES AND NATURAL RESOURCES

POLLUTION :

"Any undesirable change in physical, chemical or biological characteristic of air, water and land which is harmful to the man directly or indirectly through the animals, plants industrial unit or raw materials is called **pollution**."

Pollutants : "Any material or product of man or nature which leads to pollution is called pollutants".

Type of Pollutat Usually Pollutants are Divided into Following Categories

1. **Nondegradable pollutants :** Many of such pollutants are usually not degraded or degraded partially in environment. Such as **aluminium pecks, Mercury compounds of phenols, Glass, D.D.T., Benzene, BHC pesticides,** etc.

   They are collected in the environment and cause polluton. These pollutants are harmful even in low concentration and harm increases with their increasing concentration. No treatment is found in the nature for their recycling. There are only two methods by which we can stop the pollution caused by pollutant.

   (i) Such type of substance should be banned by law.

   (ii) Use their alternative substance.

2. **Biodegradable pollutants -** The **domestic sewage papers, woods, garbage, live stock wastes,** etc. are easily **degraded completely by microorganisms,** it becomes useful. But if these materials enter the environment in such large quantities, that they can not be degraded completely then addition of these materials cause pollution in environment.

   1. **Primary pollutants -** These perists in the form in which they are added to the environment.
      eg., DDT, CO etc.
   2. **Secondary pollutants -** These are formed by chemical reaction amongst primary pollutants.
      eg., **Photochemical smog, London smog, PAN, O_3.**

   Synergism - Formation of secondary pollutants is known as synergism. Secondary pollutants are more toxic than primary pollutants.

1. **Quantitative pollutants -** These are the susbtance which occur in nature but become pollutant when their concentration reaches beyond a threshold value in the environment.
   eg., CO_2, Nitrogen oxide.
2. **Qualitative pollutants -** These are the substance which do not occur in the environment but are passed in through human activity.
   eg., Fungicides, Harbicides, DDT etc.

Other type of pollution :

1. **Natural pollution -** Caused by natural sources like, **CH_4 from paddy fields** and **cattle, marsh, forest fire.**
2. **Anthropogenic pollution -** Caused by **human activities.**

   Main sources of pollution :

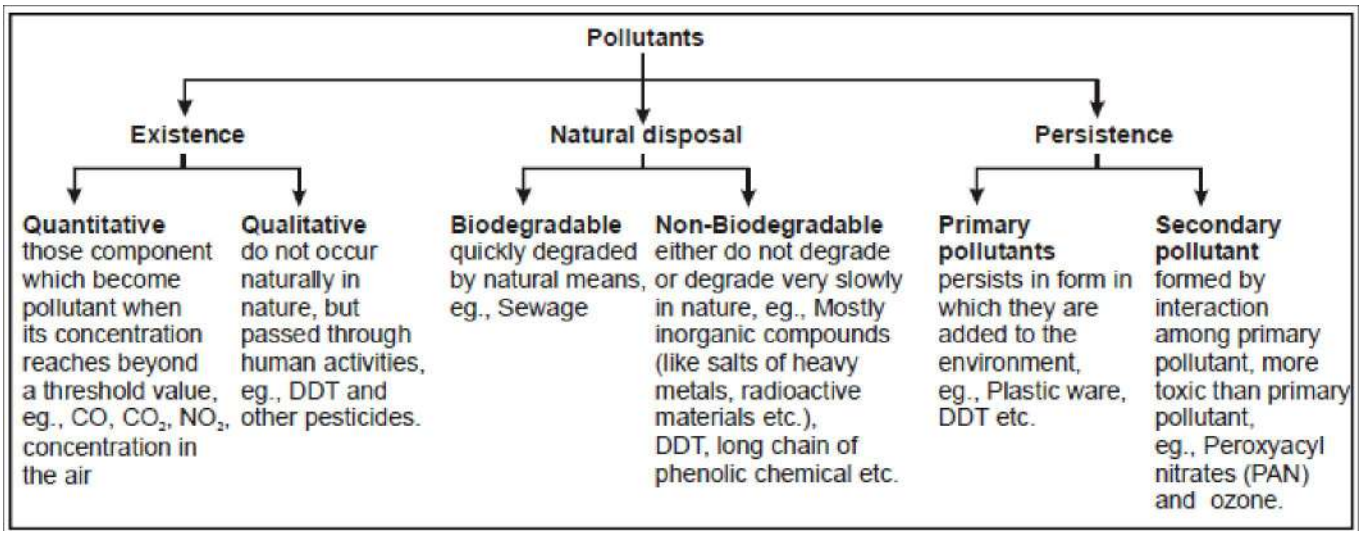
   (i) Point source pollution - Where the effluent discharge occur at a specific site.
   eg., factory outlet and Municipal sewage

   (ii) Line source pollution - It is passed along a narrow belt, Roads,
   eg., Rods, Railway tracks.

(iii) Diffuse source pollution - It is over a large area.

eg., sprayed fertilizer or pesticides through run off.

(iv) Area source pollution - Industrial estate and mining area.



AIR POLLUTION :

(A) The air pollution is caused due to addition of unwanted substances or gases. The atmospheric pollution is mainly caused by the activities of man and concentrated to the inhabited and the industrial complexes in cities.

(B) There are two main categories of air pollutants :

(i) Gases **(ii) Particulates**

(i) Gases

The gaseous materials include various gases and vapours of volatile substances or the compound with a boiling point below 200ºC.

Particulate matter :

(a) Particulate matter consist of solid particles or liquid droplets (aerosols) small enough to remain suspended in air. eg., soot, smoke, dust, asbestos, fibres, pesticides, some metals (including Hg, Pb, Cu and Fe) and also biological agent like tiny dust mites and flower pollen.

(b) Atmospheric particles having diameter > 10 μm, generally settle out in less than a day, whereas particles with diameters 1 μm or less can remain suspended in air for weeks.

(c) Suspended particulate matter in the lower atmosphere (troposphere) causes and aggravates human respiratory illness, like asthama, chronic bronchitis etc.

(d) According to **Central Pollution Control Board (CPCB) particulate size 2.5 micrometers** or less diameter (PM 2.5) are responsible for causing harm to human health as inhaled deep into lungs can cause breathing and respiratory symptoms, irritation, inflammations, damage to lungs & premature death.

MAJOR AIR POLLUTANTS AND THEIR EFFECTS

1. Carbon monoxide (CO) -

Source - It is the main air pollutant released from smoke of automobiles.

Effect - Carbon monoxide is highly toxic gas, it **combines with haemoglobin** of the blood and blocks the **transportation of oxygen.** Thus, it **impairs repsiration** and it causes **death due to asphyxia** when inhaled in large amount.

2. **Unburn Hydrocarbons - (3,4 Benzopyrine, CH_4, Benzene)**

Source - These are mainly released from **automobiles** and **burning of fossil fuel (coal, petrol, diesel). Methane** (CH_4) is the most abundent hydrocarbon in atmosphere and its main source is marshy area and paddy field.

Effect - Hydrocarbons cause **lungs cancer.**

Polynuclear hydrocarbon is major hydrocarbon pollutant which cause cancer.

3. **Ethylene -**

Source - It main sources are **automobiles, chimneys.**

Effect - Falling of leaves without particular reason, falling of **flowering bud before** time.

4. **Nitrogen oxide (NO, NO_2) -**

Source - Burning (combustion) of fossil fuel in automobiles.

Effect - These nitrogen oxide form **photochemical smog** in atmosphere and release ozone. Nitrogen oxide also responsible for **acid rain.** Entry of these nitrogen oxide causes respiratory trouble such as **emphysema, bronchitis, swelling of lungs** and **lungs cancer** etc.

5. **Sulphur oxide (SO_2, SO_3)**

Source - These are most harmful gaseous pollutants, main source of sulphur oxides are **coal burning, smelters, oil refineries.**

Effect - Lichen and mosses do not grow in SO_2 polluted areas, Lichen and mosses are indicator of SO_2 pollution. Oxides of sulphur produce **acid rain** and **smog** in atmosphere.

6. **Smoke - (SO_2, SO_3, NO_2, NO, CO, CO_2)**

SECONDARY POLLUTANTS :

A. Smog (Smoke + Fog) -

This word was given by **Desvoeux**. Smog/Smoke is measured by **Ringlmann method.**

(a) Los Angles Smog or Photochemical smog -

It was first observed in Los Angeles. In this process **smoke, fog, nitrogenoxide, hydrocarbons, oxygen, UV light** and **high temperature** are **essential**. These components react with each other and form reddish brown smog (PAN + O_3 + Nitrogen oxides) or brown haze/brown air. Los angeles smog i**s light induced smog.**

Effect -

(i) Due to smog elastic susbtances (rubber/tyres) also affected. Smog causes damage in rubbers. During smog **peroxyacetyl nitrate (PAN)** is formed. PAN stops or **inhibits the photolysis of water** in hill reaction of photosynthesis and inhibit the photosystem-II. PAN also **inhibit the chlorophyll formation in plants.**

(ii) In animals PAN cause **irritation in eyes** and **harms the lungs.**

(iii) Ozone causes harm to mucous membrane.

(b) London smog or sulphur smog -

It was first observed in London. In this process **coal, smoke, fog, sulphure oxide** and **low temperature** are involved**.** These components react with each other and form vapour (Fog) of H_2SO_4 which is known as London smog.

Effect -

Due to inhalation of H_2SO_4 vapour with fog **4000 people died in London in 1952.**

B. Acid rain-

This word was given by **Robert August.** NO_2 and SO_2 released from different sources in form of smoke and dissolved in atmospheric water vapour to form sulphuric acid and nitric acid (H_2SO_4 + HNO_3). These acids come down on earth with rain water, this is called acid rain.

Wet deposition :- If acid comes down on earth with **rain, fog** and **smog,** it is known as wet deposition.

Dry deposition :- If acid settled on earth surface through **solid dust particles** with **nitrate** or **sulphate**, this is called dry deposition.

Note :

(i) **The pH of acid rain is lesser than 5.6**

(ii) In acid rain the ratio of H_2SO_4 and HNO_3 is **7 : 3** (70% H_2SO_4 + 30% HNO_3)

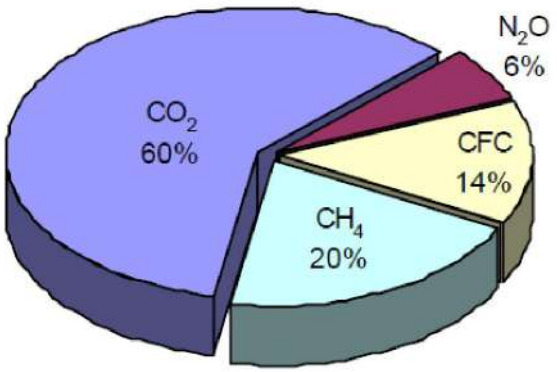
Effect -

(i) Due to acid rain acidity of soil and water increases.

(i) Acid rain also cause **damage historical monuments. eg., Taj Mahal, Red fort.**

GREEN HOUSE EFFECT

Usually carbon dioxide is not considered as pollutant, but its higher concentration forms a thick layer above the earth's surface, checks the radiation of the heat from the earth surface. Because of this, temperature of the earth's surface increases, this is called **"Greeen House Effect" or Global warming.**



The relative contribution of different green house gases

Main green house gases are **CO_2, CH_4, CFC, N_2O.** These are **radiation active gases,** Because they absorb long wave infra red radiations. SO_2, NO_2, O_3 **not** contribute in green house effect. Water vapour are also released from industries and agriculture which are responsible to increase the green house effect.

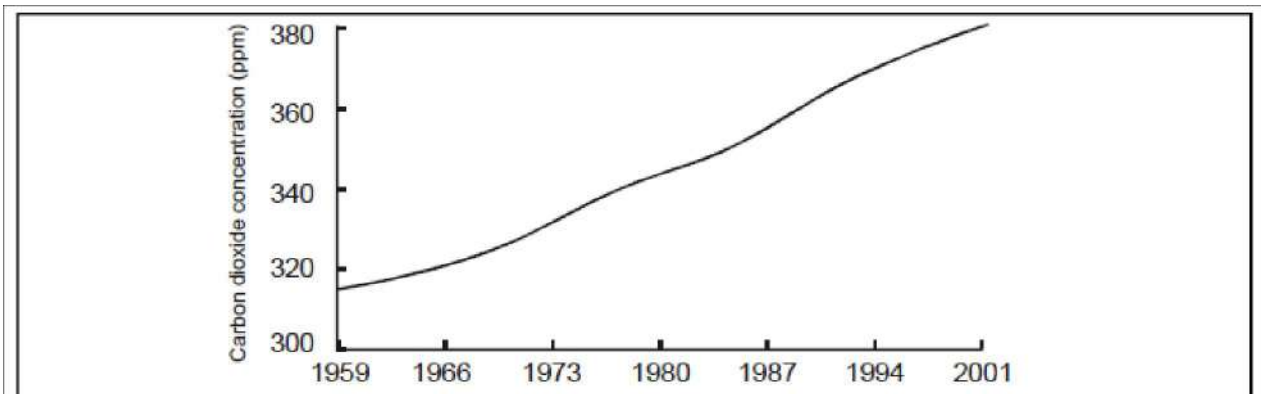


Diagram IV : Showing the increase in mean carbon dioxide concentration in the atmosphere from 1959 to 2001 based on a data from Maunaloa observatory, USA

☛ In this phenomenon cover of CO_2 layer around the earth, allow the short wavelength (U.V. rays) incoming solar radiation to come in but does not allow the long wavelength (IR) of out going heat radiation from warm surface of earth and surface keep to earth warm. The **consequent increase in the global mean temperature** is reffered to as a **global warming.**

Effects of Green House Gases :

1. It has been observed that in the recent past, the level of CO_2 in the atmosphere has increased from **280 ppm to 368 ppm in 1956 to 2002.** If present growth rate is continued then the amount of CO_2 will be doubled upto 2020 century. Even 2-3ºC rise in temperature will be lead to **melting of glaciers** and **ice caps of polar region** and consequently the **floods in rivers, rise in sea** level and **changes in cycle of rain.** Islands may be submerged in sea water. **CO_2 conc. in 2009-2010 is 385ppm.**
2. **Carbondioxide fertilisation effect -** Due to increased CO_2 concentration the rate of photosynthesis will increase (up to a few year). The response of the plants to elevated concentration of CO_2 is known as the CO_2 fertilization effect, if would be **shown by C_3 plant,** if rest of environment factors are optimum. The **stomatal conductance decrease (due to partial closure of stomata).** Thus **transpiration may be reduced** and **water use effeciency will increase.** It allows many species to grow successfully in regions of water scarcity.

   Under high CO_2 conc. **higher rate of photosynthesis** provide high amount of food to roots. This **greater root production** enhence mycorrhizal development and **N_2 fixation in root nodules** and enables the plant to grow in nutrient poor soil.

   But all these effects are possible only when the rest of environmental factors are optimum.
3. The **global mean temperature** has increased by **0.6ºC in 20th century.** Depletion of ozone layer in stratosphere.
4. **Sea level has been raised by 1 to 2 mm per year during 20th century.**

Control of Global Warming :

1. Reducing the green house gases emission by limiting uses of fossil fuel and developing alternative renewable sources of enenrgy (wind and solar energy).
2. Increasing the vegetative cover mainly forests for photosynthetic utilization of CO_2.
3. Minimizing the use of Nitrogen fertilizers in agriculture for reducing N_2O emission.
4. Developing substitute for CFC's.

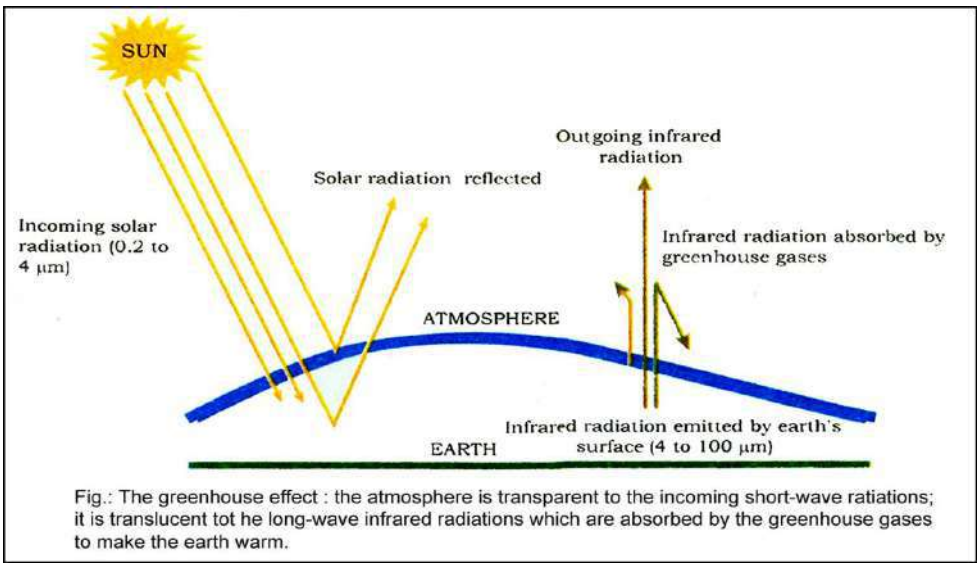


Fig.: The greenhouse effect : the atmosphere is transparent to the incoming short-wave ratiations; it is translucent tot he long-wave infrared radiations which are absorbed by the greenhouse gases to make the earth warm.

1. **Control of particulate matter -** Two devices are use to remove particulate air pollutants.
   (a) Arresters **(b) Scrubbers**

(a) ARRESTERS :

These are used to separate particulate matters from **contaminated air.**

Arresters are of different types :

(i) Cyclonic separators and Trajectory separators : These are commonly used to separate out particulate matters from **industrial emissions with minimum moisture content.** These separators work on the principle of **dust separation by centrifugal force.**

(ii) Electrostatic Precipitator : It is the **most efficient device** to remove fine particulate pollutants. Electrostatic precipitation device work on the principle of **electrical charging of the dust particles** and collecting it on a differently charged platform.

It can remove 99% of particulate matter present in exhaust form a **Thermal Power Plant.** It has **electrode wire (act as anode)** which maintained at several thausend volts, which **produce carona** and release **electrons.**

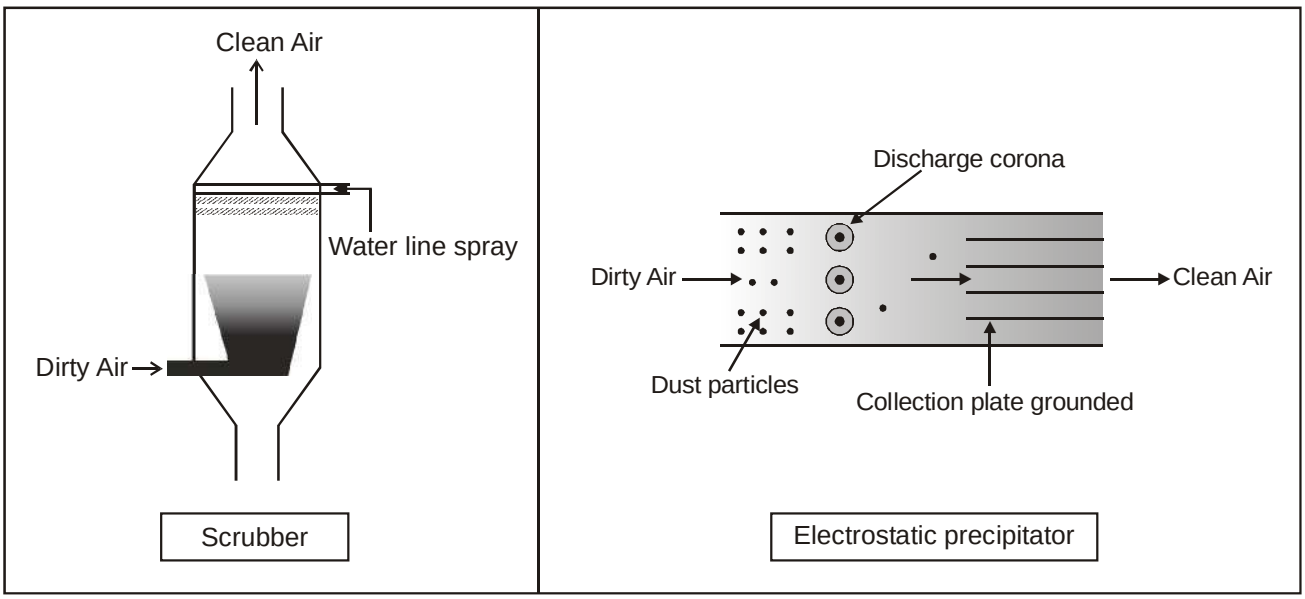
(a) These electrons attached to dust particles providing them negative charge. The base have **collecting plate (acts as cathod)** and attracts the charged dust particles.

(b) The low velocity air is provided between the plates which allow the dust to fall.

(b) SCRUBBERS:

(i) These are used to clean air for both dust and gases. Wet and dry two types of scrubbers are used for dust separation.

(ii) They can **remove gases like sulpher**. In scrubber the exhaust is passed through a sprey of water or lime.



2. **Control of gaseous pollutants : Combustion**, **absorption** and **adsorption technique** are used to control gaseous pollutants.

(a) Combustion - In combustion process, **oxidisable gaseous pollutants are completely burnt** at a high temperature. Petrochemical, fetilizer, paints and varnish industries used combustion control of gaseous pollutants.

(b) Absorption - In this technique, gaseous pollutants are absorbed in suitable **absorbent materials**.

(c) Adsorption - This technique is applied to control toxic gases, vapours and inflammable compounds that could not be efficiently removed or transferred by a fore said technique. Such air pollutants are adsorbed on large solid surface.

(d) Catalytic converters : Automobiles are a mojor cause for atmospheric pollution in the metro cities. Proper maintenance of automobiles along with use of lead free petrol or diesel can reduce the pollutants they emit. **Catalytic converters** having expensive metals **platinum, palladium** and **rhodium** as the catalysts, are fitted into automobiles for **reducing emission of poisonous gases.** As the exhaust passes they catalytic converter, **unburnt hydrocarbons are converted into CO_2** and **water**, **CO and nitric oxide are changed into CO_2 and nitrogen gas repectively.** Motor vehicles equipped with catalytic converter should **use unleaded petrol because lead in the petrol inactivates the catalyst.**

Some other Method -

1. Engines should not be kept started when vehicle is in rest condition.
2. **Barium compound mixed with petrol** reduce the smoke.
3. It is also very essential to check the quality of gases released from the factories.
4. Industries should not be established at one place.
5. The smoke should be released into the atmosphere after filtration and purification (by cyclone collector or electrostatic precipitators)
6. To seperate particles larger than 50 μm, gravity settling tanks or porous filters are being used.

Controlling Vechicular Air Pollution : (A case study of Delhi)

1. With its very large population of vehicular traffic, Delhi leads the country in its level of air-pollution- it has more cars than the state of Gujrat and West Bengal put together.
2. In the 1990s, Delhi ranked fourth among the 41 most polluted cities of the world. Air pollution problems in Delhi becomes so serious that a Public Interest Litigation (PIL) was filed in the Supreme Court of India. After being censured very strongly by the Supereme Court, under its directives, the government was asked to take, within a specified time period, appropriate measures, including switching over the entire fleet of public transport, i.e., buses, from diesel to **compressed natural gas (CNG).** All the buses of Delhi were converted to run on CNG by the end of 2002.
3. Why CNG is better than diesel. The answer is that **CNG burns most efficiently,** unlike petrol and diesel, in the automobiles and very little of it is left unburnt. Moreover **CNG is cheaper than petrol or diesel, cannot be siphoned off by thieves and adulterated like petrol or diesel.**
4. The main problem with sweitching over to CNG is the difficulty of laying down pipelines to deliver CNG through distribution point / pumps and ensuring uninterrupted supply.
5. Simultaneously parallel steps taken in Delhi for reducing vehicular pollution include **phasing out of old vehicles, use of unleaded petrol, use of low-sulphur petrol and diesel, use of catalytic converters in vehicles,** application of stringent pollution-level norms for vehicles, etc.
6. The Government of India through a new auto fuel policy has laid out a roadmap to cut down vehicular pollution in Indian cities. More stringent norms for fuels means **steadily reducing the sulphur and aromatic content in petrol and diesel fuels. Euro-II norm,** for example stipulate that **sulphur be controlled at 350 parts-per million (ppm) in diesel** and **150 ppm in petrol.**
7. Aromatic hydrocarbon are to be contained at 42% of the concerned fuel. The goal, accroding to the roadmap, is to **reduce sulphur to 50 ppm in petrol and diesel** and bring down the level of 35%. Corresponding to the fuel, vehicle engines will also need to be upgraded.
8. The **Bharat Stage-II (equivalent to Euro-II norms),** which currently in place in Delhi, Mumbai, Kolkata, Chennai, Banglore, Hyderaba, Ahmedabad, Pune, Surat, Kanpur and Agra, **will be applicable to all automobiles throughout the country from 1 April 2005.**
9. All automobiles and fuel-petrol and diesel- were to have met the **Euro-III emission specification** in **these 11 cities from 1 April 2005** and have to meet the **Euro-IV norms by 1 April 2010.** The rest of the country will have **Euro-III emission norm compliant automobiles and fuels by 2010.**

OZONE DEPLETION

1. Ozone is present in less quantity in atmosphere. But at height of **16 km to 25 km** on earth, concentration **of ozone is maximum in stratosphere.**
2. Naturally there is bad ozone and good ozone. 'Bad' ozone, formed in the lower atmosphere (troposphere) that harms plants and animals. There is 'Good' ozone also; this ozone is found in the upper part of the atmosphere called the **stratosphere,** and it acts as a shield absorbing ultraviolet radiation from the sun.
3. UV rays are highly injurious to living organisms since **DNA and proteins** of living organisms preferentially **absorb UV rays,** and its **high energy, breaks the chemical bonds within these molecules.** The thickness of the ozone in a column of air from the ground to the top of the atmosphere is measured in terms of **Dobson unit (DU).**
3. Ozone gas is continuously formed by the action of UV rays on molecular oxygen in the stratosphere. There should be a balance between production and degradation of ozone in the stratosphere. Of late, the balance has been disrupted due to enhancement of ozone degradation by **chlorofluorocarbons (CFC's), CH_4, N_2O.**
4. CFCs find wide use as refrigerants. CFCs. discharged in the lower part of atmosphere move upward and reach stratosphere. In stratosphere, UV rays act on them releasing Cl atoms. Cl degrades ozone releasing molecular oxygen, with these atoms acting merely as catalysts; Cl atoms are not consumed in the reaction.

(i) In this process **one chlorine atom** convert one each O_3 molecules into O_2 by photodissociation.

(ii) The life time of **CF_2Cl_2 (CFC-12)** is **139 year** while that for **$CFCl_3$ (CFC = 11)** is about **77 years**.

Chemical process of ozone depletion - chain reaction

$$CF_2Cl_2(g) + hv \longrightarrow Cl^{\cdot}(g) + {}^{\cdot}CF_2Cl(g)$$

$$Cl(g) + O_3(g) \longrightarrow ClO^{\cdot}(g) + O_2(g)$$

$$ClO^{\cdot}(g) + O(g) \longrightarrow Cl^{\cdot}(g) + O_2(g)$$

↑

Active chlorine

5. Hence, whatever CFCs are added to the stratosphere, they have permanent and continuing affects on Ozone levels. Although ozone depletion is occuring widely in the stratosphere, the depletion is particularly marked over the **Antarctic region**. This has resulted in formation of a large area of thinned ozone layer, commonly called as the **ozone hole**.
6. For making these discoveries related to ozone depletion or O_3 destructruction. **Sherwood Rowland, Mario Molina, Paul Curizen honoured with Nobel Prize for chemistry in 1995.**
7. U.V. radiation of wavelengths shorter than UV-B, are almost completely absorbed by Earth's atmosphere, given that the ozone layer is intact. But, **UV-B damages DNA and mutation** may occur. It causes **aging of skin, damage to skin cells** and **various types of skin cancers (Melanoma). In human eye, cornea absorbs UV-B radiation,** and a high dose of **UV-B causes inflammation of cornea,** called **snow blindness, cataract**, etc. Such exposure may **permanently damage the cornea.**
8. Recognising the deleterious affects of ozone depletion, and international treaty, known as the **Montreal Protocol,** was signed at **Montreal (Canada) in 1987 (effective in 1989) to control the emission of ozone depleting substances.**
9. Subsequently many more efforts have been made and protocols have laid down definite roadmaps, separately for developed and developing countries, for reducing the emission of CFC's and other ozone depleting chemicals.
10. At normal temperature and pressure thickness of ozone layere is **3 mm.** (But at poles thickness of ozone layer is **4 mm).**

11. **Ozone hole was first discovered in 1985 over Antarctica** by **Nimbus-7** satalite. It is also confirmed at **Arctic in 1990.**
12. The aerosols like C.F.C (Chloro flouro carbon) release into the atmosphere from the **refrigerators**, **air conditioners** and **jet planes** deplete or **reduce the ozone layer.** This is called ozone depletion and these substance are called **O.D.S. (ozone depleting substance).** This thin layer ozone is also known as ozone holes. (The decline in ozone thickness in spring time (Feb-April) is called ozone hole.)

$$O_3 \xrightarrow[\text{C.F.C.}]{\text{U.V.}} O_2 + O$$

13. Number of pollutants like **CFCs (14% of total depletion)**, Nitrogen oxide [3.5%], CH_4 and halogens (chlorine) cause depletion of ozone layer. **Maximum ODP** (ozone depleting potential) is of **CFCs due to release of chlorine.**

Some other Informations :

1. Thickness of ozone layer is measured by **Dobson unit** (1 DU = 1ppb)

Year	**Thickness of ozone layer**
1979	225 DU.
1985	136 DU.
1994	94 DU.

2. Ozone hole occurs mainly during (July - October) and lowest during spring time (Feb. - Apr). Means concentration of O_3 is highest in stratosphere in Feb.-April (spring season) and lowest during July-October (Full season).

SOUND POLLUTION / NOISE POLLUTION

1. Air (Preventation and Control of pollution) Act. 1981 amended in 1987 to include **noise as Air pollution. Noise is undesired high level of sound.**
2. Increase in the noise in the atmosphere is called noise pollution or sound pollution. Noise is a loud and unwanted or unpleasant sound. The common things which are responsible for noise pollution are- industries and mills, means of transportation, television, stereo, loud speakers and jet plane etc.

   Intensity : The intensity of sound is measured in **bel or decibel** [1 bel = 10 decibel]. A man can hear at **0-decibel.** Normally at 25 decibel, the atmosphere may be peaceful. **Above 80 decibel intensity** of sound is called **noise pollution.**

   Effect : It causes **drousyness, irritation, weakness** and **130-140 decibel causes heart palpilation and pain.** Noice pollution **reduces the capacity of hearing** and result in **headache. Sudden excitation in skin, constriction of gastric muscles starts above the 90 decibel.** It also produces excitation in habit of man and anger. Noise pollution causes **ulcers, heart disease, high blood pressure, higher secretion of adrenal hormones** etc. Excluding these, high intensity of sound can also **break down the walls of the houses.**

   Control : Noise pollution can be control by the use of such type of apparatus which can decrease the intesity of sound at place or origin. Sound **absorbents** must be used to minimise the sound. Growing of more plants can also minimise the noise pollution, by **Muffling.**
3. Strict following of laws like delinitation of horn free zones around Hospitals, Schools, permissible sound level of crackers and loud speakers, timing after which loud speakers not played etc.

	Day time	**Night time**
Industrial	75 dB	70 dB
Commercial	65 dB	55 dB
Residential	55 dB	45 dB
Silence zone	50 dB	40 dB

Very Quiet	20-30 dB	Sound quiet place is - 20 dB, Motion Picture Studio, Broadcasting studio
Silence/Quiet	30/35 - 50 dB	Hospitals (30 - 35), Schools (45 - 50), Libraries (45 - 50), Offices (40 - 50)
Normal Voice	55 dB	
Conversational speech	60 dB	
Moderately Loud	70 dB - 90 dB	Factories (60 - 65 dB) Average traffic - 70 dB Heavy city traffic - 90 dB
Uncomfortable	above 100 dB	Air craft (120 dB)
Painful	above 130 dB	Rocket (180 dB) Jet plane (150 dB)

WATER POLLUTION

The water pollution is caused by the addition of organic and inorganic chemicals as well as the biological materials which change the physical and chemical properties of water. This harmful process is called **water pollution**.

The water pollution is caused by many sources such as **sewage matter, industrial wastage, agriculture wastage, domestic wastage, hot water of thermal plant and nuclear reactors etc.**

(i) Water having **D.O. (Dessolved Oxygen)** content below **8.0 mgL^{-1}** may be cosidered as **contaminated** and below **4.0 mgL^{-1} heavily polluted.**

(ii) D.O. is measured by **oximeter.**

1. Biochemical Oxygen Demand (B.O.D.) :

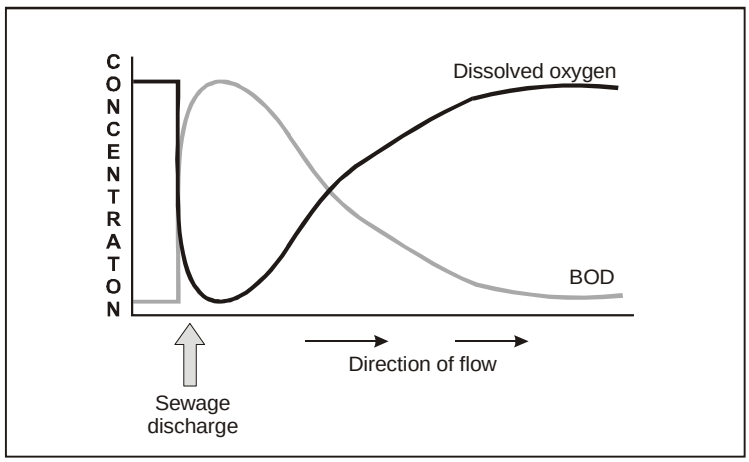
(i) The water pollution by organic wastes is measured in term of Biochemical oxygen demand. It is the amount of dissolved oxygen **(D.O. = Dissolved Oxygen)** needed by bacteria in decomposing the organic wastes present in water.

B.O.D. increased = water polluted B.O.D. $\propto$ input of organic wastes

(ii) If **B.O.D. is increased dissolved oxygen is decreased in water.** Higher amount of organic waste increase the rates of decomposition in water. O_2 is rapidly consumed by microbes, thereby causing drop in D.O. content in water.

(iii) **Dophnia** is the indicator of **B.O.D.**

(iv) Biochemical oxygen demand [BOD] is the amount of **oxygen taken up by the micro organisms present in water.** BOD is measured by keeping a sample of water containing known amount of oxygen for **5-days at 20ºC in the dark.** At end of this period the oxygen content is again measured. A high BOD indicates intense level of microbial pollution.



2. **Chemical Oxygen Demand (C.O.D.) :**

   It is the **oxygen requirement by chemicals for oxidation of total organic matter** (biodegradable + non biodegradable) in water.

   Note : C.O.D. value is always higher than B.O.D. value.

3. **Biological magnification :**

   (i) The non biodegradable heavy metals (Density > 5g/cm^3) pollutant like **Al, Hg, Fe, D.D.T., Pesticides, Phenolic compound ABS** (Alkyl benzene sulphonate) are not decomposed by micro-organisms.

   (ii) **They get accumulated in tissue in increasing concentration along the food chain at successive trophic levels is called biological magnification. The highest concentration occur's in top consumer.**

   (iii) It occurs as the toxic substances accumulated by organisms cannot be metabolised or excreted and pass on to next higher trophic level. The most common biomagnification is of Hg and DDT. The DDT concentration is starts from 0.003 ppb in water, it can ultimatly reach 25 ppm in fish eating birds through biomagnification.

   (iv) High concentration of **DDT** distrub **calcium metabolism** in birds, which causes **thinning of egg shell** and their **permature breaking,** eventually causing **decline in bird populations.**

4. **Eutrophication :**

   (i) The **process of nutrient enrichment of water and consequent loss of species diversity** (or death of aquatic animals) is reffered to as **eutrophication** and lake is known as **eutrophic lake**. In this process **presence of nutrients (Nitrogen and Phosphorous)** in lake stimulates **growth of algae (algal bloom)** increase organic loading and bring about reduction in the oxygen content of water causing death of aquatic animals.

   (ii) **Eutrophication is the natural aging of a lake by** biological enrichment of its water. Natural aging of a lake span thousands of years and lake finally converted into land due to deposition of silt. Pollutants from **man's activities like effluents from the industries and homes can radically accelerate the aging process,** this phenomenon is called **accelerated eutrophication.**

   (iii) In past century many lakes are eutrophicated by sewage and agricultural and industrial waste. The prime contaminations are **nitrate** and **phosphate**. Which acts as plant nutrients, which over stimulate the growth of algae causing unsightly scum & unpleasent order and depletes oxygen dissolved in water which harm aquatic life. The other pollutants flowing in lake may poison whole population of fishes, whose deposition also depletes dissolved oxygen and ultimately leads to death of lake.

   (iv) **B.O.D. of Eutrophic lake is very high.**

Water Pollution can be caused by the following man made sources

1. **Household Detergents :** The house hold detergents include the compounds of **phosphate, nitrate, ammonium** and **alkyl-benzene sulphonate** (ABS) etc. harmful substances which are gathered in water. **Alkyl benzene sulphonate** is non degradable, so its concentration increase which is harmful for aquatic life.

   Inorganic phosphorus and Nitrogen : The growth of algae is very fast due to presence of higher concentration of these susbtance. After the death of algae their carbonic material decomposed and deprived of oxygen, which causes death of aquatic organisms. The presence of large amount of organic material leads to eutrophication because of this, amount of oxygen in water decreases. Some of the algae also secrete toxic materials. The drinking of such polluted (toxic) water causes death of the cattles.

   For the control of this pollution, **lime ferric chloride**, etc. are used to precipitate the phosphate. **Zirconium** considered best for this purpose.

2. **Industial waste :** The wastes of industries are discharged into the running water of rivers and canals Industrial waste mainly contains inert **suspended particles such as dust, coal, toxins like acid, base phenol cyanides, mercury, zinc etc. inorganic reduced** material like-**ferrous salts sulphide, oil** and other residues of organic material and hot water. The water polluted by mercury, lead etc. metals when used which caused disorganisation of nervous system. It means it produces insanity. **The minamata disease was caused in Japan by eating of polluted fishes from the water polluted by mercury.** So, many humans died because of this disease.

   For the control of the industrial wastes and **toxic components should be purified before draining** into rivers lakes and ponds or sea. So the water pollutions by industrial effluents can be controlled by suitably treating the pollutants.

3. **Sewage :** Sewage contains highest amount of **carbonic materials** and **biological material,** as pollutants. These carbonic materials increase the number of decomposers like bacteria and fungus. The rate of reoxygenation is reduced as compared to deoxygenation in a water reserviors. The acceleration of microbial activity increases BOD of water. This indicates the essential amount of oxygen required for decomposition by bacteria.

Method of water purification :

Water (prevention and control of pollution) Act. 1974 passed by Government of India.

The industrial and municipal waste water are treated in "Effluent Treatment Plant" (ETP) Generally following treatments are given in ETP.

1. **Primary treatment :** This physical process involves the separation of large debris (particles), followed by sedimentation in tanks.
2. **Secondary treatment :** This is a biological process and is carried out **by microorganism.** In this process, the waste water is pumped in shallow stablisation or oxidation ponds or activated sludge chamber, where the microbes oxidise its organic matter. The process results in release CO_2 and this CO_2 is used by algae in photosynthesis. In photosynthesis process algae release O_2.
3. **Tertiary treatment :** This physiochemical process removes **turbidity** in waste water caused by the presence of nutrients (**Nitrogen**, **Phosphorus** etc.), **dissolved organic matter**, **metals, pathogens.**

(i) This step involves chemical **oxidation of waste** water by **strong oxidising agents**, such as **chlorine gas**, **perchlorate salts**, **ozone gas** and **UV radiations.**

(ii) After tertiary treatment, the wast-water can be discharged into natural water sources or used for irrigation.

Daphnia, trout fishes and larva of stone fly are sensitive to water pollution and show the intensity of water pollution.

A Case Study of Intergrated Waste Water Treatment :

(i) Waste water including sewage can be treated in an integrated manner, by utilising a mix of artificial and natural processes. An example of such an initiative is the **town of Arcata,** situated along the **northern coast of California.**

(ii) Calloborating with biologists from the **Humboldt State University,** the towns people created an **integrated waste water treatement process** within a natural system.

(iii) The cleaning occurs in two stages - (a) The **conventional sedimentation, filtering** and **chlorine treatements** are given. After this stage, lost of dangerous pollutants like dissolved heavy metals still remains. To combat this, an innovative approach was taken and (b) the biologists developed a series of **six connected marshes over 60 hectares of marshland.**

(iv) Appropriate plants, algae, fungai and bacteria were seeded into this area, which neutralise, absorb and assimilate the pollutants. Hence, as the water flows through the marshes, it gets purified naturally.

(v) The marshes also constitute a santuary, with a high level of biodiversity in the form of fishes, animals and birds that now reside there. A citizens group called **Friends of the Arcata Marsh (FOAM)** are responsible for the upkeep and safeguarding of this wonderful project.

(vi) All this time, we have assumed that removal of wastes requires water, i.e, the reaction of sewage. But what if water is not necessary to dispose off human waste, like excreta? Can you imagine the amount of water that one can save if one didn't have to flush the toilet? Well. This is already a reality. Ecological sanitation is a sustainable system for handling human excreta, using dry composting toilets.

(vii) This is a practical, hygienic, efficient and cost-effective solution to human waste disposal. The key point to note here is that with this compositing method, human excreta can be reycled into a resource (as natural fertiliser), which reduces the need for chemical fertilisers. There are working **'EcoSan'** toilets in many areas of **Kerala** and **Sri Lanka.**

RADIOACTIVE POLLUTIONS

The property of **sudden emmission of the different particles (charged) and radiation (rays) by the decay of atomic nuclei is called radioactivity** and the **elements** are called as **radiactive elements.** The radioactivity of the atmosphere is increased by Atomic power stations and Atomic tests. Radioactivity contributes to the **pollution of air, water** as well as soil and it proves extremely harmful to the organisms.

The various sources of radioactive materials as follows

(i) **Natural sources :** Cosmic rays, radiation from the earth such as Radium-224, Uranium-235, Uranium-238, Thorium-232, Radon-222, Potassium-40 and Carbon-14.

(ii) **Man made Radiation :** The radiations are released in the atmosphere during mining and purification of Thorium and Plutonium, and in producing nuclear weapons etc.

(iii) Nuclear reactor and nuclear fuel causes pollution by radioactive radiation. The nuclear fuel and coolants are the sources of radioactive radiation. Radioactive waste is also most important radio active pollutants because these wastes are not dumped at particular or right place.

(iv) **Other sources :** Some of the radioactive elements (isotops) are used in experimental laboratories for scientific researches which causes radio active pollution. X-rays are also proved to have harmful effects. In month of April 2010, 6 peoples at Delhi affected by such radioactive pollution by **coablt-60.**

Harmful radiation are divided into two categories

(a) Non ionising components : Non ionising components such as UV radiation. UV radiations are harmful for living beings. These radiations causes harm to the DNA, RNA and protein. Higher concentration of U.V. radiation can causes **xeroderma pigmentosum** disease. **UV radiations causes destruction of hydrogen bonds in DNA.**

(b) Ionising components : X-rays, α-particles, β-particles etc are ionising components. Ionising radiations are high energy radiations which release electrons from atoms and form a pair of negative and positive ions.

Ionising radiations cause **physical weakness** and **sudden death of living beings.** The effects like **hereditary changes, mutations**, **tumours**, **cancer** and developmental changes are seen due to radiations.

- Excluding these, **Iodine-131, Stronstium-90** are spreading in the environment through nuclear explosion and their effects remains for long duration. **Iodine-131** reaches in the human body through the food chain and causes harm to the **bone marrow, WBC, Lymph nodes** and **spleen**. Similarly, the lead to **skin cancer, sterility** and **poorer eye sight**. **Stronstium-90** leads to **bone cancer** and **degeneration of tissues.**

Control Measures : The competition of nuclear weapons should be completely banned to prevent radioactive pollution. An atomic bomb was first used in Hiroshima and then in Nagasaki in 1945 during

the second world war and due to that genetic disorders are present even today therefore, such type of atomic blast should be avoided. Leakage of nuclear reactions has been totally plugged. Transportation, use and disposal of the radioactive fuels and wastes has to be handled carefully.

SOIL POLLUTION

(A) Soil is also polluted through water and air. These pollutants are mixed into the soil through the rain water.

(B) Such as H_2SO_4 acid formed by mixing of SO_2 with rainy water in the air. The **fertilizers**, **pecticides** and **weedicides** are being sprayed over the crops. All these are mixed with soil to produce harmful effects. The **growth of plants is inhibitated or reduced** due to this type of pollution and sometime their death also take place.s Excluding these, soil pollution also caused by the disposal of house hold **detergent sewage, flowering oils, radio active substances and hot water etc.** The main pollutants of soil are **D.D.T.** and **weedicides [2, 4D** (2, 4 dichlorophenoxy acetic acid), **2, 4, 5-T** (2, 4, 5-Trichlorophenoxy acid.)**]**.

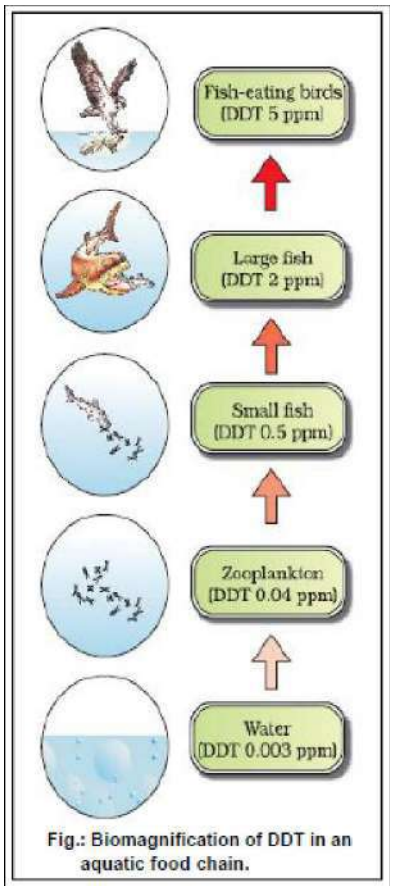


Fig.: Biomagnification of DDT in an aquatic food chain.

Case Study of Organic Farming

(a) Integrated organic farming is a cyclical, zero-waste procedure, where waste products from one process are cycled in as nutrients for other processes. This allows the maximum utilisation of resource and increases the efficiency of production.

(b) **Ramesh Chandra Dagar,** a farmer in **Sonipat, Haryana,** is doing just this. He includes **bee-keeping, dairy management, water harvesting, composting** and **agriculture** in a chain of processes, which support each other and allow an extremely economical and sustainable venture.

(c) There is no need to use chemical fertilisers for crops, as cattle excreta (dung) are used as manure. Crop waste is used to create compost, which can be used as a natural fertiliser or can be used to generate natural gas for satisfying the energy needs of the farm.

(d) Enthusiastic abut spreading infromtation and help on the practice of integrated organic farming. Dagar has created the **Haryana Kisan Welfare Club,** with a current memebership of **5000 farmers.**

(C) **Plant indicators :** "Such type of plants which give additional information about the environment or habitat are called plant indicators". eg., Growing of **Viola plants** indicates the presence of **Zinc in soil.**

(D) **Ocimum** shows presence of **copper in soil. Silene** (a plant) indicate presence of **cobalt**. The presence of **Lichens** shows that atmosphere is free from the pollutants like **CO** and **SO_2.**

SOLID WASTES

(A) Solid wastes means everything that goes out in trash. Muncipal solid wastes are waste from homes, offices, stores, schools, hospitals etc. which are collected and disposed by municipality. It comprise mainly paper, food waste, plastics, glass, metals, rubbers, leather, textiles etc.

(B) Generally, these wastes are burned. Sanitary landfills are adopted as the substitute for openbring dumps in which wastes are dumped in depression or trench and covered with dirt.

(C) But also cause harm as it cause danger of seepage of chemicals and cause pollution of underground water.

(D) Whole solid waste can be categorised as :

(1) Biodegradable (2) Recyclable (3) Non-biodegradable

(E) Plastic is non-biodegradable, so it use should be minimize by minimum use of plastic bag or use of ecofriendly packaging material.

(F) Electronic waste or e-waste are the irreparable computers, mobiles, electronic goods. E-waste are buried in landfills or incinerates.

(G) Over half of e-waste of developed world are exported to developing countries mainly China, India, Pakistan where metals like copper, iron, silicon, nickle and gold are recovered during recycling process.

(H) In these countries the peoples participate in recycling of e-waste are exposed to toxic substance present in e-waste.

(I) The ecofriendly recycling is only treatment of e-waste.

Case Study of Remedy for Plastic Waste :

(A) A plastic sack manufacturr in **Bangalore** has managed to find the ideal solution to the ever-increasing problem of accumulating plastic waste. **Ahmed Khan**, aged 57 years old, has been producing plastic sacks for 20 years. About 8 years ago, he realised that plastic waste was a real problem. **Polyblend**, a **fine powder of reycyled modified plastic,** was developed then by his company.

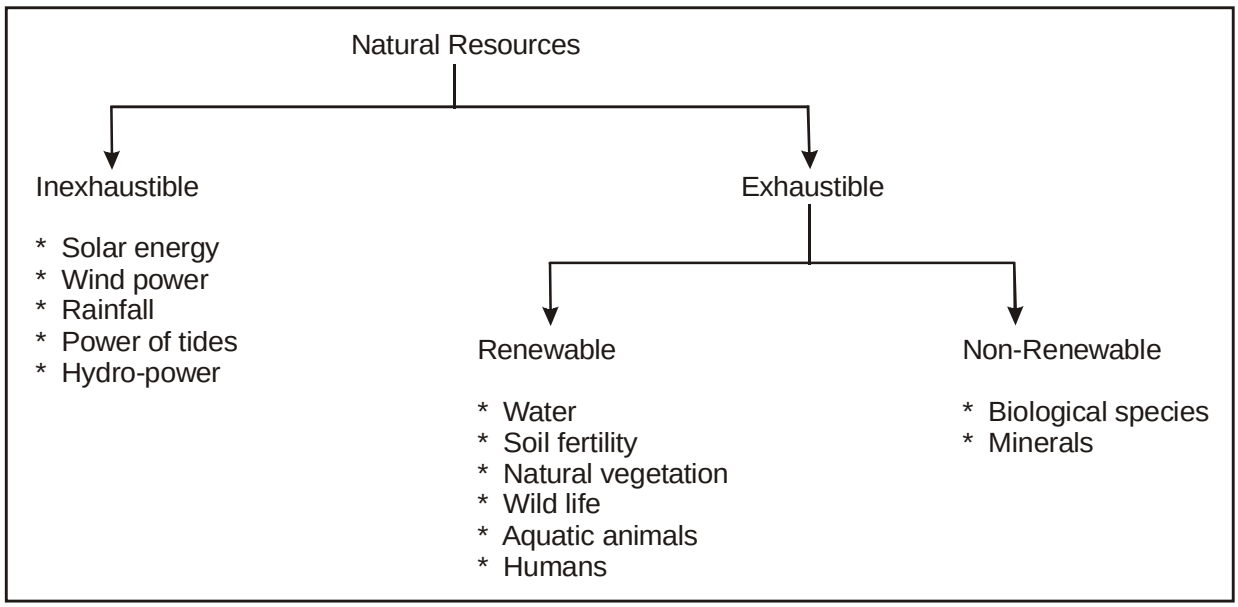
(B) This mixture is mixed with **betumen** that is used to lay roads. In collaboration with **R.V. Collage of Engineering and the Banglore City Corporateion**, Ahmed Khan proved that blends of **Polybend** and **betumen**, when used to lay roads, enhanced the bitumen's water repellant properties, and helped to increase road life by a factor of three.

(C) The raw material for creating Polyblend is any plastic film waste. So, against the price of Rs. 0.40 per kg that rag pickers had been getting for plastic waste, Khan now offers Rs. 6.

(D) Using Khan's technique, by the year 2002, more than 40 kms of road in Bangalore has already been laid. At this rate, Khan will soon be running short of plastic waste in Banglore, to produce Polyblend.

(E) Thanks to innovations like Polyblend, we might still avoid being smothered by plastic waste.

NATURAL RESOURCES AND THEIR CONSERVATION



The materials or any component, that can be utilised by man and are necessary for welfare of life, which is available in the natural environment in Atmosphere, Hydrosphere, Lithosphere is called natural resources.

e.g. O_2, Land, Soil water, Forest, Animals, Soil, microorganism.

Classification of natural resources :

1. **Inexhaustible resources :** Available in unlimited quantities, and the earth quantity may reamin unchanged by human impact.

   e.g. Solar Energy, Wind Power, Tidal power, Air, Geothermal Energy.

   Its quality can be affected due to continuous increase in human population. **e.g.** Air pollution

2. **Exhaustible resources :** These are likely to be finished by human use or unsustainable uses. **It is further divided in two groups**

   (i) Renewable resources : Those which are being continuously consumed by man but renewed continuously by nature, always available if managed in a proper way, otherwise they may even get totally exhausted.

   e.g. Biotic resources, forest, grazing animals, Rangeland, wild life, Agriculture crop system and fresh water yield, soil etc.

   (ii) Non renewable resources : They are not renewable after use and are not replaced by nature, can not be regained.

   e.g. Fossil fuel (Coal, Petroleum), Natural Gas, Nuclear energy, Biotic species, Minerals etc.

   Nuclear energy is non renewable and unlimited resources.

HYDROSPHERE OR WATER RESOURCES

1. Water is the major constituent of the hydrosphere and covers 3/4 of the earth's surface.
2. The total volume of water in the hydrosphere is 1.4 bilion cubic kilometer [Km^3], about **97.5 %** is the **ocean water**, unsuitable for human use. Only **2.5 %** is available as **fresh water.** About **1.97 %** is stored in **ice ocean** (Polar ice) and **glaciers** and **0.5 % is ground water** and **soil mositure (0.01 %).** The rest a [about **0.36 percent**] is distriuted in **lakes swamps, river** and **streams**.
3. About **84 %** of the total **global evaporation** occurs from **ocean surface** and **16 %** from land surface.
4. Kelps and a few marine animals are used as human food. Various chemicals are extracted as iodine and industrial gums from seaweeds. Agar-agar is produced from the **red algae-Gracilaria and Gelidium.** Alginin is derived from **Sargassum** and **Turbinaria species.**

LAND REOURCES

1. Earth's one-fourth area is formed by land.
2. About 4/5 of the land area is covered by soil.
3. At the beginning of 20th century, about 30 % of land in India was covered with forest but the end of the 20th century, the **forest cover reduced to 19.4 %.** Out of 19.4 %, only **12 % area covered by dense forest.**
   (i) Per capita forest area available in India is = **0.06 hec.**
   (ii) Per capita forest area avialble in world is = **0.64 hec.**
   (iii) In India **33 % forest area is recommended by national forest policy (1988).**

MINERAL RESOURCES :

Table - Some Important Mineral and some of their uses

1. **Metallic**

Minerals	**Uses**
Uranium	Nuclear bombs, electricity, tinting glass
Thorium	Nuclear bombs, electricity, gas mantles
Iron	Steel
Manganese	Alloy steels, disinfectants
Cobalt Alloy,	catalysts, radiography, therapeutics
Columbium	Stainless steel, nuclear reactors
Chromium	Metallurgy, refractory, chemicals
Molybdenum	Alloys steels
Nickel	Alloys
Tungsten	Alloy and chemicals
Vanadium	Alloys
Copper	Electrical products, alloys

Lead	Batteries, gasoline, paints, alloys
Tin	Tin plate, solder, chemicals
Zinc	Galanising, solder, die-materials, electrical wiring, utensils
Aluminium	Aircraft, rockts, building materials, electrical wiring, utensils
Magnesium	Structural refractories
Titanium	Pigments, aircraft, alloys
Zirocnium	Refractories, ceramics, metals, chemicals
Beryllium	Copper alloys, refractories, atomic energy field
Gold	Monetary purposes, jewellery,
Radium	Medical and industrial uses, radiography

2. Non-metallic Minerals

Minerals	Uses
Asbestos	Insulation, textiles, roofings, glass, ceramic, gasoline, solid propellants
Corundum	Abrasives
Feldspar	Ceramic flux, artificial teeth
Fluorspar	Flux, acid, refringerants, propellants
Phosphates	Fertilisers, chemicals
Salt	Chemicals, glass, metallurgy
Sulphur	Fertilisers, acid iron and steel industries

SOIL CONSERVATION

Soil is the mixture of living and nonliving materials. Soil is only responsible for anchorage and sustainance of the plants. The fertility of soil is reduced due to growing of plants again and again. Natural factors like water, air etc. are also responsible for transporting the top soil and decrease fertility. This is called soil erosion.

Soil Erosion

The structure of soil is different at the different depths of land. Its some upper part is called top soil. This region is very essential for the growth of the plants. Its thickness is about 15-20 cm. This **top soil** contains **humus** and **various micro-organisms** which increase the fertlity of the soil. When this **top soil** r**emoved by fast wind, fast rain, cyclone and running water** then it is called **soil erosion.** The following reasons are responsible to minimise the fertility power of soil in nature.

1. Shortage of mineral substance.
2. Leaching : The dissolved minerals go into the depth (lower layers) with water. Roots of the plants ususally remain in top soil so the minerals are not available to the plants.
3. Erosion is divided into the following types on the basis of erosing factors.

(A) Wind Erosion :- This type of erosion is carried by fast air, wind, cyclon etc. It is very harmful in dry places.

It is of three types

(a) Suspension : The air blows away the fine particles of soil in the form of dust in the atmosphere.

(b) Saltation : The medium size and medium weight particles of soil colliding with each other during the transfer through the air.

(c) Surface Creep : The heavy particles of soil screeping on the surface of the earth by the force of air.

(B) Water Erosion : The top soil transfer to the another place due to the fast water currents and heavy rains.

It is of three types

(a) Rill erosion : The net of groove are formed in the surface due to continuous irregular flow of water.

(b) Sheet erosion : A similar upper layer is removed on the surface through the water.

(c) Gully erosion : If the rill erosion takes place for long time then the groove are wider and deeper and are called gullies.

(C) Land Slides : Such type of erosion is found in such places where heavy rain takes place. Becuase of heavy rain, water flows in gullies which becomes more deeper and water is absorbed in higher amount. So that big pieces of land break off and slide. This type of erosion occurs in hilly areas.

(D) Stream bank or Riparian Erosion : The fast flow of water collides with the bank of river during the flood. So that soil is removed from the banks and by which the direction of flow of river may be changed.

(E) Overgrazing and Deforestation : Over grazing also removes the top soil and decrease the fertility of the soil. The formation of **desert in Rajasthan** has the main reason as **over grazing.** Simultaneously deforestation in the catchment areas in the hilly regions causes floods on the plain areas which destroys the useful part of the soil. Excluding all reasons, water fall erosion and soil pollution etc also reduce the fertility of soil.

Soil conservation

Some management measures are essential to check the soil erosion. Accordiing to this some principle are as follows :-

(i) To protect the soil form the drops of rainy water.

(ii) To stop the accumulation of water as well as stop the flow of water on the slopes.

(iii) To prevent the transportaion of soil particles.

(iv) To slow down the wind velocity on the surface of the earth.

Method of soil conservation :

Generally, two methods are used for soil conservation :-

(A) Biological Method : In which soil erosion is checked by the use of plants.

(B) Mechanical Method : These methods are also useful as biological methods in which soil erosion is prevented by dams, water reservoir etc.

(A) Biological Method : The following techniques are used in biological methods :

(i) Reforestation or Afforestation : Afforestation is the main measure to control the soil erosion, floods. Forest are very useful in dry places and deserts to prevent wind erosion. Plants are growing as wind breaker or wind barriers agains the direction wind currents. This **method is sucessful in Rajasthan** to prevent the spreading of desert in east direction. The plants used as wind breaks are as follows :-

Lawsonia alba (Mehandi), Oak, Calotropis gigantata, Agave americana,
Ber = Zizypus jujuba,
Kattha = *Acacia catechu*, Shisham = *Dalbergia sisso* and Mango = *Mangifera indica* etc.

(ii) Dry farming : This farming has been carried in low rain fall regions. Only few crops are grown in these places. Excluding this, grass land have also been developed for grazing of animals.

(iii) Contour farming : The ridges and furrows are formed in the field during the sowing of seed crops. Rain water accumulates in furrows which is absorbed by soil. The flow of water is minimised due to presence of ridges. Therefore soil erosion is checked.

(iv) Mulching : Stubble are left during the harvesting of crops in this method. These stubbles from a protective layer. The stalks of Maize, Bajara, Potatoes, Tobbaco are spreading in the field in the form of a layer, by which evaporation decrease and water holding capacity of soil increases. This method is **useful in both-wind erosion and water erosion.**

(v) Crop rotation : The repeated growing of the same crops in each year like Wheat and Maize, removes some of the specific (N_2) elements in the soil, so that this reduces its fertility. Changing of crops in each season is to maintain the fertility of soil. The **leguminous crop plants** increase content of nitrogen compounds, which improve the fertility of soil.

(vi) Strip cropping : The crops are grown in lines. These lines may be situated at 90º angle to the direction of wind or it may be parallel. The leaves of one type of plants stop the blowing of soil particles, such plants are known as erosion **checking plants.** The other line is having small plants which are unable to check the erosion are called **erosion permitting plants.** In this, alternation of two different type of leaves takes place.

(vii) Ley Farming : The grasses grow along with the crops in various season alternatively.

(viii) Growing of grass on land : The binding of soil particles is the main and special feature of grasses. So that the grasses becomes the permanent vegetation in grassland areas which minimise the erosion through the rains.

(B) Mechanical Methods : The following techniques are coming under the mechanical methodsd.

(i) Dam Building : THe dams are built to stop the fast flowing water which is used later on according to the needs.

(ii) To control the over grazing of animals.

(iii) Basin Listing : Small catchment area of water are formed for the collection of water during the rain.

(iv) Contour Terracing : The canals are formed along the terraces on the slopes of hills. This reduce the speed of higher amount of water and changes the direction of water.

(v) Gully Control : The bonds dams and canals formed to control the high speed of water and to prevent the soil erosion.

FOREST CONSERVATION

It is conducted by two methods

1. **Protection or conservation foresty :** By making national park and Biosphere Reserve.
2. **Production or commerical forestry : It is two types**

(a) Social forestry : To grow trees and shrubs on unused farmland, raod sides, rail sides, community land etc.

(b) Agro Forestry : woody species are grown in combination with herbaceous crops either at the same time or in time sequence.

Taungya system : Growing agricultural crops between rows of planted trees.

Shifting Cultivation or Jhum Cultivation : It is a major cause of deforestation. Many tribal communities practise slab and burn agriculture in tropical and subtropical regions of Asia. Africa and Oceania. This consists cutting down trees and setting them or fire and raising crops on the resulting ash called "Juming" in north estern India.

WET LANDS :

Low lying area's covered with shallow water are called wet land's. The wet lands are transitions, zones between terrestrial and aquatic area's. **6% of the world** land surface is occupied by wet lands.

(i) **Marshes :** Wetlands where grass - like plants dominate.

(ii) **Swamps :** Wetlands where trees or shrubs dominate.

(iii) **Reverine forest :** Periodically Flooded forest found in lowland along streams.

(iv) **Mangrove is saltly water swamp**

Siginificance of Wet lands :

(i) Wetland are higly productive, provide food and habitat.

(ii) Wetlands helps to control flooding by holding excess water.

(iii) Ground water recharging area.

(iv) Help to clean and purify water run-off.

(v) Provides sites for fishing, boating, nature study.

Weltands conservation measures :

(i) Preparation of wetland inventories.

(ii) Checking waste disposal in wetland.

(iii) Reduction of excessive inflow of nutrients and silt into wetlands.

Grassland management measures :

(i) Protection from grazing.

(ii) Use of rotational grazing.

(iii) Removal of woody bushes or shrubs and weeds.

(iv) Conservation of soild and water of grasslands.

(v) Use of controlled burning to promote recycling of nutrients.

Some Other Information related to Grass land -

(a) India has 16 recognised forest types, which represent a rich diversity.

(b) In **India,** the Grass cover area including fallow and waste land is **18% of total land** area.

(c) 37% of land are avaialable for grazing including forest.

(d) **Grassland** is also called **rangeland**.

(e) The conversion of grassland or forest to desert is called **desertification**.

(f) The average annual production of dry grass or hay in India is about 250 million tonnes.

Conservation and management of water :

Main approcaches for conservation of water are :

(i) Reducing agricultural water wastage by increasing efficiency of irrigation.

(ii) Reducing water wastage in industry by recycling the used water.

(iii) Reducing domestic water wastage by cnstructing waste water treatment.

(iv) Rainwater harvesting by employing practices to store rainwater and recharge ground water.

(v) Afforestation and protection of water sheds to improve water economy. Approaches to provide a sustainable supply of high quality water are :

(a) Construction of dams and reservoirs to ensure year-round supply of water, in addition, controlling flood and generating electricity.

(b) Desalinisation of sea water and saline ground water and making it fit for drinking and other purposes.

Forest Cover in India (1999 Estimate)		
Class	**Area (sq. km.)**	**% Geographic area**
Dense forest[1]	377358	11.5
Open forest[2]	255064	7.8
Mangrove[3]	4871	0.1
Sub-total	637293	19.4
Scrub[3]	5896	1.6
Non-forest (other land use)	2598074	69.0
Total	**3287263**	**100**
[1]Canopy cover >40 percent of land		
[2]Canopy cover 10-40 percent of land		
[3]Canopy cover <10 percent of land		

DEGRADATION BY IMPROPER RESOURCE UTILISATION AND MAINTENANCE

- The degradation of natural resources can occur, not just by the action of pollutants but also by improper resource utilisation practices.

(i) Soil erosion and desertification : The development of the fertile top-soil takes centuries. But, it can be removed very easiy due to human activities like over-cultivation, unrestricted grazing, deforestation and poor irrigation practices, resulting in arid patches of land. When large, barren patches extend and meet over time, a desert is created. Internationally, it particularly due to increased urbanisation.

(ii) Water logging and soil salinty : Irrigation without proper drainage of water leads to waterlogging in the soil. Besides affecting the crops, waterlogging draws salt to the surface of the soil. The salt then is deposited as a thin crust on the land surface or starts collecting at the roots of the plants. This increased salt content is inimical to the growth of crops and is extremely damaging to agriculture. Waterlogging and soil salinity are some of the problems that have come in the wake of the Green Revolution. This leads to **'sem'** problem in many canal irrigated areas of India.

Deforestation :

(A) Deforestation is the converstion of forested areas to non-forested ones. According to an estimate, almost 40% forests have been lost in the tropics, compared to only 1% in the temperate region. The present scenario of deforestation is particularly **grim in Inida.**

(B) At the beginning of the twentieth century, **forests covered about 30% of the land** of India. By the end of the century, it shrunk to 19.4%, whereas the National Forest Policy (1988) of India has recommended 33% forest cover for the plants and **67% for the hills.**

(C) How does deforestation occur? A number of human activities contribute to it. One of the major reasons is the conversion of forest to agricultural land so as to feed the growing human population. Trees are axes of timber, firewood, cattle ranching and for several other purposes.

(D) Slash and burn agriculture, commonly called as **Jhum cultivation** in the north-eastern state of India, has also contributed to deforestation. In slash and burn agriculture, the farmers cut down the trees of the forest and burn the plant remains.

(E) The ash is used as a fertiliser and the land is then used for farming or cattle grazing. After cultivation, the area is left for several years so as to allow its recovery. The farmers then move on to other areas and repeat this process. In earlier days. when **Jhum cultivation** was in prevalence, enough time-gap was given such that the land recovered from the effect of cultivation. With increasing population, and repeated cultivation, this recovery phase is done away with, resulting in deforestation.

(F) What are the consequences of deforestation? One of the major effects is enhanced carbon dioxide concentration in the atmosphere because trees that could hold a lot of carbon in their biomass are lost with deforestation. Deforestation also causes loss of biodiversity due to habitat destruction, disturbs hydrologic cycle, causes soil erosion, and may lead to desertification in extreme cases.

(G) Reforestation is the process of restoring a forest that once existed but was removed at some point of time in the past. Reforestation may occur naturally in a deforested area. However, we can speed it up by planting trees with due consideration to biodiversity that earlier existed in that area.

Case study of People's Participation in Conservation of Forest

(A) People's participation has a long history in India. In **1731,** the **king of Jodhpur in Rajasthan** asked one of his ministers to arrange wood for constructing a new place. The minister and workers went to a forest near a village, Khajadli inhabited by **Bishnois**, to cut down trees.

(B) The Bishnoi community is known for its peasful co-existance with nature. The effort to cut down trees by the kings was thwarted by the Bishnois.

(C) A Bishnoi women **Amrita Devi** showd examplary courage by hugging a tree and daring king's men to cut her first before cutting the tree. The tree mattered much more to her than her own life.

(D) Sadly, the king's men did not heared to her pleas, and cut down the tree along with **Amrita Devi**. Her three daughter and hundreds (total 363 peoples of other Bishnois followed her, and thus lost their lives saving trees.

(E) Nowhere in history do we find a commitment of this magnitude when human beings sacrificed their lives for the cause of the environment. The Government of Rajasthan has recently instituted the **Amrita Devi Bishnoi Wildlife Protection Award** for individuals or communities from rural areas that have shown extraordinary courage and dedication in protecting wildlife.

(F) Government of India in situated Indra **Gandhi Priydarshni; Vraksh Mitra Award** for forest conservation.

(G) You may have heard of the **Chipko Movement** of Garhwal Himalayas. In 1974, local women showed enormous bravery in protecting trees from the axe of contractors by hugging them. People all over the world have acclaimed the **Chipko movement**.

(H) Realising the siginificane of participation by local comunities, the **Government of India** in **1980s** has introduced the concept of **Joint Forest Management (JFM)** so as to work closely with the **local communities for protecting and managing forests.** In return for their services to the forest, the communities get benefit of various forest products (e.g., fruits, gum, rubber, medicine etc.) and thus the forest can be conserved in a sustainable manner.

SPECIAL POINTS

WILDLIFE ORGANISATIONS

I.U.C.N.	=	The Intenational Union for Conservation of Nature and Natural Resources. (Switzerland)
W.W.F.	=	The World Wildlife Fund.
I.B.W.L.	=	India Board for Wildlife.
B.N.H.S.	=	The Bombay Natural History Society.
W.P.S.I.	=	The Wildlife Preservation Society of India.
C.P.C.B.	=	Central Polution Control Board.
I.B.P.	=	International Biology Programme.
M.A.B.	=	Man and Biosphere Programme.
U.N.E.P.	=	United Nation Environment Programme.
N.M.N.H.	=	National Museum of Natural History.
U.N.D.P.	=	United Nations Development Programme.
B.R.P.	=	Biosphere Reserve Programme.
Z.S.I.	=	Zoological Survey of India.
B.S.I.	=	Botanical Survey of India.
C.A.Z.R.I.	=	Central Arid Zone Research Institute, Jodhpur.
C.I.T.E.S.	=	Convention and International Trade in Endangered Species of Wild Fauna and Flora.(1976)
F.R.I.	=	Forest Research Institute, Deharadun.
W.I.I.	=	Wild Life Institute of India, Deharadun.
U.N.E.S.C.O.	=	United Nations Educational Scientific and Cultural Organization.

28th February	-	Science Day
21st March	-	World Forest Day
22nd April	-	Earth Day
5th June	-	World Environment Day
7th July	-	Van Mahotsav Day
11th July	-	World Polulation Day
16th September	-	World Ozone Day
3rd October	-	World Animal Day
4th October	-	World Habitat Day
1st Week of October	-	Wild life week
2nd December	-	National Pollution prevention day or National environment day
3rd Decemebr	-	World Conservation Day
22th May	-	World Biodiversity Day

(A) **MIC Methyl Isocyanate]** was released in Bhopal gas tragedy on **3rd December 1984**. Which is used in the production of "Savin" insecticide in Union Carbide.

(i) Tetraethyl lead and tetramethyl lead are formed by combustion of petroleum. They are known to hamper haemoglobin formation.

(ii) The disease produced by use of lead polluted water is called as **plumbism.**

(iii) Lead caused nervousness anaemia in human beings. It also damages kidney.

(iv) Lead concentration in blood is considered alarming if it is 10 μg/500 ml.

(B) Common dust disease is known as **Pneumoconiosis.**

(i) Disease due to cotton dust in testile workers is - **Lung fibrosis or Byssinosis.**

(ii) Disease due to coal dust - **Anthracosis.**

(iii) Disease due to asbestos dust - **Asbestosis.**

(iv) In stone grinders disease due to silica dust - **Sillicosis.**

(v) In iron mill disease due to iron dust - **Siderosis.**

(vi) **Cadmium** causes anaemia, hypertension, damage to liver and kidneys. In Japan it caused bone softning or skeleton deformitcis called **Itai-Itai disease or Ouch-Ouch.**

(C) **Stone leprosy** is caused due to acid rain because due to acid rain outer surface of metals, marbels and stone destroyed.

(D) **Blue Baby disease :** This disease is caused by the high amount of **nitrate in water.** It is also known as **Methaemoglobinaemia** or **cyanosis.**

(E) **Hypertension and Uremia :** Caused by **Copper.**

(F) **Arsenic :** It causes **black-foot disease** and **poisoning in fodder plants** which are eaten by live stock and causes their death.

(G) **Fluorides :** The higher concentration of flouorides causes **chlorosis** or **necrosis** in tips and margin of leaf (leaf lamina). The compounds of fluorine reach in the animals through the fodder and causes abnormal calcification of teeth, this is called **Fluorosis.**

Note : The experts hold that the maximum level of fluoride which the human body can tolerate is **1.5 parts per million (ppm).** When ingested in excess over a long period of time causes "Fluorosis".

(H) **EL Nino effect :** It is the process in which water of Pacific ocean get warm, in this process warm water currect flow to equator & peru in between 5 to 8 year at christmas time. **Effect of EL Nino is flood,** drought and masnsoon damage in India.

(I) Cesium (Cs) accumulates in muscles and causes muscular pain.

(J) Strontium-90 is radioactive element which causes **Leukamia and bone cancer.**

(K) Iodine isotope-131[I^{131}] causes damage of RBC, bone marrow, Lymphnodes and Skin cancer.

(L) Tobacco and smoke contain seven poly cyclic hydrocarbon and Radio active Polonium-210, which is carcinogen and causes Lung cancer.

(M) Aldehydes produce irritation in the gastrointestinal and respiratory tract.

(N) Phenols caused damage to spleen, Kidney, liver and lungs.

(O) D.D.T. caused Cerebral haemorrhage and malfunctioning of sexual maturtity.

(P) Largest source of air pollution **(80%) caused by automobiles** in the cities i.e., **CO(77.2%). Nitrogen oxide (7.7%), Hydrocarbons (13.7%), SO_2, NH_3, Aldehyde and Lead** [in the form of $Pb(C_2H_5)_4$ and $Pb[(CH_3)_4$ as antiknocking agent]. Lead is an air pollutant. Automobiles also reduce atmosphereic O_2 which is utilised in oxidation.

(Q) Particulate pollutants [soot] are Carcinogenic [Cancer causing].

(R) The particulate matter released to the atmosphere by mechanical operations include a number of trace metals contained in the **flyash.** Some of harmful trace metals are Antimony, Arsenic, Beryllium, Cadmium, Germanium, Lead, Mercury, Nickel, Selenium, Vanadium and Yttrium.

ENVIRONMENT LAW FOR CONTROLLING POLLUTION

1. **The National Environment (Protection) Act (NEPA) 1986 :** This act clearly brings the protection of water and soil quality, and the control environmental pollutants.
2. **The insecticide Act, 1968 :** This act deals with the regulation of import, manufacture, sale, transport, distribution and use of insecticides with a view of preventing risk to human health and other organisms.
3. **The water (Prevention and control of pollution) Act. 1974 :** This act deals with the preservation of water quality and the control of water pollution with a concern for the detrimental effects of water pollutants on human health.
4. **The air (Prevention and Control of Pollution) Act. 1981 :** This act deals with the preservation of air quality and the control of air pollution with a concern for the detrimental effects of air pollutants on human health and also on the biological world.
5. In 1987, important amendments to the air Act.1981 were made and noise was recognised as an air pollutants.

(S) Conference on human environment in 1972 held at Stockholm.

(T) In 1987, 27 industrialised contries signed the **Montreal** protocol to protect **stratospheric ozone.** Till date more than 175 contries have signed the montreal protocol.

(U) UNCED (United Nations Conference on Enivronment and Development) **Earth Summit helt at Rio-de-Jenerio (Brazil) in 1992 for reducing green house gases** and **biodiversity conservation** and make **Agenda-21.**

(V) **Kyoto protocol** conference held in **Kyoto** (Japan) for **climate change** (1997). This protocol requires countries to take appropriate measures to **reduce** their overall **green house gas emisson** to a level at 5 percent below the 1990 level by the commitment period **2008-2012.**

(W) **Earth Summit** or **world summit** on sustainable development **(2002)** was held in Johanncsburg (S.Africa).

(X) International Biological Programme (IBP) 1967-74.

(Y) The united Nations, conference on desertification was held in Nairobi (Kenya) in 1977 under the United Nations Environment Programme (UNEP)

Type of Lakes -

(i) Eutrophic lake - They are shallow water lakes which contain **high amount of organic materials** and nutrients. They have little O_2 because decomposers rapidly use it up. Chironomous larva are commonly present in it.

eg., Dal lake of Kashmir

(ii) Oligotrophic lakes - These are deep lakes which have **less amount of organic materials and nutrient.**

(iii) Dystrophic lake - Maximum amount of **undecomposed organic matter** is present.

eg., Marshy lake.

(A) Third pollution or land scape pollution : To make Fertile-land barren by dumping wastes.

eg., ash, insustrial waste.

(B) Incineration : Solid wastes burning in presence of oxygen.

(C) Pyrolysis : Solid wastes burning (combution) in the absence of oxygen.

(D) Flu gas : Gas which release of from chimnies.

(E) Plume : Smoke which release from chimnies.

(F) Hydro thermal vents : These are hot water springs in the deep ocean having high concentration of H_2S, ocean water oxidizes H_2S producing energy which is used by bacteria, Filter-Feeders (clams) eat the bacteria so that this food chain based on chemical energy.

(G) Phytotrons : A such type of house where plants are grown in controlled environment.

(H) Hydrocarbon : Are also known as volatile organic carbons (VOC).

(I) Snow blindness : In human eye cornea absorbs U.V.-B radiation, and a high dose of U.V.-B radiations causes inflammation of cornea, called snow-blindness cataract.

(J) Electronic wastes is also called e-wastes.

(K) Ganga Action plan for controlling pollution in ganga (1985) included city : (i) Kolkata (ii) Kanpur.

(i) Maximum NO_2 polluiton in Ahmdabad.

(ii) Maximum SO_2 pollution in Kolkata.

(iii) Maximum SPM pollution in Kolkata.

(iv) Land of maximum wind mills - Netherland.

(v) Largest wind will complex in India, Lamba (Gujrat)

(L) At 50 ppm, CO converts 7.5% of haemoglobin in to carboxy haemoglobin with in 8 hours.

(M) Maximum grean house gas released by - USA

(N) Cotton dust is an important pollutant in Ahmedabad.

(i) **CEPHERI :** An institution established in India to check pollution i.e., "Central Environmental and Public Health Engineering Research Institute" (CEPHERI).

This institution submits the measures on the basis of results of detailed survey.

(ii) **NEERI :** National Environmental Engineering Research Institute - Nagpur.

(Environmental plannig organisation is related with NEERI)

(iii) **IPCC :** The "Intergovermental Panel on Climate Change".

(iv) **I.A.P. :** Index of atmospheric pollution prepared with the help of lichens.

(v) **I.W.P. :** Index of water pollution, prepared by Daphnia, E.coli, Trout.

(vi) **M.P.N. :** Most probable number of E.coli in water.

The increase in the concentrations of green house gases in the in the atmosphere as affected by human activities				
Green house gases	**Pre-industrial concentration ~ 1750 AD**	**Concentration in 2000 AD**	**Increase since ~ 1750 AD**	**Atmospheric life-time (years)**
Carbon dioxide (CO_2)	280 ppm	368 ppm	31	5 - 200
Methane (CH_4)	700 ppm	1750 ppb	151	12
Nitrous oxide (N_2O)	270 ppb	316 ppb	17	114
Chlorofluorocarbons (CFC - 11) + Hydroflurocarbons (HFC - 23)	0	282 ppt		45-260

EXERCISE - 1

Q.1 Which of the following would be a natural pollution –
(1) Occurence of NO_2 in atmosphere
(2) Forest fires
(3) Eutrophication
(4) Occurence of smog

Q.2 Freon is –
(1) Metal fluoride
(2) Iron containing polycyclic hydrocarbons
(3) Chlorofluorocarbon
(4) Ferrous sulphide pollutant

Q.3 In addition to SO_2, metals and textiles are damaged by –
(1) Fluorides (2) Carbon monoxide
(3) Aldehydes (4) Nitrogen oxides

Q.4 Pollutant of automobile exhausts that affects nervous system/produces mental diseases is-
(1) Sulphur oxide (2) Mercury
(3) Lead (4) Nitrogen oxide

Q.5 In what way, the fossil fuel burning is damaging–
(1) It generates lot of smoke and smog in atmosphere
(2) It causes depletion of fossil reserves
(3) It generates more CO_2 in atmosphere
(4) It causes green house effect and acid rain

Q.6 Pollution is –
(1) Release of toxic/undesirable materials in environment
(2) Conservation of energy
(3) Removal of top soil
(4) All the above

Q.7 Ozone layer is disturbed by –
(1) Large number of factories
(2) Supersonic jets
(3) Large number of automobiles
(4) None of above

Q.8 Air pollution is caused by –
(1) Smoke
(2) Automobile exhausts
(3) Thermal Power Exhaust
(4) All of the above

Q.9 Main air pollutant is –
(1) N_2 (2) CO
(3) Sulphur (4) CO_2

Q.10 The PAN blocks –
(1) ATP synthesis (2) Hill reaction
(3) Glycolysis (4) CO_2 fixation

Q.11 Which of the following is a photochemical reaction product –
(1) Fluorides (2) CO and CO_2
(3) SO_2 (4) O_3

Q.12 P.A.N. stands for –
(1) Peroxy acetyl nitrite
(2) Peroxy acetyl nitrate
(3) Peroxy aceto-nitrile
(4) Pyridine aceto-nitrite

Q.13 Which of the atmospheric pollutant cause general chlorosis i.e. destruction of chlorophyll–
(1) SO_2 (2) Hydrocarbons
(3) CO (4) CO_2

Q.14 The C.F.C. pollution sources include –
(1) Fire extinguishers and jet air crafts
(2) Refrigerators and jet air crafts
(3) Jet air crafts only
(4) All of these

Q.15 PAN (peroxyacetyl nitrate) is an important constituent of 'Photochemical smog, is a –
(1) Corollary pollutant
(2) Primary pollutant
(3) Natural pollutant
(4) Secondary pollutant

Q.16 Smog is produced due to –
(1) Smoke and fog
(2) Air and metal dust
(3) Water and nitrogen oxide
(4) None of above

Q.17 Which human disease becomes aggravated by atmospheric pollution –
(1) Bronchitis (2) Leucoderma
(3) Haemophilia (4) Rheumatism

Q.18 The gas released in Bhopal tragedy was –
(1) Phosgene (2) MIC
(3) $COCl_2$ (4) None of above

Q.19 Lichens are best indicators of –
(1) Water pollution
(2) Soil pollution
(3) SO_2 pollution
(4) All types of pollution

Q.20 Which of the following damages WBC, bone-marrows and lymph nodes –
(1) Ca^{40} (2) I^{131}
(3) Sr^{90} (4) Cs^{137}

Q.21 Spraying of DDT produces pollution of –
(1) Air and soil
(2) Air, water and soil
(3) Air
(4) Air and water

Q.22 Which of the following is extreme example of noise pollution –
(1) Sonic booms produced by aircraft
(2) Rock music
(3) Noise produced by industrial operations
(4) Noise produced by traffic

Q.23 Radioactive pollution along Kerala coast is due to –
(1) Zinc (2) Thorium
(3) Caesium (4) Plutonium

Q.24 Which disease in children is caused by the intensive use of nitrate fertilizers –
(1) Jaundice
(2) Septicaemia
(3) Mumps
(4) Methaemoglobinemia

Q.25 The noise created at the launching of space rocket measures around –
(1) 180 db (2) 240 db
(2) 120 db (4) 150 db

Q.26 Inadequate drainage in a soil will lead to –
(1) Salination (2) Floods
(3) Soil erosion (4) Aridity

Q.27 Leukaemia is caused by –
(1) Sr^{90} (2) Iodine
(3) Ca^{40} (4) Caesium

Q.28 Through food chain radioactive Sr (Sr^{90}) is deposited in which part of human body –
(1) Muscles (2) Thyroid
(3) Kidneys (4) Bones

Q.29 Atomic bomb was used during world war II in-
(1) 1939 (2) 1945
(3) 1941 (4) 1943

Q.30 The ultimate environmental hazard or the most outstanding danger for the survival of living beings on this planet is –
(1) Radiation hazard or nuclear pollution
(2) Glaciation
(3) Deforestation
(4) Desertification

Q.31 The first effect of noise is –
(1) Anxiety and stress reactions
(2) Increased heart beat
(3) Digestive spasm
(4) Constriction of blood vessels

Q.32 One of the most dangerous radioactive pollutant is –
(1) C^{14} (2) S^{35}
(3) Sr^{90} (4) P^{32}

Q.33 Which of the following is a rich source of energy but never causes atmospheric pollution–
(1) Solar energy
(2) Nuclear energy
(3) Coal
(4) Wood

Q.34 Noise pollution is measured in –
(1) Nanometres (2) Decibles
(3) Fathoms (4) Hertz

Q.35 Indiscriminate use of DDT is undesirable because –
(1) It is harmful
(2) It is degradable
(3) It causes mutation
(4) It is accumulated in food chain

Q.36 Chief source of water and soil pollution is–
(1) Thermal power plant
(2) Agroindustry
(3) Mining
(4) All the above

Q.37 Which of the following is a land pollution –
(1) Soil erosion
(2) Accumulation of litter
(3) Humus formation and accumulation
(4) Accumulation of animal waste

Q.38 Some reliable indicators of air pollutants (SO_2 and noxious gases) are –
(1) Lichens and mosses
(2) Ferns and Cycas
(3) 'Neem' tree and Eichhornia
(4) Green algae and aquatic liverworts

Q.39 Labours working in a cement factory suffers from –
(1) Cytosilicosis
(2) Bone marrow cancer
(3) Cardiac disease
(4) Asbestosis

Q.40 When DDT was applied in an orchard as a pesticide, the fruit production decreased . This happened because –
(1) DDT killed the pollinating insects along with the pests
(2) DDT inhibited flowering
(3) DDT is a growth retardant
(4) DDT disturbed hormonal balance essential for fruit setting

Q.41 Ozone is a secondary pollutant because –
(1) It is formed by the oxidation of O_2 of the atmosphere
(2) It is formed by the transformation of NO_x in sun light
(3) It is not primarily important
(4) It develops secondary effects on living organisms

Q.42 C.O.D. stands for –
(1) Chemical oxygen demand
(2) Control of diesel
(3) Caesium oxide deposition
(4) Chemistry of depositions

Q.43 The common refrigent chlorofluoro-methane(freon) and NO_x are serious pollutants because –
(1) Destroys haemoglobin
(2) Disrupts O_3 layer
(3) It lowers atmospheric temperature
(4) Prevents cloud condensation

Q.44 The Mathura refinery smoke is thought to reduce the shine of Tajmahal by –
(1) Increasing U.V radiations
(2) Acid rain
(3) 3, 4 benzpyrene
(4) All of these

Q.45 Lichens do not like to grow in cities because of the –
(1) SO_2 pollution
(2) Absence of the right type of algae and fungi
(3) Absence of natural habitats
(4) Lack of moisture

Q.46 In the polluted water, the values of –
(1) C.O.D. slightly higher than B.O.D(2) C.O.D. much higher than B.O.D.
(3) B.O.D. slightly higher than C.O.D.
(4) B.O.D. much higher than C.O.D.

Q.47 A very harmful fibrous component causing pollution and an inflicting disease of lungs in human beings is –
(1) Asbestos (2) Eichhornia roots
(3) ABS micelle (4) Grease

Q.48 A rapid growth of photosynthetic algae in water develops 'bloom'. How would it affect the environment of water –
(1) The environment become comfortable to all forms of life
(2) O_2 level is decreased (OR) BOD becomes high
(3) O_2 level of water is increased
(4) Fish production is increased

Q.49 When huge amount of CO_2 is dumped into a river the BOD will –
(1) Increase
(2) Slightly decrease
(3) Remain unchanged
(4) Decrease

Q.50 The atmospheric U.V. radiations are absorbed in the zone called –
(1) Stratosphere (2) Mesosphere
(3) Thermosphere (4) Troposphere

Q.51 Photochemical smog is also called as –
(1) California type smog
(2) Tokyo type smog
(3) Los Angeles type smog
(4) New York type smog

Q.52 Which of the following pollutant is released in larger quantity from the exhaust emission of a petrol/diesel automobile –

(1) CO_2

(2) NO_2 , SO_2 & Pb

(3) Hydrocarbons & Pb

(4) CO

Q.53 Which of the following air pollutant is carcinogenic –

(1) 3, 4 – Benzpyrene

(2) PAN

(3) Ethylene

(4) N_2O

Q.54 Which of the following are bio-pollutants –

(1) Spores and pollen grains

(2) Sewage and garbage

(3) Protozoans

(4) Dairy and poultry waste

Q.55 What immediate hazard is likely to occur if the temperature of the earth rises by 5°C –

(1) Increase in productivity

(2) Melting of polar ice

(3) Destruction of phytoplanktons

(4) Inundation of coastal towns

Q.56 For how long and at what temperature an experiment is run to determine the value of BOD of a water body –

(1) 10° C for 10 days

(2) 20°C for 5 days

(3) 50°C for 2 days

(4) 5°C for 20 days

Q.57 The automobile emission can be reduced by adding the following in the petrol –

(1) Barium salts (2) Calcium salts

(3) Cobalt salts (4) Silicon oil

Q.58 Which of the following could be used in purification of sewage –

(1) Fungi

(2) Blue-green algae

(3) Unicellular green algae

(4) All plants

Q.59 The main causative agent of Minamata disease is atmospheric pollution by alkyl mercury which comes from –

(1) Water contaminated with effluents of vinyl industries

(2) Piggery & poultry raised on open grasslands

(3) Chimney waste of plastic industries

(4) Exhaust emissions of automobiles

Q.60 Minamata disease was traced to atmospheric pollution caused by –

(1) Inorganic mercury compounds

(2) Metallic/elemental mercury

(3) Organic mercury compounds

(4) All the above together

Q.61 The 'Environment Protection Act' was promuglated in India in the year –

(1) 1981 (2) 1986

(3) 1988 (4) 1974

Q.62 The particulate matter dispersed in the atmosphere is –

(1) Non-gaseous

(2) Mainly non-gaseous

(3) Mainly gaseous

(4) Gaseous

Q.63 Major pollution causing agent is –

(1) Animals

(2) Hydrocarbon gases

(3) Man

(4) None of the above

Q.64 Ultra-violet light causes –

(1) Destruction of hydrogen bonds between complementary DNA strands

(2) Photodynamic action

(3) Sticky metaphases

(4) Formation of pyrimidines

Q.65 Effect of pollution is first marked on –

(1) Natural balance of the ecosystem

(2) Geological cycle

(3) Rainfall and climate

(4) Fauna of a place

Q.66 Addition of phosphates and nitrates/ fertilizers into water leads to –
(1) Increased algal growth
(2) Nutrient enrichment/eutrophication
(3) Increased growth of decomposers
(4) Reduced algal growth

Q.67 Jet air lines produce fluoro-carbons in the form of –
(1) Mist
(2) Fog
(3) Photochemical smog
(4) Aerosol

Q.68 Non-ionising radiations with specific biological effects are –
(1) Beta - rays (2) Gamma rays
(3) X-rays (4) UV radiations

Q.69 Which of the following statements is not true–
(1) Nitrogen and Magnesium are serious pollutants of our environment
(2) Lichens are affected by SO_2
(3) All pollutants are not waste
(4) Carbon monoxide is a serious pollutant

Q.70 Fluoride pollution produces necrosis or chlorosis of –
(1) Midrib
(2) Leaf margin and tip
(3) Stem
(4) Petiole but not lamina

Q.71 Which of the following does not contributes to "Green house effect" –
(1) Carbon dioxide
(2) Carbon monoxide
(3) Chloro-fluoro carbon and Methane
(4) Refrigerant freon

Q.72 SO_2 and NO_2 produce pollution by increasing–
(1) Acidity (2) Neutrality
(3) Buffer action (4) Alkalinity

Q.73 What is environmental consequence of 25% increase of CO_2 level in our atmosphere –
(1) Death of all animals
(2) Green house effect
(3) Direct pollution
(4) Death of all plants

Q.74 Ultraviolet radiations are lethal because of inactivation of –
(1) Minerals, air and water
(2) Water, carbon dioxide and oxygen
(3) Proteins, nucleic acids and pigments
(4) Carbohydrates, fats and vitamins

Q.75 Which of the following is the most dangerous environment hazard to mankind–
(1) Noise pollution
(2) Water pollution
(3) Nuclear waste
(4) Air pollutions

Q.76 The most polluted city of the world is –
(1) Mexico (2) Calcutta
(3) Tokyo (4) New York

Q.77 The gases which develop green house effect (OR) contributes to global warming are –
(1) N_2O, CH_4, CI, CFC, CO_2
(2) CH_4, CO_2, SO_2, NO_x, NH_3
(3) CFC, CO_2, SO_2 , NH_3,H_2S
(4) CO_2, CO, SO_2, N_2O, N_2

Q.78 Which is not a pollutant from exhaust of motor vehicle –
(1) SO_2 (2) CO
(3) Fly ash (4) Hydrocarbon gas

Q.79 What is the potential danger of 'Green House effect' –
(1) Poor photosynthesis
(2) Heavy rainfall
(3) Coastal flooding
(4) More humidity in environment

Q.80 Effect of to-day's radioactive fall out will be more on future children than children living to-day due to –
(1) Radiations have delayed effect
(2) Mutated genes are usually recessive
(3) Infant susceptibility to radiations
(4) Increase of susceptibility to radiations with age

Q.81 One of the effects of dust pollution is to cause–
(1) Yellowing of leaves
(2) Opening of stomata
(3) Closure of stomata
(4) Folding of leaves

Q.82 If water pollution continues at its present rate, it will eventually –
(1) Prevent precipitation
(2) Stop the water cycle
(3) Make oxygen molecules unavailable to aquatic life
(4) Make nitrates unavailable to aquatic life

Q.83 Which of the following enhances B.O.D. of water –
(1) Sugar mill effluents
(2) Algae
(3) Sand
(4) Moss

Q.84 Stiff back and fixed joint disease in human beings is due to –
(1) The use of fluoride contaminated water
(2) Bacterial infection
(3) Viral infection
(4) Mycoplasmal & fungal infection

Q.85 Major air pollutants in Bombay and Calcutta are –
(1) Hydrocarbons and hot air
(2) Ozone
(3) CO and oxides of sulphur
(4) Marsh gas and algal spores

Q.86 Only ape found in India is
(1) Gorilla (2) Chimpanzee
(3) Hoolock gibbon (4) Leaf monkey

Q.87 An endangered indian bird is
(1) Passenger pigeon
(2) Great Indian bustard
(3) Vulture
(4) Pink headed duck

Q.88 Smallest national tiger project National park is-
(1) Jim Corbett (2) Rajaji
(3) Ranthambhore (4) Sariska

Q.89 Animals and plant can be best protected in
(1) National Park (2) Zoo
(3) Botanical Garden (4) Sacred forest

Q.90 Which one of the following agriculatural practices is ecofriendly
(1) Organic farming (2) Jhum cultivation
(3) Monoculturing (4) 2 & 3 Both

Q.91 Silent velley is located in
(1) Kerala (2) Assam
(3) J & K (4) Rajasthan

Q.92 Tree hugging or chipko movement is associated with
(1) H.N. Bahuguna (2) S.L. Bahuguna
(3) Vinoba Bahave (4) None of these

Q.93 Approximately 1.5 million species have been identified. Which group contains the most species world wide
(1) Fungai (2) Vascular plant
(3) Insects (4) Mammals

Q.94 Domesticated crop plants rarely become aggresive weeds, because
(1) They are not grown in habitat favourable for rapid colonization
(2) Their high seed production is not adaptive for an invading species
(3) They possess traits with low survival value in wild
(4) They are genetically uniform

Q.95 One of the following is not a wild life conservation effors
(1) Project Kaiga (2) Project Tiger
(3) Project Hangul (4) Project elephant

Q.96 Introduction of Nile perch into lake victoria leads to extinction of
(1) Cat fish (2) Cichlid fish
(3) Shark fish (4) Doplhin

Q.97 Which of the following group of animal is the most vulnerable to extinction
(1) Amphibia (2) Aves
(3) Insect (4) Mammals

Q.98 Which of the following group of plants is the most vulnerable to extinction
(1) Angiosperm (2) Bryophytes
(3) Gymnosperm (4) Pteridophyta

Q.99 Which equation is correct for species area relationship
(1) $S = CA^Z$
(2) $A = SC^Z$
(3) $\log S = \log C + Z \log A$
(4) 1 & 3 Both

Q.100 Species area relationship equation was given by

(1) Mayer (2) Ehrlich

(3) Hemboldt (4) Wilson

Q.101 Rivet popper hypothesis was given by ..... to explain importance of biodiversity

(1) Mayer (2) Paul Eherlich

(3) Hemboldt (4) Wilson

Q.102 Total number of Biodiversity Hot spot in india are

(1) 1 (2) 2

(3) 3 (4) 4

Q.103 Total number of Biodiversity Hot spots in world are

(1) 25 (2) 9

(3) 34 (4) 32

Q.104 Silent valley of kerala is preserved because

(1) It contain rare species of animals and plants

(2) Soil is rich in minerals

(3) Land were use extensively for agricultural purpose

(4) It has pine tree

Q.105 Ramsar convention is related to conservation of

(1) Wetland biodiversity

(2) Terrestrial biodiversity

(3) Tiger & Elephant

(4) Plant

Q.106 Which bird is symbol of Bombay Natural History Society

(1) Hornbill (2) Spoonbill

(3) Egret (4) Sunbird

Q.107 Which year was annouced as year of Tiger conservation by WWF-

(1) 1998 (2) 1996

(3) 1991 (4) 2006

Q.108 State bird of Rajasthan is

(1) Parrot (2) Bustard

(3) Peacock (4) None

Q.109 Which of the following is narrow utility of biodiversity

(1) Fiber production

(2) Taxol production

(3) O_2 production

(4) 1 & 2 Both

Q.110 Who coined the term wild life

(1) Mayer (2) Humboldt

(3) Wilson (4) Hornday

Q.111 Which of the following is state animal of Rajasthan

(1) Gazella (2) Black buck

(3) Tiger (4) Red panda

Q.112 Gir National park is famous for

(1) Tiger (2) Lion

(3) Wid Ass (4) Elephant

Q.113 Who proposed hot spot concept for region of high ecological diversity

(1) IUCN (2) Mayer

(3) Odum (4) Cormandii

Q.114 Which of the following is a correct match of animal and its habitat

(1) Elephant - Ranthambhore

(2) Flamingo - Runn of Kutch

(3) Wild ass - Dachigam

(4) Indian tailor bird - Assam

Q.115 Which of the following bird is extinct recently

(1) Carollina parrokeit

(2) Parrot

(3) Siberian crane

(4) 1 & 3 Both

Q.116 Total biodiversity present in India is .....% of total world biodiversity

(1) 8.1% (2) 6.1%

(3) 2% (4) 16%

Q.117 Which of the following is present in green book

(1) List of endangered plant

(2) List of extinct plant

(3) List of rare plant grown in botanical garden

(4) List of plant group of an area

Q.118 Which of the following species is endangered

(1) Bustard (2) Rhinoceros

(3) Asiatic ass (4) All of the above

Q.119 India's Ist butterfly park is located in

(1) Sikkim (2) Rajasthan

(3) Nagaland (4) Assam

Q.120 Silent valley is a type of

(1) Tropical forest (2) Temperate forest

(3) Deciduous forest (4) All of the above

Q.121 Which of the following is a Ramsar site

(1) Chelka lake (2) Sukna lake

(3) Sariska (4) 1 & 2 Both

Q.122 The biodiversity of a given region is an outcome of

(1) Climate & topography

(2) Possibility for dispersal

(3) Evolutionary history

(4) All of the above

Q.123 More biodiversity on large island than small island at same distance from source, this effect is known as

(1) Jump effect (2) Distance effect

(3) Area effect (4) Edge effect

Q.124 Biological diversity day is celebrated on

(1) 3rd December (2) 22nd May

(3) 4th October (4) 3rd October

Q.125 Which of the following is a method of in-situ conservation

(1) National Park (2) Cryopreservation

(3) Botanical Garden (4) All

Q.126 Which of the following are parts of Biosphere reserves

(1) Transition zone (2) Buffer zone

(3) Core Zone (4) All of the above

Q.127 Which of the following plant species is critically endangered

(1) Podophyllum

(2) Barbexis nilghiriensis

(3) Both

(4) None

Q.128 Which of the following is thought to be an indicator of ecological balance

(1) Deer (2) Black Buck

(3) Elephant (4) Tiger

Q.129 Which of the following convention is related to conservation biodiversity

(1) Rio de Janeiro Convention

(2) Montreal protocol

(3) Kyoto protocal

(4) All

Q.130 Which of the following is an endangered species present in Rajasthan

(1) Guggal (2) Nepenthes

(3) A & B Both (4) None

ANSWER KEY

EXERCISE – 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	3	4	3	3	1	2	4	2	2	4	2	1	4	4	1	1	2	3	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	2	4	1	1	1	4	2	1	1	3	1	2	4	4	1	1	1	1
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	1	2	2	1	2	1	2	3	1	3	4	1	1	2	2	1	3	1	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	1	3	1	1	2	4	4	1	2	2	1	2	3	3	3	1	3	3	2
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	3	1	1	3	3	2	3	1	1	1	2	3	3	1	2	1	3	4	3
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	3	3	1	1	1	1	2	4	4	1	2	2	2	1	1	3	4	1	1
Ques.	121	122	123	124	125	126	127	128	129	130										
Ans.	4	4	3	2	1	4	3	4	1	1										

EXERCISE - 2

Q.1 Sewage water can be purified for recycling with the action of –
(1) Micro-organisms (2) Aquatic plants
(3) Fishes (4) Penicillin

Q.2 National Environmental Planning Engineering Organisation at Nagpur is –
(1) ICAR (2) NEERI
(3) CSIR (4) CPHER

Q.3 Which of the following does not cause atmospheric pollution –
(1) Automobiles
(2) Nuclear power plants
(3) Hydroelectric power plants
(4) Thermal power plants

Q.4 Problem associated with nuclear power plants is –
(1) Emmission of hazardous radionucleides
(2) Disposal of radioactive waste
(3) Thermal pollution
(4) All the above

Q.5 The extent of darkness caused due to smoke can be determined by the help of –
(1) Horizontal microscopes
(2) Smoke filters
(3) Ringelmann's charts
(4) All of these

Q.6 The average conc of CO_2 in the atmosphere is –
(1) 100 ppm (2) 300 ppm
(3) 1000 ppm (4) 10 ppm

Q.7 The term smog was coined by –
(1) Des Voeux (2) Tansley
(3) Odum (4) Clements

Q.8 Increasing concentration of DDT in organisms of a food chain in higher trophic levels is known as –
(1) Biological chain
(2) Biotic potential
(3) Biological value
(4) Biological magnification

Q.9 Which of the following plants shows insecticidal properties –
(1) *Dalbergia sissoo*
(2) *Ocimum basilicum*
(3) *Azadirachta indica*
(4) Both (2) and (3)

Q.10 The classical smog was first observed in –
(1) London (2) Tokyo
(3) Paris (4) New York

Q.11 The light of cities is reduced in comparison to villages due to the presence of –
(1) Hydrocarbons
(2) Particulate matter
(3) SO_2 and SO_3
(4) SO_2 and oxides of nitrogen

Q.12 Plants are known to be purifiers of air due to–
(1) Nitrogen fixation
(2) Photo-transpiration
(3) Photorespiration
(4) Photosynthesis

Q.13 In human beings, anoxia is caused due to –
(1) CO_2 (2) N_2O
(3) SO_2 (4) CO

Q.14 Soil erosion means -
(1) Breaking up of rocks by water streams
(2) Deposition of new soil layers by rivers
(3) Removal of top soil layers by wind
(4) Decomposition of organic matter and development of the soil

Q.15 The cutting of trees from the forests of hill near a catchment area -
(1) Will have no effect on causing floods in plain
(2) May cause flood in plains in rainy season
(3) Will have no effect on climatic condition of that area
(4) Will benefit the mankind for more area for cultivation

Q.16 A slopy land on account of continued rainfall initially undergoes -
(1) Sheet erosion (2) Gully erosion
(3) Rill erosion (4) All of these

Q.17 The term riparian erosion is applied to -
(1) Gully erosion
(2) Slip erosion
(3) Wind erosion
(4) Stream bank erosion

Q.18 Which occurs under normal conditions -
(1) Geological erosion
(2) Surface creep
(3) Both of these
(4) Accelerated erosion

Q.19 Odum has described soil erosion as -
(1) Soil pollution
(2) Creeping death of soil
(3) Loss of living stratum
(4) Loss of feeding zone

Q.20 Soil erosion in plains consequent to rainfall is initiated by -
(1) Rill erosion (2) Sheet erosion
(3) Gully erosion (4) All of these

Q.21 The soil erosion on slopes proceeds in the following manner -
(1) Gully $\rightarrow$ Rill $\rightarrow$ Ravine
(2) Rill $\rightarrow$ Ravine $\rightarrow$ Gully
(3) Rill $\rightarrow$ Gully $\rightarrow$ Ravine
(4) Ravine $\rightarrow$ Rill $\rightarrow$ Gully

Q.22 Soil erosion can be prevented by -
(1) Allowing herbivorous animals to graze excessively
(2) Increasing fertility
(3) Making the land slopy
(4) Growing plants to form a soil cover

Q.23 Soil erosion on hills can be prevented by -
(1) Removal of vegetable cover
(2) Leaching
(3) Terrace cultivation
(4) Overgrazing

Q.24 Which of the following plants is used as wind break -
(1) *Delonix* (2) *Eucalyptus*
(3) *Mangifera* (4) *Prosopis*

Q.25 To prevent wind and water erosion, the crop is sometimes harvested in such a way that a basal stub of the plant is left behind. This technique is called as -
(1) Basin listing (2) Mulching
(3) Ley farming (4) Strip cropping

Q.26 Soil conservation is the process where -
(1) Sterile soil is converted into fertile soil
(2) Soil is protected against loss
(3) Soil erosion is allowed
(4) Soil is aerated

Q.27 The soil bindings is done in the best way by-
(1) Algae (2) Grasses
(3) Mycorrhizae (4) All of these

Q.28 An important agrostological technique to check soil erosion in the initial stages is -
(1) Land retirement (2) Ley farming
(3) Contour farming (4) Basin listing

Q.29 Which of the following functions performed by a forest helps most in controlling drought-
(1) Forests act as watersheds
(2) Forest prevents rainfall in monsoon
(3) Forests bring rainfall in monsoon
(4) Forests have lot of water plants

Q.30 One of the following is associated with the conservation of forests –
(1) Kaziranga (2) Bharatpur
(3) Silent valley (4) Gir

Q.31 Major forest types in India are -
(1) Tropical evergreen and tropical thorn
(2) Temperate mixed and tropical deciduous
(3) Tropical dry deciduous and tropical moist deciduous
(4) Tropical evergreen and tropical moist deciduous

Q.32 The main causes of deforestation are -
(1) Explosion of human and livestock
(2) Increased requirements of timber and fuel wood
(3) Expansion of cropland and overgrazing
(4) All of these

Q.33 "Chipko Movement" is world's most known eco development programme started by Sunder Lal Bahuguna (1973). It is related with -
(1) Conservation of Forests
(2) Afforestation
(3) Planting
(4) Population

Q.34 Percentage of land mass in India under forest cover is -
(1) 33% (2) 23% (3) 17% (4) 19%

Q.35 Afforestation with the purpose of environmental aesthetic and economic development is known as -

(1) Agroforestry

(2) Forest conservation

(3) Intergrated afforestation

(4) Social forestry

Q.36 Forests contribute to all the following except-

(1) Reduction in atmospheric pollution

(2) Increased amount of carbon dioxide

(3) Improvement of soil structure

(4) Prevention of soil erosion

Q.37 Shifting cultivation is being practised by some tribals in Assam and Europe. It is one of the cause of deforestation as a forest area is cleared by cutting and burning of trees for cultivation for 3-5 years and then a new forest area is cleared. The abandoned area invites erosion and wild vegetation. This cultivation is also called -

(1) Jhuming cultivation (2) Mulching

(3) Swidden cultivation (4) All of these

Q.38 Silent valley of Kerala is preserved as -

(1) It is reservoir of wild life

(2) It contains timber trees

(3) It represents tropical rain forests

(4) All of the above

Q.39 When was the National Forest Policy formulated -

(1) 1980 (2) 1964

(3) 1952 (4) 1948

Q.40 When was the Forest Conservation Act passed in India -

(1) 1960 (2) 1970

(3) 1950 (4) 1980

Q.41 The famous forest conservation movement in India is -

(1) Silent valley movement

(2) Chipko Andolan

(3) Both (1) and (2)

(4) MAB and IBP

Q.42 Forests called Nation's Green Gold, are important as -

(1) They prevent erosion of soil by binding soil particles and increasing the fertility and prevent pollution

(2) They provide timber and medicines

(3) They provide shelter to animals

(4) All of the above

Q.43 What is added to correct an alkaline and acidic soil –

(1) Limestone and dolomite powder

(2) Gypsum and sulphur powder

(3) Dolomite and charcoal

(4) Ammonium sulfate and sulphur powder

Q.44 Bloom occurs in -

(1) Oligotrophic lake (2) Eutrophic lake

(3) Fast flowing river (4) Rain water

Q.45 Which of the following plant has become a water weed in this country -

(1) Typha (2) Trapa

(3) Cyperus (4) Eichornia

Q.46 What is not useful to increase agriculture production -

(1) Mechanisation of agriculture

(2) Enhanced irrigation facilities

(3) Use of fertilizers

(4) Deforestattion

Q.47 Environmental Planning organisation is -

(1) CSIR (2) CPHERI

(3) ICAR (4) NEERI

Q.48 Which is normally not an air pollutant -

(1) CO (2) SO_2

(3) Hydrocarbons (4) CO_2

Q.49 Acidic rains are due to -

(1) O_3 (2) $SO_2 + NO_2$

(3) CO (4) CO_2

Q.50 What is found in photochemical smog -

(1) CO (2) NO_2

(3) Ozone (4) 2 and 3 both

Q.51 Lichens in a habitat indicates -

(1) Zinc in soil

(2) Copper in soil

(3) Carbon monoxide in air

(4) Lack of air pollution

Q.52 Green house effect mainly due to -
(1) SO_2 (2) CO_2
(3) CO (4) O_2

Q.53 Which pollutant exhibits biomagnification in food chain -
(1) DDT (2) SO_2
(3) CO (4) PAN

Q.54 Which will not cause any atmospheric pollution -
(1) Hydrogen (2) Sulphur dioxide
(3) Carbon dioxed (4) Carbon monoxide

Q.55 Which of the following is the main factor of water pollution -
(1) Smoke (2) Industrial waste
(3) Detergent (4) Ammonia

Q.56 Main air pollutant among the following is -
(1) CO (2) CO_2
(3) N_2 (4) Sulphure

Q.57 Pollution can be controlled by -
(1) Sewage treatment
(2) Checking atomic blasts
(3) Manufacturing electrically operated vehicles
(4) All the above

Q.58 In cities like Bombay and Calcutta the major air pollutants are -
(1) Ozone
(2) Carbon monoxide and oxides of Sulphur
(3) Hydrocarbons and not air
(4) Algal spores and march gas

Q.59 Recent reports of acid rains industrial cities are due to the effect of atmospheric pollution by -
(1) Excessive release of NO_2 and SO_2 by burning of fossil fuels
(2) Excessive release of CO_2 by burning of fuel like wood and charcoal, cutting of forests and increased animal population
(3) Excessive release of NH_3 by industrial plants and coal gas
(4) Excessive release of CO in atmosphere by incomplete combustion of coke, charcoal and other carbonaceous fuels is pancity of oxygen

Q.60 Which is the greatest air pollutant these days-
(1) factories
(2) Motor vehicles
(3) Domestic appliances
(4) animals

Q.61 Removal of the soil by the action of wind and water is known as -
(1) Erosion (2) Fossilization
(3) Leaching (4) Calcification

Q.62 Eutrophication refers to -
(1) High production in an aquatic ecosystem
(2) Low production in an aquatic ecosystem
(3) Low production in a terrestrial
(4) Stable production in a terrestrial ecosystem

Q.63 Photochemical smog was first observed in -
(1) London (2) Los Angeles
(3) Paris (4) Tokyo

Q.64 Domestic waste will lead to -
(1) Biodegradable pollution
(2) Nondegradable pollution
(3) Thermal pollution of soil
(4) Air pollution

Q.65 The major source of BOD in the river Ganga is-
(1) Leaf litter (2) Fishes
(3) Human waste (4) Auatic plants

Q.66 If a lake is contaminated with DDT, its highest concentration would be found in -
(1) Primary consumer
(2) Secondary consumer
(3) Tertiary consumer
(4) None of these

Q.67 The most harmful air pollutant produced by automobiles is -
(1) HNO_2 (2) NO (3) SO_2 (4) CO

Q.68 Major pollulant in jet plane emission is -
(1) SO_2 (2) CFC (3) CO (4) CCl_4

Q.69 It is said that Tajmahal may be destroyed due to -
(1) Flood in Yamuna river
(2) Air pollutants released from oil relinery of Mathura
(3) Decomposition of Marble as a result of high temperature
(4) All the above

Q.70 Melting of the ice caps might result from -
(1) Depletion of ozone layer
(2) Excess CFC in atmosphere
(3) Excess CO_2 in the atmosphere
(4) Excess water rain

Q.71 Cotton dust is an important pollutant in -
(1) Delhi (2) Ahmedabad
(3) Madras (4) Calcutta

Q.72 Some effects of SO_2 and its transformation products on plant include -
(1) Chlorophyll destruction
(2) Plasmolysis
(3) Golgi body destruction
(4) None

Q.73 Non ionising radiations damaging to DNA are-
(1) X-rays (2) U.V. rays
(3) Gamma rays (4) Beta rays

Q.74 Radiation is health hazard because it cause -
(1) Pneumonia (2) Leukaemia
(3) Hemophilla (4) Anaemia

Q.75 What is B.O.D. -
(1) The amount of O_2 utilised by organism in water
(2) The amount of O_2 utilized by micro organisms for decomposition
(3) The toal amount of O_2 present in water
(4) All of the above

Q.76 What is the intensity of sound in normal conversation -
(1) 10 - 20 decibal (2) 30 - 60 decibal
(3) 70 - 90 decibal (4) 120 - 150 decibal

Q.77 Which of the following is absent in polluted water -
(1) Hydrilla (2) Water hyacinth
(3) Larva of stone fly (4) Blue green algae

Q.78 Maximum green house gas relased by which country -
(1) India (2) France
(3) U.S.A. (4) Britain

Q.79 Ozone layer of upper atmosphere is being destroyed by -
(1) Sulphurdioxide
(2) Carbondioxide
(3) Chlorofluorocabon
(4) Smog

Q.80 Most hazardous metal pollutant of autombile exhaust is -
(1) Hg (2) Cd
(3) Pb (4) Cu

Q.81 B.O.D. is connected with -
(1) Hg (2) Cd
(3) Pb (4) Cu

Q.82 Soil erosion is greater when -
(1) No rain occurs
(2) Winds do not blow
(3) The rainfall is evenly distributed
(4) The Rainfall is received in heavy down pour

Q.83 Soil erosion can be prevented by -
(1) Over grazing
(2) Removal of vagetation
(3) Afforestationi (Plantation)
(4) Increasing bird population

Q.84 Soil conservation is the process where -
(1) Soil is aerated
(2) Soil erosion is allowed
(3) Soil is protected against loss
(4) Sterile soil is converted into fertile soil

Q.85 In hilly regions, erosion can be minimised by -
(1) Terracing (2) Ploughing effectively
(3) Manuring (4) Strip cropping

Q.86 Who is known as tiger man of Rajasthan
(1) Jim Corbett (2) Kailash Sankhla
(3) Salim Ali (4) Bahuguna

Q.87 Which of the following hot spots are present in India
(1) Western Ghat & SRI Lanka
(2) Indo-Burma
(3) Himalaya
(4) All of the above

Q.88 Which of the following are cause of biodiversity loss
(1) Habitat loss
(2) Over exploitation
(3) Alien species invasion
(4) All

Q.89 Which of the following become extinct due to over exploitation
(1) Passanger pegion (2) Steller's Sea cow
(3) Cichlid fish (4) 1 & 2 Both

Q.90 Out of more than 1.5 million known species insects are — of the total animals
(1) 70 % (2) 25 %
(3) 50 % (4) 75 %

Q.91 Which is not true regarding genetic dervesity?
(1) It enables a population to adapt to its environment
(2) It is also bais of speciation
(3) Ecotype formation
(4) Higher diversity increases uniformity

Q.92 Regional diversity is also called
(1) Alpha diversity
(2) Beta diversity
(3) Gamma diversity
(4) Ecosystem diversity

Q.93 Which of the following biogeographical regions in India has highest lnad coverage?
(1) Deccan peninsula (2) N.E. Himalayas
(3) Western ghats (4) Gangetic plains

Q.94 Which is not a reason of maximum diversity in tropics ?
(1) Higher pest pressure
(2) Evolutionary older zone
(3) High rate of out crossing
(4) Greater environmental variations

Q.95 Threats to biodiversity comes from
(1) Habitat loss
(2) Over exploitation
(3) Intensive agriculture
(4) All of these

Q.96 Disappearance of cheetah from India and its existence in other part of world is an example of
(1) Extinction
(2) Extirpation
(3) Back ground extinction
(4) Anthropogenic extinction

Q.97 Silent valley of Kerala is being preserved because it has
(1) Rare plants and animals
(2) Only natural forest of India
(3) Crostly timber plants
(4) Recreational value

Q.98 Anti-forest conservation is
(1) Selective felling
(2) Control of forest fire
(3) Large scale plantation
(4) Ban on hunting

Q.99 The species which are likely to be in danger of extinction in the medium term future if the factors threating their extinction continue are known as
(1) Threatened species
(2) Rare species
(3) Vulnerable species
(4) Endangered species

Q.100 In India, forests constitute about
(1) 19.4% of the land area
(2) 38.7% of the land area
(3) 33% of the land area
(4) 67% of the land area

Q.101 Select an incorrect statement w.r.t. biodiversity
(1) Moutain peaks are more diverse than foot hills
(2) Valley's are more diverse than mountain peaks
(3) Shade sides are more diverse than sun sides of mountains
(4) Western ghats are more diverse than eastern ghats

Q.102 85% of world's food comes from
(1) < 20 plant species
(2) < 50 plant species
(3) < 5 plant species
(4) < 100 plant species

Q.103 A population characteristic of a species susceptible to extinction is
(1) Low trophic level in food chain
(2) Inability to switch over to alternate food source
(3) Wide range of distribution
(4) High biotic potential

Q.104 Number of red list categories prepared by WCU (IUCN) is
(1) 6 (2) 7
(3) 8 (4) 9

Q.105 According to IUCN, when a taxon is facing an extremely high risk of extinction in the immediate future, it is
(1) Extinct in wild
(2) Endangered
(3) Critically endangered
(4) Vulnerable

Q.106 Protected areas are example of

(1) In-situ conservation

(2) Ex-situ conservation

(3) Cryopreservation

(4) Green Houses

Q.107 The zone of biosphere reserve where no human activity is permitted is known as

(1) Buffer zone (2) Core zone

(3) Manipulation zone (4) None of these

Q.108 Mark the tree recommended for social forestry purpose

(1) Prosopis juliflora

(2) Prosopis chilensis

(3) Capparis decidua

(4) Leucaena leucocephala

Q.109 The Indian rhinoceros is the most important protected species in

(1) Gir National Park

(2) Bandipur National Park

(3) Corbett National Park

(4) Kaziranga National Park

Q.110 Government of India has provided the private ownership rights in

(1) A national park

(2) A sancturay

(3) A biosphere reserve

(4) Zoo

Q.111 Wild populations of plants and animals and tradiational life styles of tribals are protected in

(1) Biosphere Reserve

(2) Sanctuary

(3) National Park

(4) None of these

Q.112 Man made mass extinction of species represent a very severe depletion of biodiversity called as

(1) Mass extinction

(2) Natural extinction

(3) Anthropogenic extinction

(4) Human extinction

Q.113 Which of the following exotic species has become menace to many water bodies in India?

(1) Lantana camara

(2) Eichhornia crassipes

(3) Panthenium hysterophorus

(4) Eupatorium odoratum

Q.114 Which is not a criteria used for determining hot spots

(1) Number of endemic species

(2) Degree of habitat destruction

(3) Having traditional strategy for protection of biodiversity

(4) Degree of exploitation

Q.115 Which anticancerous botano-chemical is obtained from a Gymnosperm ?

(1) Ephedrine (2) Strychnine

(3) Taxol (4) Reserpine

Q.116 Find odd one out w.r.t. endangered plants

(1) Berbesis nilghiriensis

(2) Bentinckia nicobarica

(3) Podophyllum

(4) Nepenthes khasiana

Q.117 A few years ago, the brown plant hopper (Nilaparvata lunges) threatened the cultivation of

(1) Wheat (2) Rice

(3) Maize (4) Millets

Q.118 An important international effort of convention for biodiversity conservation is

(1) UNESCO (2) WWF

(3) IBWL (4) NBPGR

Q.119 Find the odd one out (w.r.t. weed)

(1) Lantana camara

(2) Eichornia

(3) Parthenium argentatum

(4) Parthenium hysterophorus

Q.120 How many species became extinct in last 500 years

(1) 338 (2) 359

(3) 784 (4) 2000

Q.121 How many hot spots cover India's high biodiversity regions ?

(1) 25 (2) 3

(3) 34 (4) 2

Q.122 Overexploitations has resulted in the extinction of

(1) Steller's cow

(2) Lantana

(3) Passenger pigeon

(4) Both (1) & (3)

Q.123 Species diversity in an ecosystem mainly depends on -

(1) Light intensity (2) Temperature

(3) Rain fall (4) Soil type

Q.124 Red data book is famous for -

(1) Extinct plants and animals

(2) Extinct plants only

(3) Endangered plants and animals

(4) Extinct animals only

Q.125 Green book contains -

(1) The list of endangered plants

(2) The list of extinct plants

(3) The list of rare plants grown in botanical gardens

(4) Flora of certain area

Q.126 Of the followings plants which one would you consider an endangered plant, due to over exploitation -

(1) Dioscorea (2) Maize

(3) Wheat (4) Rice

Q.127 Among the following a plant species of medicinal value is endangered -

(1) ***Butea frondosa***

(2) ***Rauwolfia serpentina***

(3) ***Cocus nucifera***

(4) ***Mangifera land slides***

Q.128 The method by which endangered plant species are conserved in a botanical garden or in some controlled circumstances -

(1) Afforestation

(2) In situ conservation

(3) Ex situ conservation

(4) None of the above

Q.129 Which one of the following may be the reason for extinction of plant species due to human activities -

(1) Earthquakes

(2) Pollution

(3) Diseases

(4) Evolution

Q.130 The main aim of plant conservation is -

(1) To conserve the necessary ecological activities and life supporting systems

(2) To conserve species diversity and range of genetic meterial

(3) Both the above

(4) None of the above

ANSWER KEY

EXERCISE – 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	3	4	3	2	1	4	4	1	2	4	4	3	2	3	4	1	1	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	4	3	4	2	2	2	2	3	3	3	4	1	4	4	2	1	4	3	4
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	4	2	2	4	4	4	4	2	4	4	2	1	1	2	1	4	2	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	1	2	1	3	1	4	2	2	3	2	1	2	2	2	2	3	3	3	3
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	4	3	3	1	2	4	4	4	1	4	3	1	4	4	2	1	1	3	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	1	2	3	3	1	2	4	4	2	1	3	2	3	3	1	2	2	3	3
Ques.	121	122	123	124	125	126	127	128	129	130										
Ans.	2	4	3	3	3	1	2	3	2	3										

Q.1 Minerals, metals and fossil fuels are which type of resources of energy ?
[UTTARANCHAL 2004]
(1) Renewable (2) Non-renewable
(3) Biodegradable (4) Degradable

Q.2 Thermal pollution is caused by -
[UTTRANCHAL 2005]
(1) Power plants (2) Industries
(3) Automobiles (4) All the above

Q.3 The addition of any substance to water which leads to change in its physical and chemical characteristic it is defined as water pollution. It results in - **[UTTRANCHAL 2006]**
(1) Decrease turbidity
(2) Increase oxygenation
(3) Increase photosynthesis
(4) Increase turbidity dexoygenation

Q.4 Which of the following is not a green house gas ? **[WEST BANGAL JEE 2007]**
(1) CH_4 (2) N_2O
(3) H_2O (4) CO_2

Q.5 High BOD indicates -
[WEST BANGAL JEE 2007]
(1) Highly polluted water
(2) Less pollution in H_2O
(3) Less sewage
(4) Less microoganism

Q.6 Increasing concentration of accumulated pollutant along food chain is -
[WEST BANGAL JEE 2007]
(1) Biomagnification (2) Bioaccumulation
(3) Eutrophication (4) Biodiversity

Q.7 Which one of the following is a renewable source of energy ? **[C.G. PMT 2004]**
(1) Petroleum (2) Coal
(3) Nuclear fuel (4) Trees

Q.8 Spraying of DDT produces pollution of -
[C.G. PMT 2004]
(1) Air only (2) Air and soil only
(3) Air, soil and water
(4) Air and water only

Q.9 Sewage water is purified for recycling by the action of - **[C.G. PMT 2005]**
(1) Light (2) Micro-organisms
(3) Aquatic plants (4) Fishes

Q.10 Which one is not dangerous -
(1) Biopollutants (2) Ozone layer
(3) Nuclear blast (4) Deforestation

Q.11 Which of the following set is green house gases ? **[JHARKHAND 2006]**
(1) CFC, CH_4, CO_2, N_2O
(2) CO_2, CH_4,N_2, O_2
(3) CO_2, CH_4, N_2O_3
(4) CO_2, CFC, N_2, O_2

Q.12 Acid rain is due to the pollution by -
[JHARKHAND 2005]
(1) CO_2 (2) SO_2 and NO_2
(3) Dust particles (4) Automobiles

Q.13 Which of the following is biodegradable pollutant ?
(1) Sewage (2) Plastic
(3) Polythene (4) DDT

Q.14 Most hazardous metal pollutant of automobile exhaust is - **[JHARKHAND 2004]**
(1) Cadmium (2) Lead
(C Mercury (4) Copper

Q.15 Air quality indicator is - **[BIHAR 2005]**
(1) Lichen (2) Moss
(3) Algae (4) None of these

Q.16 Blood haemoglobin has high affinity for -
[BIHAR 2004]
(1) CO_2 (2) CO
(3) O_2 (4) H

Q.17 Minamata disease caused due to water pollution is due to - **[BIHAR 2003]**
(1) Lead poisoning
(2) Arsenic chloride poisoning
(3) Mercury poisoning
(4) Ammonia pollution

Q.18 Effect of pollution is first marked on - **[UP CPMT 2002]**

(1) Micro-organisms

(2) Green vegetation of an area

(3) Food crop

(4) None of these

Q.19 Pollution is not caused by - **[UP CPMT 2002]**

(1) Thermal power plant

(2) Automobile

(3) Radioactive power plant

(4) Hydroelctric power plant

Q.20 Taj Mahal marble is affected by - **[UP CPMT 2002]**

(1) SO_2 (2) O_2

(3) O_3 (4) NO_2

Q.21 Minimata disease first occurred in - **[UP CPMT 2002]**

(1) Japan (2) China

(3) Korea (4) Russia

Q.22 Increase in BOD of water reservior is due to- **[AIPMT-2004]**

(1) Algae (2) Soil

(3) Moss (4) Waste product

Q.23 Number of wild life is continuously decreasing. What is the main reason of this - **[CPMT 2002]**

(1) Predation

(2) Cutting down of forest

(3) Destruction of habital

(4) Hunting

Q.24 One of the following is associated with the conservation of forests - **[DPMT 87]**

(1) Kaziranga (2) Ghana

(3) Silent valley (4) Gir

Q.25 Which one of the following is a pair of endangered species - **[AIIMS 2004]**

(1) Garden lizard and Mexican poppy

(2) Rhesus monkey and Sal tree

(3) Indian peacock and carrot grass

(4) Hornbill and Indian Aconite

Q.26 If the Bengal 'Tiger becomes extinct - **[AIIMS 2004]**

(1) Hyanas and wolves will become scare

(2) The wild areas will be safe for man and domestic animals

(3) Its gene pool will be lost for ever

(4) The populations of beautiful animals like deers will get stabilized

Q.27 If high altitude birds become rare or extinct, the plants which may disappear along with them are- **[AIIMS 2004]**

(1) Pine (2) Oak

(3) Orchids (4) Rhododrons

Q.28 Which one of the following pairs of geographical areas show maximum biodiversity in our country- **[AIIMS 2005]**

(1) Sunderbans and Rann of Kutch

(2) Eastern Ghats and West Bengal

(3) Eastern Himalaya and Western Ghats

(4) Kerala and Punjab

Q.29 One of the **ex situ** conservation methods for endangered species is - **[AIIMS 2005]**

(1) Wildlife Sanctuaries

(2) Biosphere Reserves

(3) Cryopreservation

(4) National Parks

Q.30 Reason for elimination of wild life is - **[AIPMT 1998]**

(1) Deforestation (2) Forest fire

(3) Floods (4) Less Rain fall

Q.31 Main reason of disturbance of biological diversity- **[AIPMT 1998]**

(1) Green house effect

(2) Hunting

(3) Soil erosion

(4) Destruction of natural habitats

Q.32 Best method to preserve the wild relatives of plants - **[AIPMT 1999]**

(1) By growing them in natural habitats

(2) Gene library

(3) By storing seeds

(4) Cryopreservation

Q.33 Species diversity is maximum in - **[AIPMT 1999]**

(1) Tropical rain forest

(2) Temperate forest

(3) Deserts

(4) Hill slops

Q.34 According to forestory comission report-1997 the total forest cover fo India - **[AIPMT 1999]**

(1) 11 % (2) 19.5 %

(3) 17 % (4) 18.7 %

Q.35 What shall be the effect of destruction of wild life - **[AIPMT 2000]**

(1) Wild gene of disease resistance will not be obtained

(2) Soil erosion

(3) Floods

(4) Green house effect

Q.36 Occurence of endemic species in south america and Australia due to - **[AIPMT 2001]**

(1) There species has been extinct from other regions

(2) Continental separation

(3) There is no terrrestrial route to these places

(4) Restrogressive evolution

Q.37 In your opinion, which is the most effective way to conserve the plant diversity of an area- **[AIPMT 2004]**

(1) By creating biosphere reserve

(2) By creating botanical garden

(3) By developing seed bank

(4) By tissue culture method

Q.38 Biodiversity Act of India was passed by the Parliament in the year - **[AIPMT 2005]**

(1) 2002 (2) 1992

(3) 1996 (4) 2000

Q.39 According to IUCN Red List. What is the status of Red Panda (***Ailurus fulgens***) ? **[AIPMT 2005]**

(1) Critically species

(2) Vulnerable species

(3) Extinct species

(4) Endangered species

Q.40 One of the most important functions of botanical gardens is that - **[AIPMT 2005]**

(1) they provide a beautiful area for recreation

(2) one can observe tropical plants there

(3) they allow ex-situ conservation of germ plasm

(4) they provide the natural habitat for wild life

Q.41 Which of the following pairs of an animal and a plant represents endangered organisms in India ? **[AIPMT 2006]**

(1) Cinchona and Leopard

(2) Banyan and Black buck

(3) Bentinckia nicobarica and Red Panda

(4) Tamarind and Rhesus monkey

Q.42 Which one of the following is not included under in - situ conservation ? **[AIPMT 2006]**

(1) Biosphere reserve

(2) National park

(3) Sanctuary

(4) Botanical garden

Q.43 Which one of the following is the correctly matched pair of an endangered animal and a National Park ? **[AIPMT 2006]**

(1) Wild ass - Dudhwa National Park

(2) Great Indian Bustard - Keoladeo National Park

(3) Lion - Corbett National Park

(4) Rhinoceros - Kaziranga National Park

Q.44 Which of the following is considered a hot-spot of biodiversity in India ? **[AIPMT 2006]**

(1) Eastern Ghats (2) Aravalli Hills

(3) Western Ghats (4) Indo-Gangetic Plain

Q.45 Identify the odd combination of the habitat and the particular animal concerned - **[AIPMT 2007]**

(1) Rann of Kutch - Wild Ass

(2) Dachigam national - Snow Leopard Park

(3) Sunderbans - Bengal Tiger

(4) Periyar - Elephant

Q.46 Which one of the following pairs of organisms are exotic species introduced in India ? **[AIPMT 2007]**

(1) Nile perch, Ficus religiosa

(2) Ficus religiosa, Lantana camara

(3) Lantana camara, Water Hyacinth

(4) Water hyacinth, Prosopis cinereia

Q.47 Which one of the following is not observed in biodiversity hotspots ? **[AIPMT 2008]**

(1) Lesser inter-specific competition

(2) Species richness

(3) Endemism

(4) Accelerated species loss

Q.48 The table below gives the populations (in thousands) of ten species (A – J) in four areas (a – d) consisting of the number of habitats given within brackets against each. Study the table and answer the question which follows-

Area and Number of habitats	Species and their populations (in thousands) in the areas									
	A	B	C	D	E	F	G	H	I	J
a (11)	2.3	1.2	0.52	6	-	3.1	1.1	9	-	10.3
b (11)	10	-	0.62	-	1.5	3	-	8.2	1.1	11.2
c (13)	11	0.9	0.48	2.4	1.4	4.2	0.8	8.4	2.2	4.1
d (12)	3.2	10.2	11.1	4.8	0.4	3.3	0.8	7.3	11.3	2.1

Which area out of a tod shows maximum species diversity ? **[AIPMT 2008]**

(1) d (2) a

(3) b (4) c

Q.49 Tiger is not a resident in which one of the following national park ? **[AIPMT 2009]**

(1) Jim Corbett (2) Ranthambhor

(3) Sunderbans (4) Gir

Q.50 Which one of the following is an example of ex-situ conservation? **[AIPMT Pre 2010]**

(1) Wild life centurary

(2) Seed bank

(3) Sacred groves

(4) National Park

Q.51 The Indian Rhinoceros is a natural inhabitant of which one of the Indian states - **[AIPMT Pre 2010]**

(1) Uttar Pradesh (2) Himachal Pradesh

(3) Assam (4) Uttarakhand

Q.52 Which of the following is the non conventional source of energy - **[DPMT 86]**

(1) Coal

(2) Petroleum

(3) Electricity from nuclear power plants

(4) Solar radiations

Q.53 Petrolium resource is - **[CBSE PMT 92]**

(1) Renewable

(2) Non renewable

(3) Synthetic & biodegradable

(4) Infinite & unconventional

Q.54 Biological Oxygen Demand (BOD) is measure of - **[AIIMS 2003]**

(1) Industrial wastes poured into water bodies

(2) Extent to which water is polluted with organic compouds

(3) Amount of Carbon monoxide inseparably combined with haemoglobin

(4) Amount of oxygen needed by green plants during night

Q.55 In almost all Indian metropolitan cities like Delhi, the major atmospheric pollutant(s) is/are - **[AIIMS 2003]**

(1) Suspended particulate matter (SPM)

(2) Oxides of sulphur

(3) Carbon dioxide and carbon monoxide

(4) Oxides of nitrogen

Q.56 Nitrogen oxides produced from the emission of automobiles and power plants, are the source of fine air borne particles which lead to - **[AIIMS 2004]**

(1) Photochemical smog

(2) Dry acid depposition

(3) Industrial smog

(4) Wet acid deposition

Q.57 A lake with an inflow of domestic sewage rich in organic waste may result in - **[AIIMS 2004]**

(1) Drying of the lake very soon due to algal bloom

(2) An increased production of fish due to lot of nutrients

(3) Death of fish due to lack of oxygen

(4) Incrased population of aquatic food web organisms

Q.58 Minamata disease was caused due to the consumption of - **[AIIMS 2004]**

(1) Sea food containing lot of cadmium

(2) Fish contaminated with mercury

(3) Oysters with lot of pesticide

(4) Sea food contaminated with selenium

Q.59 Which one of the following statements pertaining to pollutants is correct - **[AIIMS 2005]**

(1) DDT is a non-biodegradable pollutant

(2) Excess fluoride in drinking water causes osteoporosis

(3) Excess cadmium in driking water causes black foot disease

(4) Methylmercury in water may cause "Itai Itai" disease

Q.60 If CO_2 is absent in atmosphere of earth then - **[AIPMT-1998]**

(1) Temperature will decrease

(2) Temperatuer will increase

(3) Plants will flourish well

(4) No effect

Q.61 CO is harmful because - **[AIPMT-1998]**

(1) It forms stable compound with haemoglobin

(2) It blocks mitosis

(3) It is mutagenic

(4) It causes defloation

Q.62 Beside CH_4 and CO_2 other green house gas from agriculture area - **[AIPMT-1998]**

(1) SO_2 (2) NH_3

(3) NO_2 (4) CFC

Q.63 Temperature variation in Pacific ocean in present time is called - **[AIPMT-1998]**

(1) Cyclone effect (2) Alnino effect

(3) Green houe effect (4) Gaudikov's effect

Q.64 Sewage purification is performed by - **[AIPMT-1998]**

(1) Microbes (2) Fertilisers

(3) Antibiotics (4) Antiseptics

Q.65 Best eocnomic method to harvest the solar energy- **[AIPMT-1999]**

(1) Solar cell

(2) Energy plantation

(3) Cultivation of sugar cane then energy obtain by burning it

(4) solar cooker

Q.66 Bhopal gas tragedy is related with - **[AIPMT-1999]**

(1) Methan

(2) Carban monooxide

(3) Methyl Iso cyanate (MIC)

(4) SO_2

Q.67 Concentration of DDT is highest in - **[AIPMT-1999]**

(1) Primary consumer

(2) Producers

(3) Top consumer

(4) Decomposers

Q.68 Lichens can be used as - **[AIPMT-1999]**

(1) Bio-indicator for water and air pollution

(2) Initial vegetation for waste lands

(3) Source of wood

(4) To check the air pollution

Q.69 What is phytotron - **[AIPMT-1999]**

(1) A device to grow the plants in controlled environment

(2) Growing plants in green house

(3) Radiation chamber to induce the mutations

(4) Apparatus to study the effect of light on plants

Q.70 Which of the following is secondary pollutant- **[AIPMT-1999]**

(1) PAN (2) CO

(3) NO_2 (4) SO_2

Q.71 Maximum DDT in birds feeding on - **[AIPMT-1999]**

(1) Fishes (2) Meat

(3) Insects (4) Seeds

Q.72 Which one is associated with occupational hazard is - **[AIPMT-1999]**

(1) Fluorosis (2) Pneumoconiosis

(3) Silicosis (4) Asthama

Q.73 Green house effect is - **[AIPMT-1999]**

(1) Garderning outside the house

(2) Global cooling

(3) Global warming

(4) Green colour house

Q.74 What is B.O.D. - **[AIPMT-2001]**

(1) The of O_2 utilised by organisms in water

(2) The amount of O_2 utilized by micro organisms for decomposition

(3) The toal amount of O_2 present in water

(4) All of the above

Q.75 What is the intensity of sound in normal conversation - **[AIPMT-2001]**

(1) 10 – 20 decibal (2) 30 – 60 decibal

(3) 70 – 90 decibal (4) 120 – 150 decibal

Q.76 Which of the following is absent in polluted water - **[AIPMT-2002]**

(1) Hydrilla (2) Water hyacinth

(3) Larva of stone fly (4) Blue green algae

Q.77 Maximum green house gas released by which country - **[AIPMT-2002]**

(1) India (2) France

(3) U.S.A. (4) Britain

Q.78 Lead concentration in blood is considered alarming if it is - **[AIPMT-2004]**

(1) 30 μg/ 100 ml (2) 4-6 μg/100 ml

(3)10 μg/100 ml (4) 20 μg/100ml

Q.79 In 1984, the Bhopal gas tragedy took place because methyl isocyanate - **[AIPMT-2001]**

(1) Reacted with ammonia

(2) Reacted with CO_2

(3) Reacted with water

(4) Reacted with DDT

Q.80 Blood analysis of a patient reveals an unusually high quantity of carboxyhaemoglobin content. Which of the following conclusion is most likely to be correct ? the patient has been inhaling polluted air containing unusually high content of- **[AIPMT-2004]**

(1) Carbon monoxide (2) Carbon disulphide

(3) Chloroform (4) Carbon dioxide

Q.81 Common indicator organism of water pollution is- **[AIPMT-2004]**

(1) Entamoeba histolytica

(2) Lemna pancicostata

(3) Eichhornia crassipes

(4) Escherichia coli

Q.82 Which one of the following pairs in mismatched- **[AIPMT-2005]**

(1) Nuclear power - radioactive wastes

(2) Solar energy - greenhouse effect

(3) Fossil fuel burning - release of CO_2

(4) Biomass burning - release of CO_2

Q.83 Identify the correctly matched pair - **[AIPMT-2005]**

(1) Kyoto Protocol - Climatic change

(2) Montreal Protocol - Global warming

(3) Basal Convention - Biodiversity Conservation

(4) Ramsar Convention - Ground water pollution

Q.84 Prolonged liberal irrigation of agricultural fields is likely to create the problem of - **[AIPMT-2005]**

(1) Acidity (2) Aridity

(3) Salinity (4) Metal toxicity

Q.85 Which of the following is **not** used for disinfection of drinking water - **[AIPMT-2005]**

(1) Chlorine (2) Ozone

(3) Chloramine (4) Phenyl

Q.86 Limit of BOD prescribed by Central Pollution Control Board for the discharge of industrial and municipal waste waters into natural surface waters, is - **[AIPMT-2006]**

(1) < 100 ppm (2) < 30 ppm

(3) < 3.0 ppm (4) < 10 ppm

Q.87 The 'blue baby' syndrome results form - **[AIPMT-2006]**

(1) excess of dissolved oxygen

(2) excess of TDS (total dissolved solids)

(3) excess of chloride

(4) methaemoglobinaemia

Q.88 Montreal Protocol which calls for appropriate action to protect the ozone layer from human activities was passed in the year - **[AIPMT-2001]**

(1) 1988 (2) 1985

(3) 1986 (4) 1987

Q.89 Photochemical smog pollution does not contain- **[AIPMT-2006]**

(1) Carbon dioxide

(2) PAN (peroxy acyl nitrate)

(3) Ozone

(4) Nitrogen dioxide

Q.90 In a coal fired power plant electrostatic precipitators are installed to control emission of- **[AIPMT-2007]**

(1) CO (2) SO_2

(3) NO_8 (4) SPM

Q.91 Which one of the following is not a bioindicator of water pollution ? **[AIPMT-2007]**

(1) Sewage fungus (2) Sludge - worms

(3) Blood-worms (4) Stone flies

Q.92 Which one of the following is the correct percentage of the two (out of the total of 4) green house gases that contribue tothe total global warming ? **[AIPMT-2008]**

(1) N_2O 6 %, CO_2 86 %

(2) Methane 20 %, N_2O 18 %

(3) CFCs 14 %, Methane 20 %

(4) CO_2 40 %, CFCs 30 %

Q.93 World summit on sustainable Development (2002) was held in - **[AIPMT-2008]**

(1) Argentina (2) South Africa

(3) Brazil (4) Sweden

Q.94 About 70 % of total global carbon if found in - **[AIPMT-2008]**

(1) Ocean (2) Forests

(3) Desert (4) Rain forest

Q.95 A lake near a village suffered heavy mortlity of fishes within a few days. Consider the following reasons for this ? **[AIPMT-2008]**

(a) Lots of urea and phosphate fertilizer wer used in the crops in the vicinity

(b) The area was sprayed with DDT by and aircraft

(c) The lake water turned green and stinky

(d) Phytoplankton populations in the lake declined initially thereby greatly reudcing photosynthesis

Which two of the above were the main cause of fish mortality in the lake ?

(1) a, c (2) a, b

(3) b, c (4) c, d

Q.96 According to Central Pollution Control Board (CPCB), which particulate size in diameter (in micrometers) of the air pollutants is resposible for greatest harm to human health ? **[AIPMT-2008]**

(1) 1.0 or less (2) 5.2 – 2.5

(3) 2.5 or less (4) 1.5 or less

Q.97 Montreal Protocol aims at - **[AIPMT-2009]**

(1) Control of CO_2 emission

(2) Reduction of ozone depleting substances

(3) Biodiversity conservation

(4) Control of water pollution

Q.98 Chipko movement was launched for the protection of - **[AIPMT-2009]**

(1) Wet lands (2) Grasslands

(3) Forests (4) Livestock

Q.99 Steps taken by the government of India to control air pollution include - **[AIPMT-2009]**

(1) Use of non-polluting Compressed Natural Gas (CNG) only as fuel by all buses and trucks

(2) Compulsory mixing of 20 % ethyl alcohol with petrol and 20 % biodisel with disesel

(3) Compulsory PUC (Pollution Under Control) certification of petrol driven vehicles which tests for carbon monoxide and hydrocarbons

(4) Permission to use only pure diesel with a maximum of 500 ppm sulphur as fuel for vehicles

Q.100 Biochemical Oxygen Demand (BOD) in a river water - **[AIPMT-2009]**

(1) Increases when sewage gets mixed with river water

(2) Remains unchanged when algal bloom occurs

(3) Has no relationship with concentration of oxygen in the water

(4) Gives a measure of salmonella in the water

Q.101 DDT residues are rapidly passed through food chain causing biomagnification because DDT is- **[AIPMT-2009]**

(1) Water soluble

(2) Fat soluble

(3) Moderately toxic

(4) Non-toxic to aquatic animals

Q.102 Global agreement in specific control strategies to reduce the release of ozone depleting substances, was adopted by - **[AIPMT-2009]**

(1) The Vienna Convention

(2) Rio Janerior Conference

(3) The Montreal Protocol

(4) The Koyoto Protocol

Q.103 Breeding of crops with high levels of minerals, vitamins and proteins is called- **[AIPMT Pre 2010]**

(1) Somatic hybridation (2) Biofortification

(3) Biomagnification (4) Micropropagation

Q.104 The two gases making highest relative contribution to the green house gases are-

[AIPMT Pre 2010]

(1) CO_2 and CH_4 (2) CH_4 and N_2O

(3) CFCs and N_2O (4) CO_2 and N_2O

Q.105 A renewable exhaustible natural resource is-

[AIPMT Pre 2010]

(1) Coal (2) Petroleum

(3) Minerals (4) Forest

Q.106 When domestic sewage mixes with river water-

[AIPMT Pre 2010]

(1) The increased microbial activity releases micro-nutrients such as iron

(2) The increased microbial activity used up dissolved oxygen

(3) The river water is still suitable for drinking as impurities are only about 0.1%

(4) Small animals like rats will die after drinking river water

Q.107 Measuring Biochemical Oxygen Demand (BOD) is a method used for : **[AIPMT Pre 2012]**

(1) working out the efficiency of oil driven automobile engines.

(2) measuring the activity of *Saccharomyces cerevisae* in producing curd on a commercial scale.

(3) working out the efficiency of R.B. Cs. about their capacity to carry oxygen.

(4) estimating the amount of organic matter in sewage water.

Q.108 Which one of the following is a wrong statement?

[AIPMT Pre 2012]

(1) Ozone in upper part of atmosphere is harmful to animals.

(2) Greenhouse effect is a natural phenomenon.

(3) Eutrophication is a natural phenomenon in fresh water bedies.

(4) Most of the forests have been lost in tropical areas.

Q.109 Which one of the following areas in India is a hotspot of biodiversity ?

[AIPMT Pre 2012]

(1) Gangetic Plan (2) Sunderbans

(3) Western Ghats (4) Eastern Ghats

Q.110 Select the correct statement about biodiversity :

[AIPMT Mains 2012]

(1) The desert areas of Rajasthan and Gujarat have a very high level of desert animal species as well as numerous rare animals.

(2) Large scale planting of Bt cottn has no adverse effect on biodiversity.

(3) Western Ghats have a very high degree of species richness and endemism.

(4) Conservation of biodiversity is just a fad pursued by the developed countries.

ANSWER KEY

EXERCISE –3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	4	3	1	1	4	3	2	2	1	2	1	2	1	2	3	2	4	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	4	3	3	4	3	4	3	3	1	4	1	1	2	1	2	1	1	4	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	4	4	3	2	3	1	1	4	2	3	4	2	2	1	2	3	2	1	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	3	2	1	2	3	3	1	1	1	1	2	3	2	2	3	3	3	3	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	2	1	3	4	2	4	4	1	4	4	3	2	1	1	3	2	3	1	1
Ques.	101	102	103	104	105	106	107	108	109	110										
Ans.	2	3	2	1	4	2	4	1	3	3										

These questions consist of two statements each, printed as "ASSERTION" and "REASON". While answering these Questions you are required to choose any one of the following responses.

(1) If both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.

(2) If both Assertion and Reason are True but Reason is not correct explanation of the Assertion

(3) If Assertion is True but the Reason is False.

(4) If both Assertion and Reason are false.

Q.1 **Assertion :** Degree of water pollution is measured in terms of BOD.

Reason : BOD value is low when water is highly polluted.

Q.2 **Assertion :** Rill erosion is caused by running water.

Reason : It is biological method of soil conservation.

Q.3 **Assertion :** Long chain phenolic compounds, glass and plastic etc. are persistent pollutants.

Reason : These pollutants are not decomposed naturally or by activity of micro-organisms thus are not recycled back into the environment.

Q.4 **Assertion :** D.D.T. is biologically magnified.

Reason : D.D.T. causes water, soil and air pollution.

Q.5 **Assertion :** In the presence of Chlorella in water, water become free from bacteria.

Reason : It shows protocooperation.

Q.6 **Assertion :** Natural gas is a pollution free source of energy.

Reason : In India natural gas is maximum utilised source.

Q.7 **Assertion :** B.O.D. value is low when water is highly polluted.

Reason : High amout of fertilizer found in oligotrophic lake.

Q.8 **Assertion :** PAN is secondary pollutant

Reason : PAN is formed by chemical reaction of secondary pollutants.

Q.9 **Assertion :** Oxygen is very less in amount in nutrient rich lake.

Reason : B.O.D. is high in such lakes.

Q.10 **Assertion :** Grazing animal are the renewable resources.

Reason : It is exhaustible resources.

Q.11 **Assertion :** Los Angles somg is a photochemical smog requires high temperature.

Reason : Los Angles smog occurs mainly due to sulphure oxide.

Q.12 **Assertion :** Plants and animals are renewable resources.

Reason : These are exhaustible resources.

Q.13 **Assertion :** The global mean temperature has increased by 0.6ºC during 20^{th} century.

Reason : There has been a progressive increased combustion of fossil feuls generating more green house gases.

Q.14 **Assertion :** Ozone protects the earth from U.V. radiations from sun.

Reason : Ozone is Tropospheric pollutant.

Q.15 **Assertion :** Ozone is the Tropospheric pollutnat.

Reason : Ozone protects us from the harmfull U.V. radiation.

Q.16 **Assertion :** Air pollutants are always gaseous.

Reason : Because it is always released from chimmeys.

Q.17 **Assertion** : Suspended particulate matter (SPM) is an important pollutant released by diesel vehicles.

Reason : Catalytic converters gretly reudce pollution caused by automobiles.

Q.18 **Assertion** : Presently, the global atmosphere is warming up.

Reason : The depletion of stratospheric ozone layer has resulted in increase in ultraviolet radiations reaching the earth.

Q.19 **Assertion :** In In-situ conservation speices are protected in botanical gardens

Reasaon : In-situ conservation also take place in zoos

Q.20 **Assertion :** Desert shows poor biodiversity and their productivity is minimum

Reasaon : Annual rain fall is very less in desert.

Q.21 **Assertion :** In India, Mangrove vegetation is found in Sunderban.

Reasaon : Marshy land of Sunderban is physically dry.

Q.22 **Assertion :** Sunderbans have mangrove community.

Reasaon : Only mangrove vegetation present in it.

Q.23 **Assertion :** Corals are responsbile to form rocks in the sea.

Reasaon : Coral reef is the best example of stable marine ecosystem.

Q.24 **Assertion :** There is no noise in the forest during night in silent valley.

Reasaon : Animals are not found there.

Q.25 **Assertion :** Seed, gene banks come under ex-situ conservation.

Reasaon : This is the conservation of plants outside their habitat.

Q.26 **Assertion :** The silent valley is so called because it is silent during the night.

Reasaon : There is no human activity is allowed in night time.

Q.27 **Assertion :** Alpha diversity is diversity with in a community.

Reasaon : Diversity depends upon the rate of replacement of species along a gradient of habitats.

Q.28 **Assertion :** In per unit area maximum productivity occur in tropical rain forest.

Reasaon : Maximum number of producers found in Tropical rain forest in per unit area.

Q.29 **Assertion :** Western ghats are included among the hot spots of biodiversity.

Reasaon : Western ghats have greater amphibain diversity than eastern ghats.

Q.30 **Assertion :** Tropical regions are more diversity rich in comparison to temperate areas.

Reasaon : Availability of more solar energy indirectly affects the presence of more species in these areas.

Q.31 **Assertion :** Process of extinction is random.

Reasaon : Any species not adapted to environmental conditions cannot survive.

Q.32 **Assertion :** Habitat distruction is the main reason of loss of biodiversity.

Reasaon : This actually cause the increase in edge area and reduction in core area.

Q.33 **Assertion :** Pristine forests are among in situ conservation strategies.

Reasaon : These are sacred grooves where biota is protected on site.

ANSWER KEY

EXERCISE –4

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	3	1	2	4	3	4	3	1	2	3	2	1	2	2	4	2	2	4	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33							
Ans.	3	3	2	3	1	3	2	3	1	1	3	3	4							

Quick Review Table

Instruction to fill

(A) Write down the Question Number you are unable to solve in column A below, by Pen.

(B) After discussing the Questions written in column A with faculties, striks off them in the manner so that you can see at the time of Revision also, to solve these questions again.

(C) Write down the Question Number you feel are important or good in the column B.

EXERCISE NO.	COLUMN : A	COLUMN : B
	Question I am unable to solve in first allempt	**Good / Important questions**
Exercise # 1		
Exercise # 2		
Exercise # 3		
Exercise # 4		
Other Exercise		

Advantages

1. It is advised to the students that they should prepare a question bank for the revision as it is very difficult to solve all the questions at the time of revision.
2. Using above index you can prepare and maintain the questions for your revision.

BIOLOGY

COMPLETE SOLUTION TO NEET/AIIMS/JIPMER

. THEORY NOTES
. MULTIPLE CHOICE
. EXCERCISE

ALL MODULES
COMPLETE BOOKLET

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