ECOSYSTEM

Introduction:

- It is the sum total of interacting biotic & abiotic factors that are capable of independent existence.
- The term **ecosystem** coined by **Tansley (1935)**.
- **Carl mobius** used the term **biocoenosis**.
- **Forbes** coined the term **microcosm**.
- **Sukhachov** used the term **Biogeocoenosis.**
- **Mishra** used the term **Ecocosm**.
- **Ecosystems are of two types.**
  - **(i) Terrestrial ecosystem : e.g. Forest, Grassland, Desert.**
  - **(ii) Aquatic ecosystem : e.g. Sea, freshwater ecosystem.**
- **On the basis development, ecosystem involves two types :**
  - **(a) Natural ecosystem :** It is formed naturally with out human interfare : **e.g. forest, ocean.**
  - **(b) Anthropogenic or man made ecosystem or Artificial–ecosystem :** It is formed by human activities. **e.g. Agriculture land, Garden, Aquarium.**
- **Ecosystems are of four types on the basis of size:**
  - **(a) Megaecosystem :** Large sized – **e.g. sea.**
  - **(b) Mesoecosystem (Macroecosystem) :** Medium sized **e.g. forest Grassland, Desert.**
  - **(c) Microecosystem :** Small sized **e.g. Pond, Lake.**
  - **(d) Nano ecosystem :** very small sized– **e.g. Kitchen graden, Log of wood, Aquarium**

Ecosystem – open system :

- **Ecosystem is open system :** It receives input of solar energy and nutrients from external source that are distributed in various components.
- Either ecosystem/individual performs out put of waste substance & energy in the external environment.

Components of Ecosystem :

(1) Biotic **(2) Abiotic**

(1) Biotic components :

It involves living beings that can be differentiated into three categories.

(a) Producers **(b) Consumers** **(c) Decomposers.**

(a) Producers (Autotrophs) :

- They are able to synthesize their own food by photosynthesis in the presence of sunlight. **e.g. Green plant, photosynthetic bacteria, Blue green algae**
- **Koromondy** coined the term **Transducer's** for **producers** because the latter convert radiant energy of sunlight in to chemical energy.
- **Phytoplanktons are main producers in aquatic ecosystems whereas rooted plants in terrestrial ecosystem.**
- Rooted plants of shallow water are called macrophytes.

(b) Consumers (Heterotrophs) :

- They are unable to synthesize their own food directly or indirectly.
- They depend upon producers for obtaining nourishment.
- Consumers can be differentiated into following catagories.

(1) Primary consumers / Herbivores :

- ❖ They obtain their nutrition from producers. **e.g. Cow, Goat, Sheep, Horse, Deer, Rat, Rabbit, Grasshopper, Buffalo, Zebra, Elephant, Zooplanktons.**
- ❖ They are also known as **key industry animals** because they convert plant material into animal material.

(2) Secondary consumers / Primary carnivores:
They obtain their nutrition from primary consumers. **e.g. Frog, Fox, jackel, Hyaena, Wolf, Wild cat, Snake, Small fishes.**

(3) Tertiary consumers / secondary carnivores:
They obtain their nutrition from secondary consumers or primary consumers.

- ❖ They can not be prayed by other animals hence they are also called **top consumers e.g. Eagle (hawk), Kite, Vulture, Peacock, Lion, Tiger, Crocodile shark.**

(c) Decomposers :

- ❖ These are microscopic organisms like Bacteria and fungi that degrade or decompose dead organic matter or Dead parts of animals and plants they are also called **reducers**.
- ❖ They are also called **microconsumers**. They are also called **osmotrophs**.

Resonate the Concept

Two other categories of living beings are **Detrivores and parasites**.

- **Detrivores / Scavangers** obtain their nourishment from dead parts of plants, animals **e.g. Earthworm, Vulture.**
- **Parasites** obtain their nutrition from host. **e.g. Protozoans, worms.**

Structure of ecosystem:

- ❖ **Species composition :** It is different in different species.
- ❖ **Standing crop (Biomass) :** It is amount of living matter present in any ecosystem. **(AIPMT – 2015)**
- ❖ **Standing state :** Amount of inorganic substances present in ecosystem.

*__Stratification : Vertical distribution of different species occupying different levels is called stratification. (AIPMT- 2015) For example, trees occupy top vertical strata or layer of a forest, shrubs the second and herbs and grasses occupy the bottom layers. It is not a functional aspect of ecosystem. (AIPMT- 2012)__

Functions of ecosystem : For AIIMS & NEET

It involves

(I) Productivity (II) Decomposition (III) Energy flow (IV) Nutrient cycling

(I) Productivity :

- ❖ Synthesis of energy containing organic or biomoss by any trophic level in unit area in unit time is described as Productivity or rate of production of biomass is called productivity

Productivity is of two types :

(1) Primary productivity : Total energy accumulation in green plants in the form of biomass/organic matter in unit area over a period of time through photosynthesis is called primary productivity.

Primary productivity involves two types :

(a) Gross primary Productvity (GPP) : Synthesis of organic matter in producers by photosynthesis in unit area in unit time is called GPP **(AIPMT-2015)**. It involves loss of energy through Respiration and other metabolic activities.

(b) Net Primary Productivity (NPP) : Amount of organic matter stored in producers by photosynthesis in unit area in unit time is called NPP.

NPP = GPP – R **R = Respiration.**

*** NPP -** It is available biomass for hosts (as herbivores or decomposers).

(2) Secondary productivity : It is resynthesis of organic matter in secondary consumers.

❖ **Loss of energy through rspiration is 20% in producers. 30% in Herbivores and 60% in carnivores.**

Resonate the Concept

(1) High productivity ecosystems : Productivity is 2– 4 kg. /m^2/ yr. It is 6 – 20 g. m^2/ day. **e.g. Tropical rain forest, Coral reefs, estuaries land of upwelling, Flood plains, sugarcane field Maximium productivity–Coral reefs.**

(2) Hot deserts : Deficiency of water and higher temperature decrease productivity.

(3) Cold deserts : Low temperature decreases productivity.

(4) In deep sea low light intensity decreases productivity.

(II) Decomposition :

❖ It is physical and chemical breakdown of dead organic matter through the action of some specific organisms called **decomposers**.

❖ Organic remains (Dead plant parts, deadparts of Animals, Excretions) is called **Detritus**.

Detritus involves two types :

(A) Above ground detritus : (Plant litter, dead plant parts & animal parts excretory substances).

(B) Below ground detritus : Dead roots of plant, Dead animals in soil.

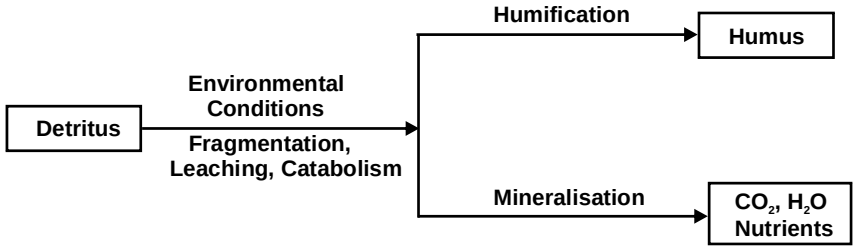


Fig: Processes involved in decomposition of detritus

Process of Decomposition :

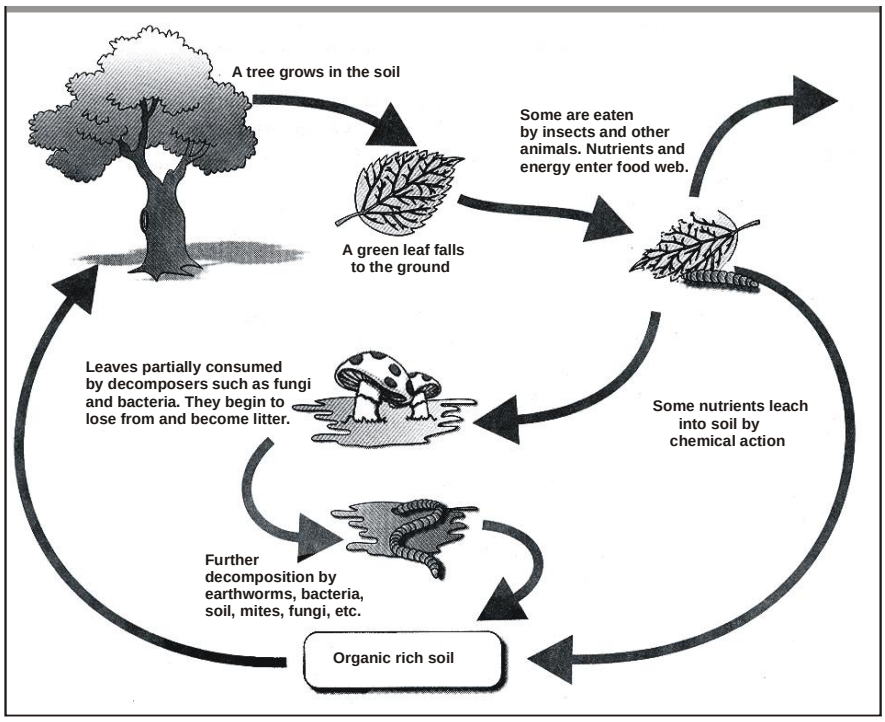
(1) Fragmentation of Detritus : Large fragments of detritus break into small fragment by Detrivores (Termites, carrian flies, Earthworms). Pulverisation of Detritus takes place in the digestive tract of detrivores after that digested organic matter becomes immobilized in their body.

(2) Catabolism : Bacteria and fungi splits large & complex organic substances into simple inorganic and simple organic substances. a part of digested organic matter becomes immobilized in the body of bacteria, that is called nutrient **immobilization**.

(3) Leaching : Soluble substances formed by decomposition, passage in the depth of soil/soil water by percolating water is called **leaching.**

- Decomposition gives rise to two products Humus and minerals.
- Process of formation of Humus is called **Humification**.
- Humus is dark coloured amorphous sabstance that is rich in nutrients and having good water holding capacity and aeration.
- Micro-organisms like bacteria perform saperation of inorganic substances [Non minerals - CO_2 & H_2O] and minerals (Ca^{++}, Mg^{++}, NH_4^+ etc.) from organic matter that is called **Mineralization**.

  Decomposition 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 detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars. 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 whereas low temperature and anaerobiosis inhibit decomposition resulting in build up of organic materials.



(III) Energy flow

- Usually it is unidirectional in an ecosystem. Sun light → **Producer → Consumer → Decomposer**
- Energy flow in ecosystem can be explained by two laws of thermodynamics.
  - **(i) First law of thermodynamics:** Energy can niether be destroyed nor synthesized but It can change in one form to another.
  - **(ii) Second law of thermodynamics :** When energy transfers from one level to next level then some energy is lost as heat or entropy.
- Sun is then only source of energy for all ecosystems on earth the **incident solar radiation less than 50% of it is PAR (Photosynthetically Active Radiations) - AIPMT pre. 2011.**
- **1– 5% Incident solar radiations or 2 – 10% PAR** is trapped by **photosynthetic organisms** to form organic food during photosynthesis.
- The loss of energy by respiration is 20% in producers therefore the net primary productivity is 0·8-4% of incident solar radiation or 1·6 – 8% of PAR.

Trophic level:

- Any food level of an ecosystem or food chain is called trophic level.
  (a) Producers –T_1 **(b) Primary consumers –T_2**
  (c) Secondary consumers –T_3 **(d) Tertiary consumers – T_4**
  (e) Quartinary or Top consumers –T_5 **(f) Decomposers –T_6**
- **Parasites can present any trophic level**

For AIIMS & NEET

Food Chain :

- It is straight single system of individuals through which food energy travels in the ecosystem.
  It is a sequence of individuals of an ecosystem through which food and its contained energy pass with each member becoming food of the next member of the sequence.
  Food chains are of three types.
  (a) Parasitic food chain : It starts from large organisms and ended on parasite/small organism.

Tree → Birds → Parasite

(b) Detritus food Chain : It starts from dead organic matter that is eaten by detrivores (**e.g.** earthworm) the latter is prayed by pr. carnivores that is captured by secondary carnivores.

Detritus → Earthworm → frog → snake
↓ ↓
Sparrow **Falcon / Hawk / Peacock**
↓
Falcon

(c) Grazing food chain or predatory food Chain: It starts from producers

(1) Terrestrial ecosystem:

(a) Grass ⟶ Grasshopper ⟶ frog ⟶ Snake ⟶ Peacock / hawk
(b) Grass ⟶ Dear ⟶ Wolf ⟶ Lion / Tiger
(c) Grass ⟶ Rabbit ⟶ Fox ⟶ Wolf ⟶ lion / Tiger
(d) Grass ⟶ Rat ⟶ Fox ⟶ lion / Tiger,
(e) Grass ⟶ Deer ⟶ Tiger / lion,
(f) Grass ⟶ Elephant.

(2) Aquatic ecosystem:

(a) Phytoplanktons → zooplanktons→ small fishes
↓
Large fishes.
(b) Phytoplanktons → Zooplanktons → Crustaceans
↓
Predatory insects
↓
Small fishes
↓
Large fishes
↓
Crocodile
(c) Phytoplanktons → Zooplanktons → Crustaceans
↓
Small fishes
↓
Birds – kingfisher

Food web :

❖ It is a network of food chains which are interconnected at various trophic levels as to form various feeding connections among member of biotic community.

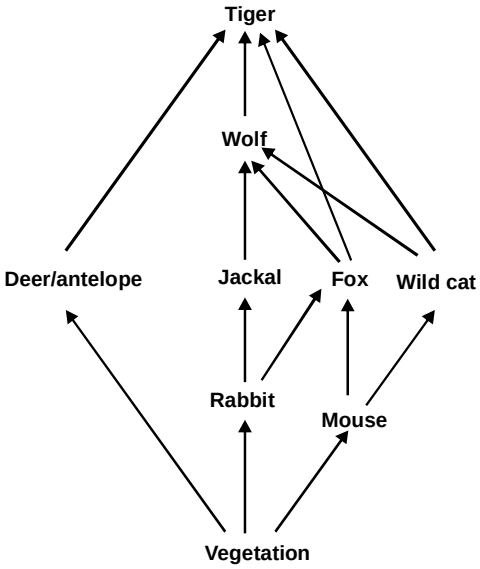


Fig: A Terrestrial food web.

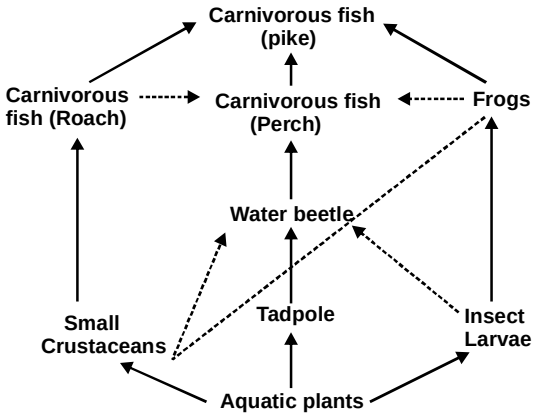


Fig: An aquatic food web with the Interconnected food chains.

Resonate the Concept
• The regulation of equilibrium in an ecosystem is called **cybernatics**.

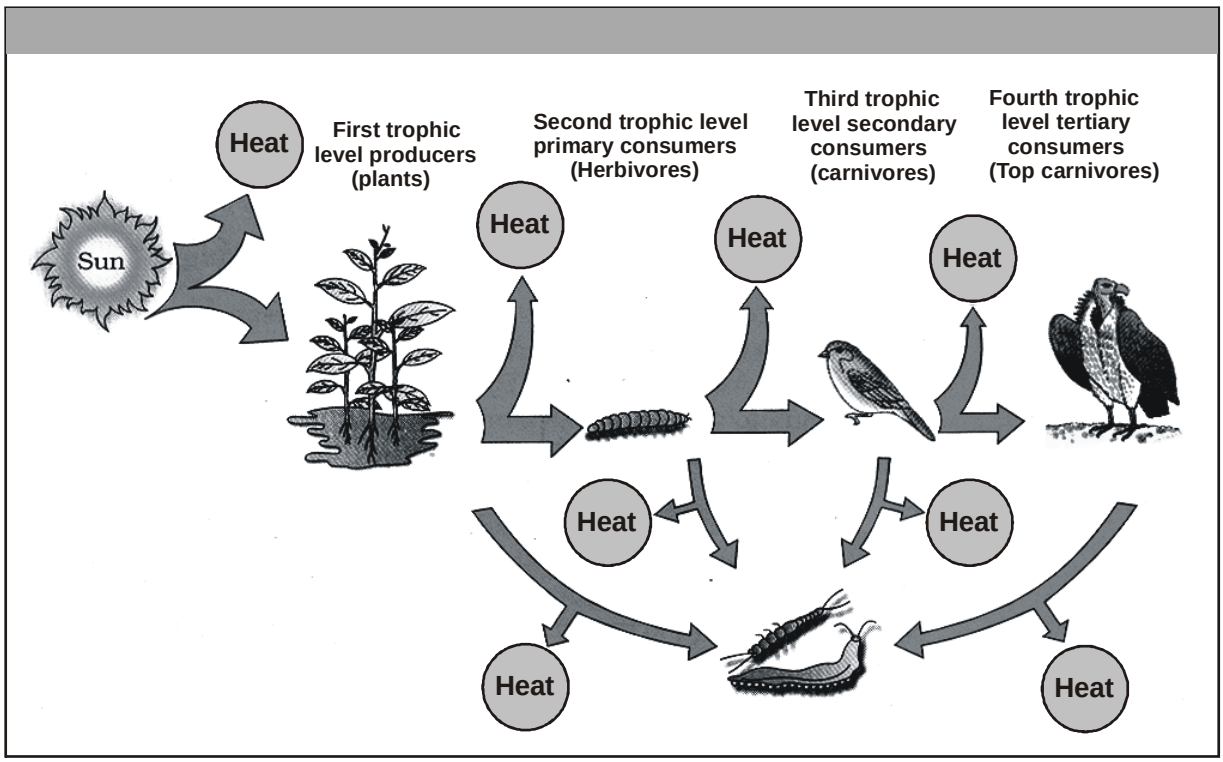


Fig : Energy flow in different trophic levels

For AIIMS & NEET

Ecological pyramids:

- The concept of ecological pyramid was given by **Charls elton (1927)** hence they are also called eltonian pyramids.
- It is graphic representation of ecological parameters like number of individuals / biomass / energy in different trophic levels of food chain with producer at the base and top consumer to top.

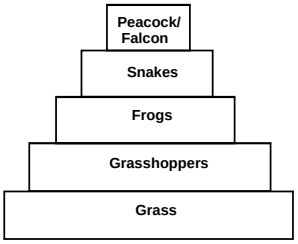


Fig: Pyramids of number in terrestrial ecosystem.

(a) Pyramids of Number :

- It is graphic reprsentation of number of individuals per unit area in different trophic levels of a food chain.

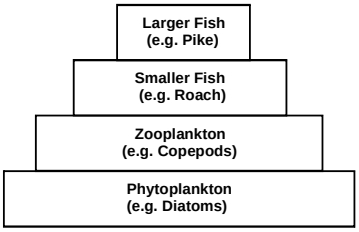


Fig: Pyramids of number in pond ecosystem–upright

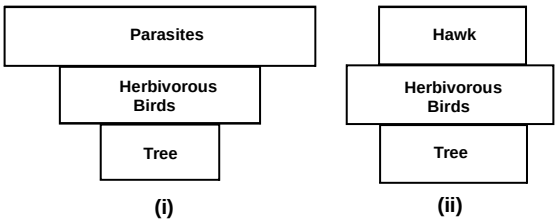


Fig: Pyramid of Numbers in Tree ecosystem (i) inverted (ii) spindle shaped.

(b) Pyramid of Biomass :

- It is graphic representation of amount of biomass per unit area in different trophic levels of food chain.

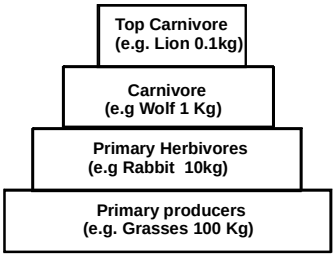


Fig: Pyramid of biomass in grassland–Upright

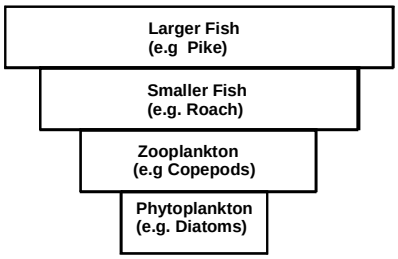


Fig: Pyramids of Biomass in pond ecosystem–Inverted

(c) Pyramid of energy :

- It is graphic representation of amount of energy trapped per unit area and time in different trophic levels of a food chain. It is always upright in all the ecosystems.

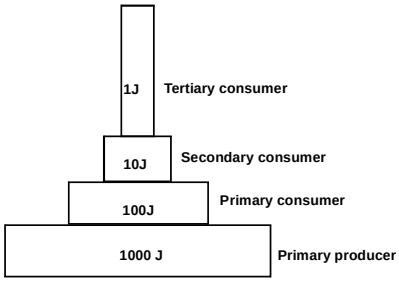


Fig: Pyramid of energy–Always upright

However, there are certain limitations of ecological pyramids such as it does not take into account the same species belonging to two or more trophic levels. It assumes a simple food chain, something that almost never exists in nature; it does not accommodate a food web. Moreover, saprophytes are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

Test your Resonance with concept

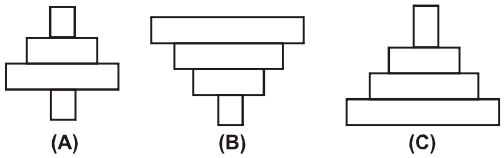
1. Correct sequence in food chain is
(1) Grass Insects BirdsSnake (2) GrassSnakeInsectsDeer
(3) GrassWolfDeerBuffalo (4) GrassRabbitWolf

2. In an ecosystem, trophic level of man is
(1) Producer (2) Herbivore (3) Omnivore (4) Carnivore.

3. Ecosystem of a pond is
(1) Lotic (2) Lentic (3) Benthic (4) Xeric.

4. Pyramid of numbers is upright in which of the ecosystems
(1) Parasitic food chains (2) Tree ecosystem
(3) Grassland ecosystem (4) None of these

5.



On the basis of above diagrams, select the suitable option having correct information about these diagrams

(1) A - Pyramid of tree - spindle shaped on the basis of number -
B - Pyramid of pond - inverted on the basis of biomass
C - Pyramid of grassland - upright on the basis of number & biomass
(2) A - Pyramid of pond - spindle shaped on the basis of biomass
B - Pyramid of tree - Inverted on the basis of number
C - Pyramid of energy - upright
(3) A - Pyramid of Parasitic food chain - spindle shaped - on the basis of number
B - Pyramid of pond - inverted on the basis of biomass
C - Pyramid of grassland upright on the basis of biomass
(4) A - Pyramid of tree - spindle shaped on the basis of number
B - Pyramid of parasitic food chain - inverted on the basis of biomass.
C - Pyramid of pond ecosystem - upright on the basis of number.

Answers

1. (4) **2.** (3) **3.** (2) **4.** (3) **5.** (1)

(IV) Nutrient cycling:

- They are exchanges, storage and transfers of Biogenetic nutrients so they can utilize again and again.
- Biochemical cycling is circulation or transportation of biogenetic nutrients between abiotic and biotic components of Biosphere.
- Biogenetic nutrients are essential elements required to organisms for their body building and metabolism.
- Organisms obtain them from earth and after their death they return back to the earth.
- Reservoir pool is a pool of biogenetic nutrients through which they are slowly transferred in the cycling pool.
- **Cycling pool :** Are being emptied or filled repeatedly by exchange between two trophic levels of Biosphere.
- **Gaseous pool of matter :** Circulatory materials between abiotic and biotic components are gases and water vapour and the reservoir pool is atmosphere and Hydrosphere.
- **Sedimentary pool of matter :** Circulatory material between abiotic and biotic components are minerals and the reservoir pool is lithosphere **e.g. Sulphur cycle, phosphorus cycle, calcium cycle, magnesium cycle, sulphur has both lithosphere & atmosphere sources.**

Components of Nutrient cycling :

(a) Input of nutrients : Ecosystem receives input of nutrients from external sources.

It is of four types

(1) Wet deposition by rain fall. **(2) Dry deposition by dust fall.**

(3) Biological N_2 fixation. **(4) Weathering of rocks.**

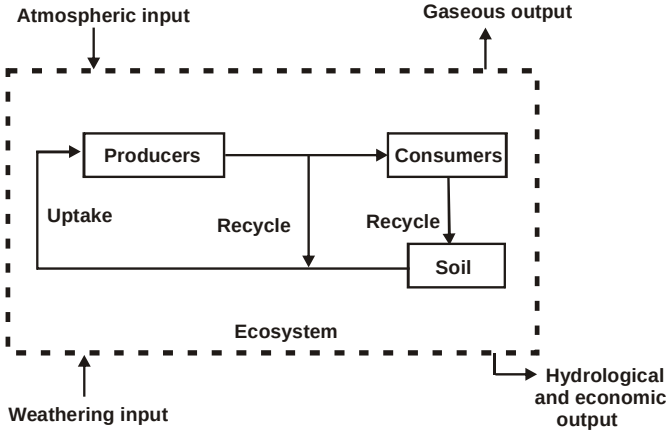


Fig: Nutrient cycling – A generalised model

(b) Output of nutrients : It takes place through run off water, soil erosion, cattle grazing, denitrification, Falling of trees, deforestation. Harvesting of crops.

(c) Internal nutrient cycling : Nutrients present in the soil are absorbed by plants that is called uptake. A part of these nutrient circulates in different trophic level of consumers through plants, and after their death these nutrients are again shifted in the soil, it is called recycling.

- In mature ecosystem the rate of uptake of nutrients is equal to the rate of their recycling.
- In young ecosystem, the rate of uptake is higher than recycling.

Thus Retention = Uptake – recycling.

- According to **Odum, (1963)** three types of cycles are operating in an ecosystem. These are
  - **(i) Hydrological cycle i.e water cycle**
  - **(ii) Biogeochemical cycles e.g. carbon & nitrogen cycles.**

(iii) Sedimentary cycles such as those of sulphur, Phosphorus etc.

- Biogenetic elements (Macro,micro,& other element) flow from the environment into and out of the plant in a cyclic manner. This flow of nutrients from abiotic to biotic components of the ecosystem and vice-versa constitute the **biogeochemical cycles.**

Carbon cycle :

- The concentration of CO_2 is 0.03% in atmosphere, which is utilized by producers in photosynthesis for making food. It has been estimated that about 4×10^{13} CO_2 is annually fixed by producers during photosynthesis

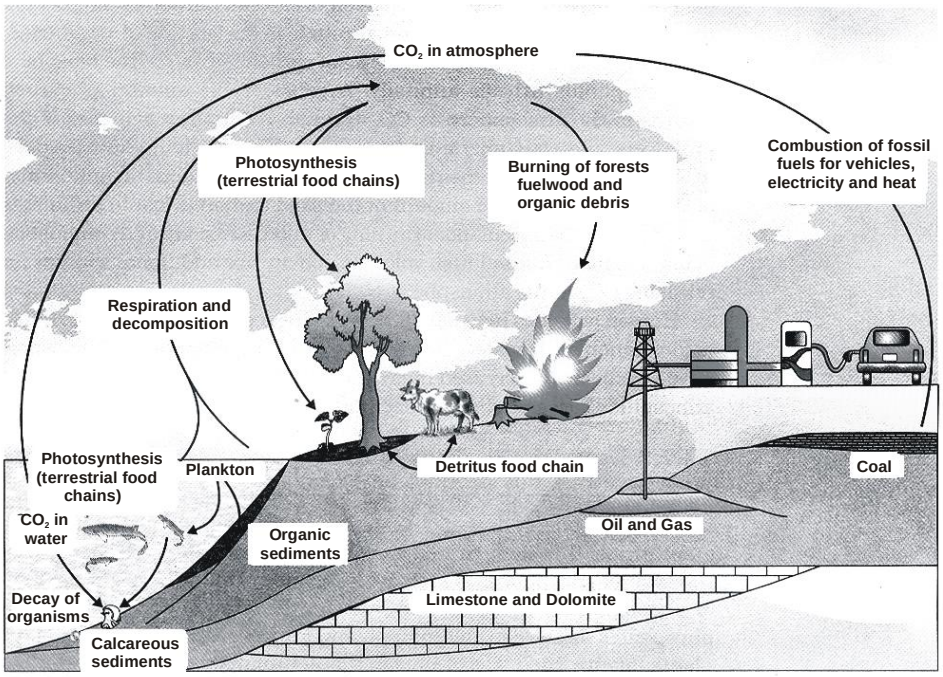


Fig : Simplified model of carbon cycle in land

- From producers, it is shifted to consumers and then through decomposers into atmosphere.
- After death, the producers, consumers & decomposers are converted into fossil fuel (coal, petrol).
- Living organisms release CO_2 in atmosphere during respiration.
- CO_2 may get dissolved in water. The lime rocks also contribute to CO_2 in water. The aquatic producer use this CO_2 for photosynthesis and return it by respiration.
- CO_2 is returned to the atmosphere by combustion of fossil fuel & also by volcanic activity.

Phosphorus Cycle:

- Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer systems.
- Many animals also need large quantities of this element to make shells, bones and teeth. The natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates. When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of the plants. Herbivores and other animals obtain this element from plants. The waste products and the dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus.

- Unlike carbon cycle, there is no respiratory release of phosphorus into atmosphere.

❖ The other two major and important differences between carbon and phosphorus cycle are firstly, atmospheric inputs of phosphorus through rainfall are much smaller than carbon inputs, and, secondly, gaseous exchanges of phosphorus between organism and environment are negligible.

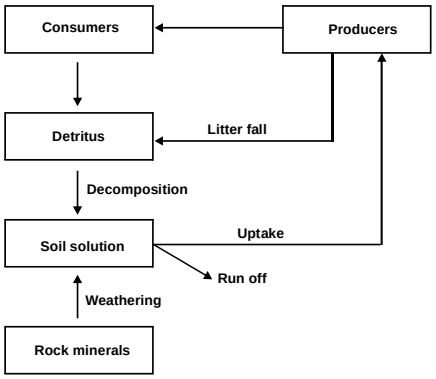


Fig: Phosphorus cycle–A simplified model

Resonate the Concept

(1) 10% law : It was proposed by **Lindeman**. He stated that only **10% of energy/biomass** is transferred from one trophic level to next trophic levels.

(2) GPP (Gross primary productivity) utilizes **1·5% of incident radiation or 2-10% of PAR (photo synthetically active radiation).** The latter is 50% of total incident radiation.

(3) Ecological Efficiency:

The ratio between the energy assimilated over the energy available between two trophic levels is called ecological efficiency.

Types of Ecological Efficiency:

(i) Photosynthetic efficiency: It is amount of incident solar radiations trapped by producers for performing photosynthesis and produce gross primary productivity.

$$\text{Photosynthetic Efficiency} = \frac{\text{Energy in Gross Primary Productivity}}{\text{Energy in incident solar radiations}} \times 100$$

(ii) Net Production Efficiency: It is ratio of percentrage of net primary productivity and gross primary productivity.

$$\text{Net Production Efficiency} = \frac{\text{Net Primary Productivity}}{\text{Gross Primary Productivity}} \times 100$$

(iii) Assimilation Efficiency: It is the ratio of percentage of food energy assimilated and food energy ingested.

$$\text{Assimilation Efficiency} = \frac{\text{Food Energy Assimilated}}{\text{Food Energy Ingested}} \times 100$$

(iv) Ecological efficiency / Trophic level Efficiency: The percentage of energy converted into biomass by a higher trophic level over the energy of food resources available at the lower trophic level is called ecological efficiency.

$$\text{Ecological Efficiency} = \frac{\text{Energy Converted into Biomass at Trophic level}}{\text{Energy Present in Biomass at Lower Trophic Level}} \times 100$$

For AIIMS & NEET

Ecological succession:

- It is the development of different biotic communites at the same site till a climax community develops there. The gradual replacement of one type of plant community by the other in same area is called **plant succession**.
- It was first studied by **King, (1685)**. The term **succession** coined by **Hult, (1885)**.
- First biotic community on a bare area is called "**pioneer community**".
- A complete range of a plant succession is called "**sere**". The ecological succession in water is called as **Hydrarch** and the stages through which it occurs collectively, constitute the **hydrosere** (in pond or lake) or **halosere** (in saline water).
- The ecological succession occurs 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 **Psammosere**.
- **Thus both Hydrach and xerarch successions lead to medium water conditions (mesic)- neither too dry (xeric) nor too wet (hydric)- AIPMT main 2011**
- The different intermediate stages of a plant succession are called **"seral stages or seral communities**" The last succession in a sere is called **"climax or a climatic climax"**.

Types of succession:

- **Depending upon the type of nudity of the area**, it is of two types
  - **(i) Primary Succession (= Prisere) :** The succession on a barren area which has never before borne a vagetative cover is known as primary succession. **e.g. Newly exposed sea floor, newly created pond, Igneous rocks, sandy dunes, estuaries, Mud bank.**
  - **(ii) Secondary sucession (= Subsere) :** It occurs on an area which was previously occupied by vegetation which was later destroyed by fire, deforestation **(AIPMT-2015)**, over grazing, volcanic eruptions and floods etc.

- **On the basis of replacement,** it is of two types.
  - **(i) Autogenic succession :** Due to modification of the enviroment by the plant community itself, when one community is replaced by another suitable community, the succession is called as autogenic succession.
  - **(ii) Allogenic succession :** In some cases however the replacement of the existing community is caused largely by any other external condition and not by the existing community organisms. Such type of succession is called as allogenic succession.

    There is a perfect equilibrium between abiotic and biotic components of the area. The final community of dominant species is not replaced by any other group of plants. The former is called **climax community** and the stage is called **climax stage**.

Lithosere: Xerosere (Biotic Succession on Bare Rock):

Various seral stage of lithosere are as following.

- **(i) Lichen stage :** Wind borne lichen propagules settle on the wet rock surface soon after rain or heavy dew. They develop very fine rhizoids for attachment. The crustose lichens are pioneer lichens. **e.g.Graphis, Rhizocarpon.** They secrete lichen acids and carbonic acid which slowly corrode rock surface. With time the wind borne soil particles and organic matter from dead lichen parts collect in them, as a result larger lichens like foliose lichens, appear in this area **e.g. Dermatocarpon**, **Parmelia**. They increase shading of the rock, cause deeper depressions and accumulate more soil particles as well as organic matter. The foliose lichens kill the crustose lichens by shading them.

(ii) Moss Stage : The new conditions are favourable for growth of hardy mosses **e.g. Tortula, Grimmia.** They create more humus and shade to eliminate lichens.

(iii) 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.

(iv) Perennial grass stage : Annual grasses are replaced by perennial grasses due to increased moisture and soil in the rock crevices. **e.g. Cymbopogon, Heteropogon**.

(v) 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. **e.g. Fragaria, Rubus, Rhus, Capparis, Zizyphus** etc, These plants can tolerate bright sunlight. They increase soil and humus content besides moisture.

(vi) Forest stage or climax forest : Several hardy and light demanding trees grow in the area occupied by shrubs. Slowly environment becomes more moist and shadier so that plants of climax community spread in the area. Type of climax community depends upon the climate. Therefore, it is also called climatic climax community. It is a rain forest in a moist tropical area, a coniferous forest or deciduous forest in temperate area. Grassland appears in area with less rainfall. The shrubs and tree stages are then omitted.

Hydrosere (Biotic Succession in water) :

The various seral stage of hydrosere are as follows.

(i) Plankton stage : Phytoplanktons like **diatoms, green algae, blue green algae** etc. are pioneer stage of the hydrosere. that 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.

(ii) Submerged stage : Hydrilla, Potamogeton and Najas form dense growth at bottom enriched with organic matter.

(iii) Floating stage : Floating leaved anchored plants **(e.g. Nymphaea, Nelumbo)** appear where water becomes shallow. These plants bear tuberous rhizomatous and creeping stems and leaves floating on the surface of water. At places, free floating plants also occur **e.g. Azolla, Wolffia, Lemna**. The bottom begins to rise making water shallower.

(iv) Reed Swamp stage : Amphibious plants grow in the shallow water. **e.g. Phragmites, Typha, Scirpus, Sagittaria.** They produce abundant organic matter and add more silt and humus at the bottom.

(v) Marsh Meadow stage : The newly built shores are invaded by **Carex, Sedge, Cyperus**, **Juncus**, grasses like **Themeda** and **dichanthium** and herbs like **Campanula**, **Caltha**, **Polygonum** etc.

(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 **e.g. Populus (cotton wood), Salix (willow), Cephalanthus, Alnus, Terminalia, Cornus (Bogwood).**

(vii) Forest stage or climax forest : New trees, shrubs and herbs appear which are in perfect harmony with the climate of the area. The climax forest depends upon the climate –rain forest in moist tropical area and mixed conferous or decidous forest in temperate area. A mixed temperate forest includes broad leaved trees like **Quercus (Oak), Ulmus (Elm) and Acer, and gymnosperms like Abies (Fir), Taxus (Yew) and Picea (Spruce).**

Ecosystem Services :

- The products of ecosystem processes are named as ecosystem services. **e.g.** Healthy forest ecosystems purify air and water, mitigate droughts and floods, cycle nutrients, generate fertile soils, provide wildlife habitat, maintain biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spritual values.
- **Robert Constanza** and his colleagues have very recently tried to put price tags on nature's life-support services. Researchers have put an average price tag US $ 33 trillion a year on these fundamental ecosystems services. This is nearly twice the value of the global gross national product GNP which is (US $ 18 trillion).
- Out of the total cost of various ecosystem services, the soil formation accounts for about 50%, recreation and nutrient cycling less than 10% each, climate regulation and habitat for wildife are about 6% each.

For AIIMS & NEET

Biomes :

Biome represents large sized ecosystem delimited by specific climate having flora and fauna.

Types of Biomes:

(A) Terrestrial Biome **(B) Aquatic Biome**

(A) Terrestrial Biome:

- It involves **Tundra, Taiga, Temperate broad leaved forests, Tropical deciduous forest, Tropical rain forest, Chapparel forest, Savannah, Grassland and Desert.**

(I) Tundra Biome:

- In winter temperature is –30 to –40ºC but in summer it is 10ºC.
- Annual rainfall less than 25 cm.
- **Soil is permafrost.**
- Vegetation involves moss (sphagnum), Lichen (Cladonia), Birch, Betula, grass.
- **Fauna** Arctic fox, polar bear, Caribou, Reindeer (mammals), Birds like snow grouse, snow owl. Polar beer performs hibernation where as Reindeer and caribou migrate in less cold areas during winter.

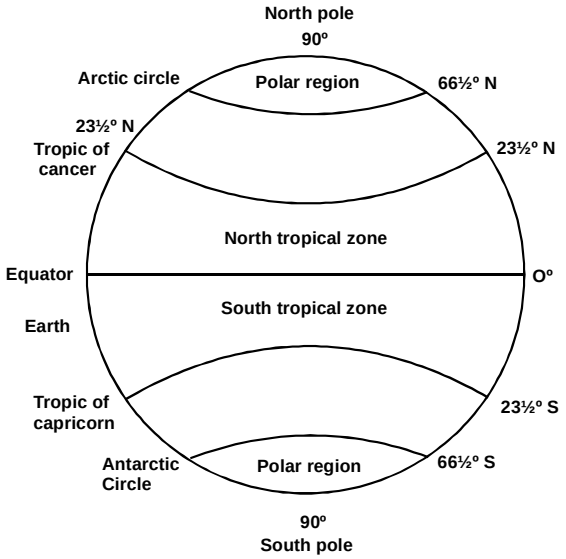


Fig: Temperature zones of earth

- **Alpine tundra** – vegetation – **Rhododendron.** Sexifraga, Juniparus.

(II) Taiga or Temperate needle leaf forest :

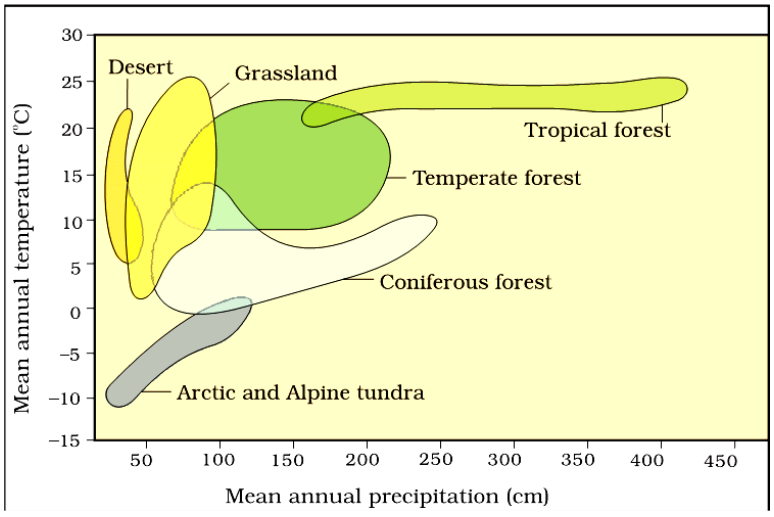
- Average temperature **6ºC – 15ºC**.
- Average rainfall **50 – 170 cm**.
- In india these are found in **himalaya region** at the **height 1700 – 3000 m.**
- **Mostly gymnosperms** are found such as **pine (Pinus wallichiana), Deodar (Cedrus deodara) Spruce (Picea smitheana), Cypress (Cuprassus torulosa), Silver (Abies pindrow)**. They represent coniferous forest.
- The height of trees (canopy) is 35–40 m.
- Moss, lichen, ferns are abundantly present.
- Leaves needle like evergreen (Persist 2-7-years).
- **Fauna :** Rabbit, Deer, Elks, Insects, Snakes, Lizards

(III) Temperate Broad Leaves forest:

- Averge temperature **6ºC – 20ºC**.
- Averge rainfall **100 – 250cm**.
- **Vegetation** – **Oak, maple, fir, spruce, Magnolia**.
- In india temperate broad leaved forest are found at the **height of 1500–2400m**. Where following species of oak are present.
  (a) Quercus semicarpifolia – Brown oak of himalaye
  (b) Quercus floribunda – Tilonaj oak
  (c) Quercus lanuginosa – Rianj oak
  (d) Quercus leucotrichophora – Banj oak
- Tree canopy height – 20 – 30 m.
- **Fauna** – Foxes, Deer, Rabbit, squirrel, Lizard, Turtle, Salamander, frog.
- Plants shed their leaves in Autumn.

(IV) Tropical deciduous forest :

- Average temperature **– 22 – 32º C.**
- Average rain fall **– 90 – 160 cm.**
- **Vegetation-sal (shorea robusta), Tendu kendu (Diaspyros melanoxylon), Teak (Tectona grandis), Chiraunjee (*Buchanania lanjan*), sandal *(Sentalum album),* Khair (*Acacia catechu*).**
- Height of trees –10 – 20 m.
- Plants shed their leaves in dry season.
- **Fauna :** Similar as Tropical evergreen forest



(v) Tropical rain (evergreen) forest :

- These are found in equatorial / subequatorial warmth and **heavy rain fall (200–350cm) areas**.
- They **show maximum biodiversity** for example one hectare forest contains 200 types of trees, 70–80% species of insects and 80–85% species of Birds.
- The **productivity** of these forest is about **12000 k. cal / m^2 / yr.**
- These forests are found in **congo basin of africa, Amazan basin of S. america, south east Asia.**
- In **India** these are found in **western ghat, andaman nicobar ice land, Assam.**
- Vegetation – Mahogong, Ebony, Rubber tree, Cinnamon, Rosewood, Fig, Artacarpus.
- Mosses, Lichens, Ferns, orchids, Lianas are abundant.
- **Soil is highly leached therefore upper layer is poor in nutrients**.
- **Fauna :** Lion, and tiger, jaguar, Leopard, tapir, Elephant, antelope, goat, forest, deer, snakes, python, anteaters, lizards, frogs, tree primates, diverse insects, birds.

(VI) Chapparel forest:

- These are broad leaved scrub forest (sclerophyllous leaves) found in meditteranean Region and pacific regions of many countries.
- **Chapparel of winter rain areas is called machhie**. **(Limited Rain takes place in winter)**.
- **These are fire resistant plants.**
- **Vagetation – Adenostemma, oak & Eucalyptus.**
- **Fauna** – Rabbits, rats, deer, snakes, lizards, birds and tiger.

(VII) Savannah / Savanna :

- Hot climate.
- These contain coarse grasses with few scattered trees & shrubs.
- Height of plants is 1– 8 m.
- These are found in **North Australia, south-east africa, S. america.**
- **The name savannah is based on the trees - Acacia, Phoenix, Eucalyptus**.
- **The main grasses of this biome are – Dicanthium, schima, Andropogon, Imperata, Sacchrum.**
- **Fauna : Kangaroo (in Australian savannah)**, zebra, giraffe, antelope, gazelle, rhinoceros, goat, rabbit, mice, elephant, fox, wolf, tiger, lion etc.

(VIII) Grassland :

- Hot climate.
- Annual rain fall **25–75 cm**.
- **Mostly leguminous grasses** instead of **grasses** of **gramineae.**
- The minimum height of grasses is 1·5 m.
- These are **fire resistant**.

  Name of famous grasslands of world.

  (i) Prairies – USA & Canada
  (ii) Steppes – Urasia
  (iii) Pampas – South america (Argentina)
  (iv) Veldts – S. africa
  (v) Tussocks – New zealand
  (vi) Dawns – Australia.

- **Fauna :** Antelope, pumas, bison, larks, mice, deer, prairies dog, snake, lizards, birds.

(IX) Desert :

- Deserts are part of total area of earth.
- **Deserts are mostly found on tropic of cancer, Tropic of capricorn at 15º–35º latitude.**
- Deserts are of two types

(i) Hot deserts e.g. Sahara and thar deserts.
(ii) Cold deserts e.g. Tibbat and Gobi doserts.

Vegetation – Xerophytic

(i) Ephemeral completes life cycle in rainy season and in the resting time live as seed. **e.g. Boehraavia, Tribulus, Euphorbia prostata.**

(ii) Annual : They also survive after few months of rainy season, **e.g. Solanum suratensse (xanthocar pum).**

(iii) Succulent : Leaves are either succulent containing mucilage or spine to reduce transpiration, **e.g. opuntia, / Euphorbia royleana.**

(iv) Fixed rooted : e.g. phoenix, Prosopis, Tamarix, Acacia, Capparis.

❖ **Fauna : Kangaroo rat / Desert rat**, rattle snake, coral snake, Gilamonstarlizard.

Resonate the Concept

(1) Standing State: Amount of biogenetic or inorganic materials present in the abiotic environment per unit area at any time.

(2) Ten percent Law (Lindemans's law of Trophic Efficiency): Ten perecent law put forth by Lindeman (1942) states that when transferring organic food from one trophic level to the next, about ten per cent of the organic matter is stored as flesh, the remaining is lost during transfer or broken down in respiration. In other words the net productivity of the next higher trophic level shall be 10% of the first one.

e.g. Producers → Herbivores → Primary Carnvores → Secondary Carnivores

20kg 2.0 kg 0.2 kg 0.02 kg

(3) Standing Crop: It is the amount of living biomass present in an ecosystem. Dry weight preferred over fresh weight because the latter is liable to be influenced by seasonal moist differences.

(4) NPP (Net primary productivity): Utilizes 0.8-4% of incident radiation or 1.6-8% of PAR (since respiratory loss is 20% at producer level).

(5) Leaching: Soluble substances formed during decomposition pass into soil alongwith percolating water to be made available to roots of plants for absorption.

(6) The upright pyramid of number is absent in forest **(AIPMT Pre.- 2012)**

Test your Resonance with concept

1. One of the following is sedimentary cycle
(1) Carbon (2) Hydrogen (3) Nitrogen (4) Phosphorus

2. Plant with higher osmotic pressure of cell sap is called
(1) Halophytes (2) Hydrophytes (3) Mesophytes (4) Xerophytes

3. Long roots are found in xerophytes for
(1) Mechanical support (2) Light
(3) Absorption of water (4) None of the above

4. The major cause of extinction of species in tropical countries is
(1) Pollution (2) Soil erosion (3) Deforestation (4) Urbanization

5. Which type of plants bear sunken stomata
(1) Halophyte (2) Xerophyte (3) Mesophyte (4) Hydrophyte

Answers

1. (4) **2.** (1) **3.** (1) **4.** (3) **5.** (2)