Digestion & Absorption

Syllabus

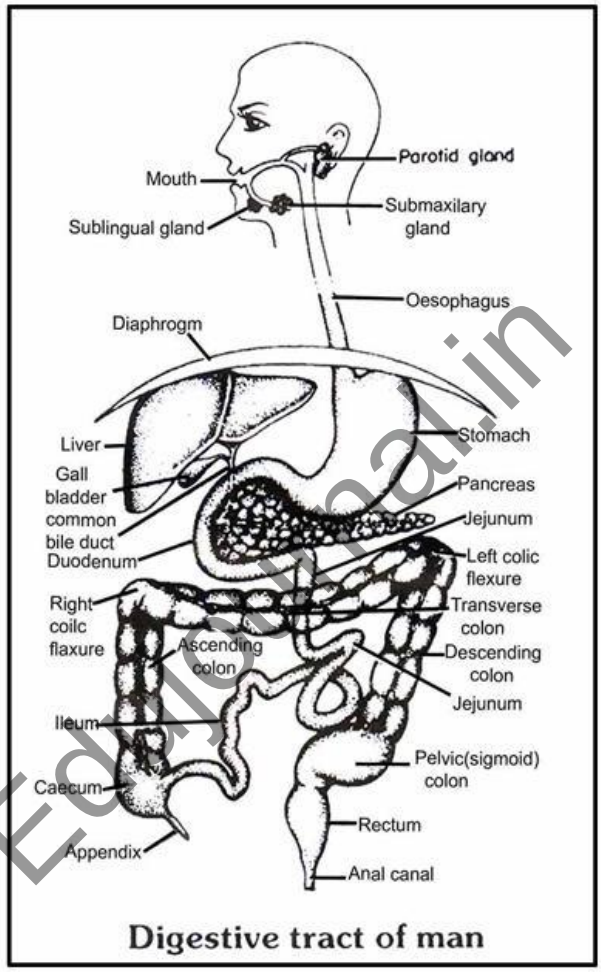
Digestion & Absorption

Digestive system

Name : _____ Contact No. _____

INTRODUCTION : :

To perform various functions of the body energy is required, which is obtained from food. The process of conversion of complex food material in to simple and diffusible forms by hydrolysis is termed as **Digestion.**



Digestive tract of man

The alimentary canal is tubular structure which extends from mouth to anus. It develops from ectoderm & endoderm.

Ectoderm – up to hard palate

Endoderm – from soft palate to rectum

Ectoderm – from anal canal to Anus

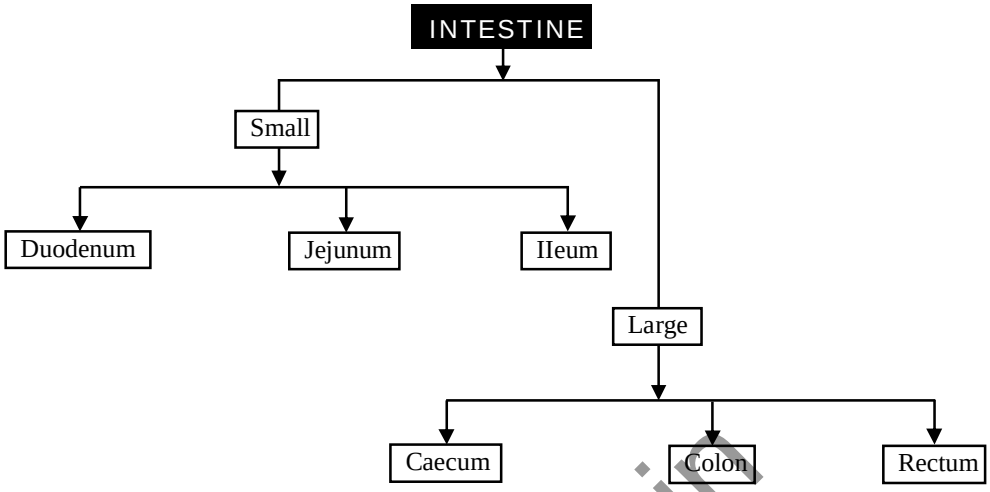
The alimentary canal is divided into following parts–

(1) Mouth and Buccopharygeal cavity

(2) Oesophagus

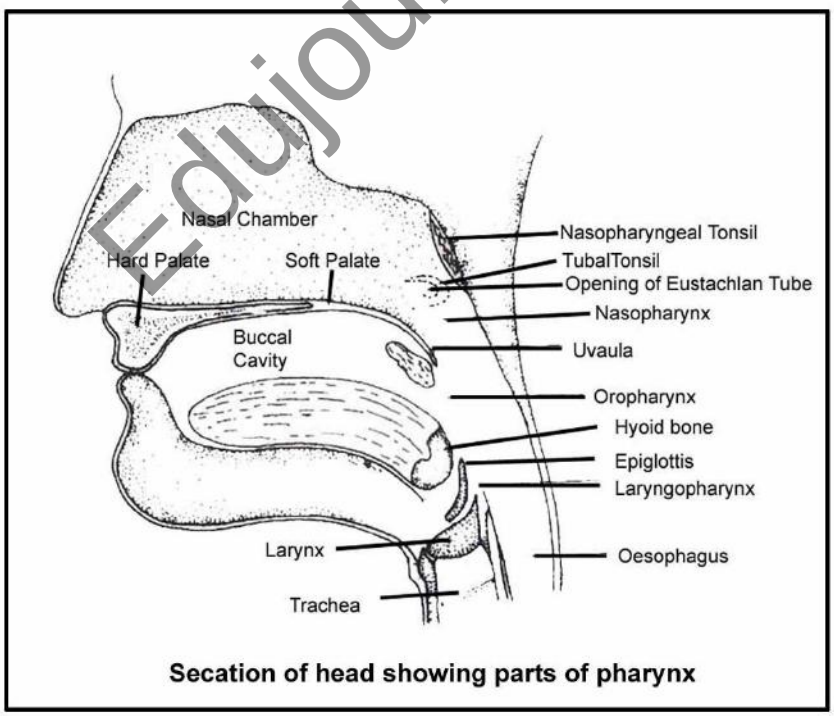
(3) Stomach

(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**

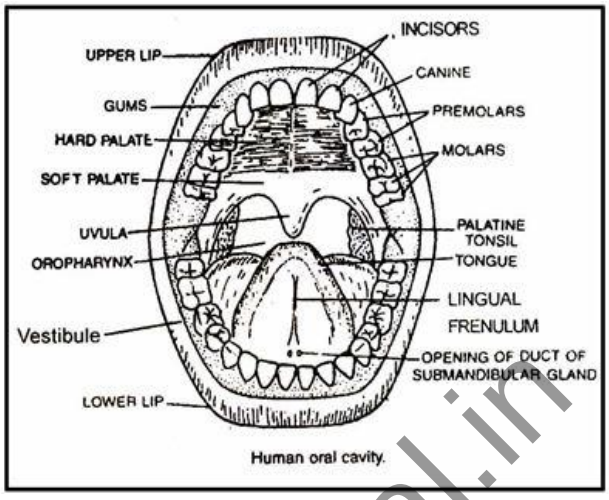


Secation of head showing parts of pharynx

(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



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.

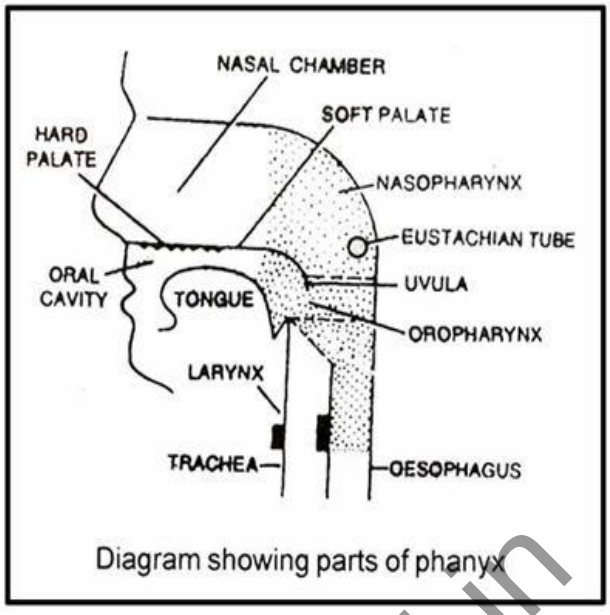


Diagram showing parts of phanyx

(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)

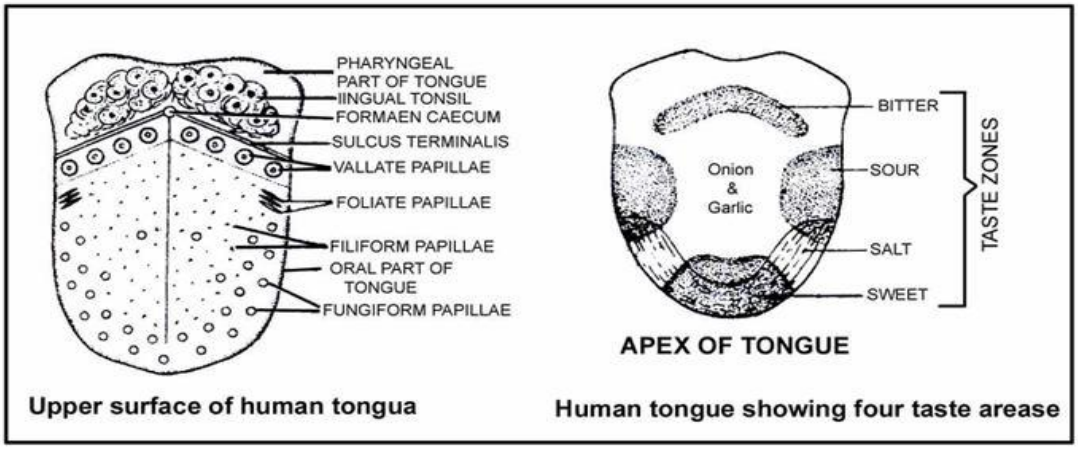
The posterior part of soft palate becomes out grow and hangs down in the form of finger like process called as **Uvula** or **Velum palati**

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 –

(I) 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.**

(II) 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.

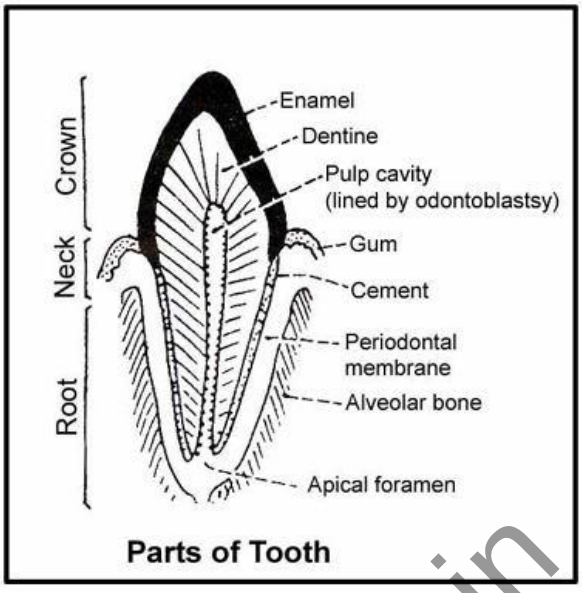
(iv) Circumvallate papillae –
They are large spherical shape papillae which are found near to sulcus terminalis. They are least in number (approx 8 to 12)

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.

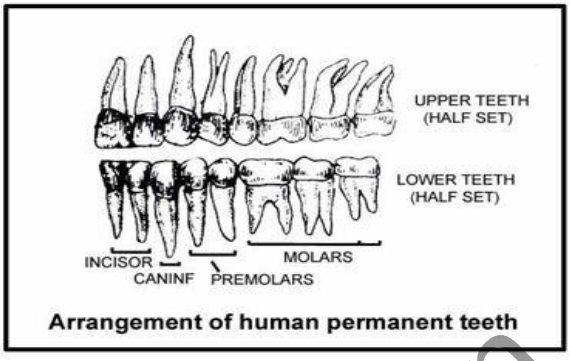
Enamel is **ectodermal**. It is secreted by **Ameloblast** cells of the ectoderm. It has maximum amount of inorganic salt (96%) in it, Inorganic salt are mainly found in the form of phosphate and carbonate of Ca, Mg, Na and K. 3% of water is found in the enamel. Along with the keratin & ossein protein (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.



Arrangement of human permanent teeth

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 = $1\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{3}{3}=\frac{8}{8}\times 2=\frac{16}{16}=32$

Rabbit` = $1\frac{2}{1}C\frac{0}{0}PM\frac{3}{2}M\frac{3}{3}=\frac{8}{6}\times 2=\frac{16}{12}=28$

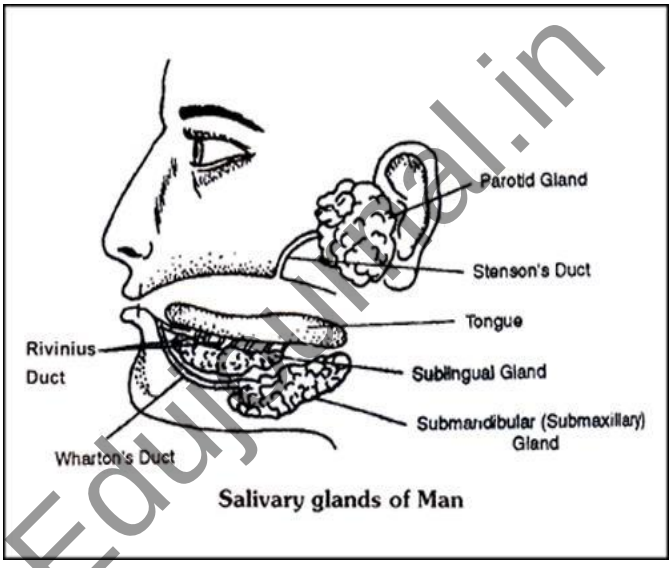
Note : In humans, premolar teeth appear in the alveoli of molar teeth while permanent molar teeth are developed in new alveoli.

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.

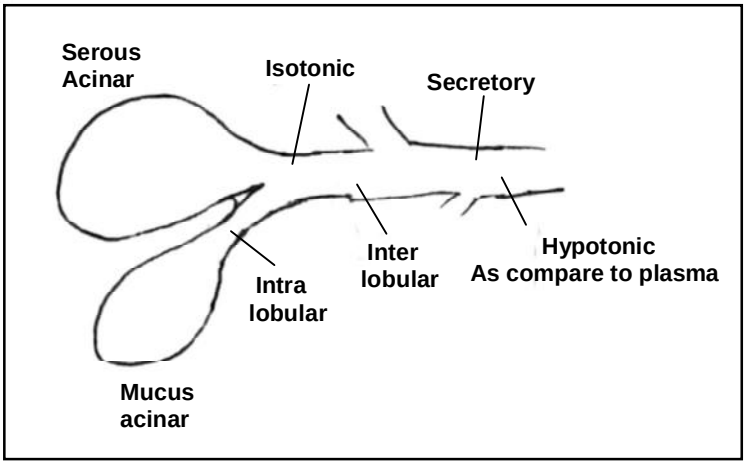


Salivary glands of Man

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

Glands	Histology	% of total saliva	Nerve
Parotid	Purelyserous	25%	IX
Submandibular	Mixed Serous & mucous	70%	VII
Sublingual	Mixed Serous & Mucous	5%	VII



Sailorrhoea – Hypersecretion of saliva – e.g. Pregnancy, tumour Parkinson's, cordo tympani nerve damage.

* **Oryfood** – increases the secretion of saliva.
* **Aldosterone** – increases the K^+ and decreases the Na^+ concentration in saliva.
* **Aptylism/xerostomia** – Stopage of secretion of saliva, fear, anxity etc.
* Maximum saliva is secreted by the **Sub-maxillary glands or Submandibular gland.**

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 :

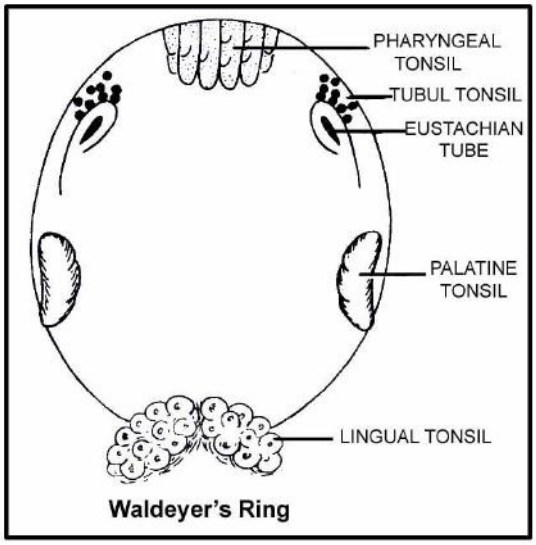
(i) Nasopharyngeal Tonsil (= Pharyngeal Tonsil) : - Refer to the nasopharynx. In children nasopharyngeal tonsil may become enlarged and referred as **adenoids.** The resulting swelling may be a cause of obstruction to normal breathing .

(ii) Tubul Tonsil : – Refer to the nasopharynx.

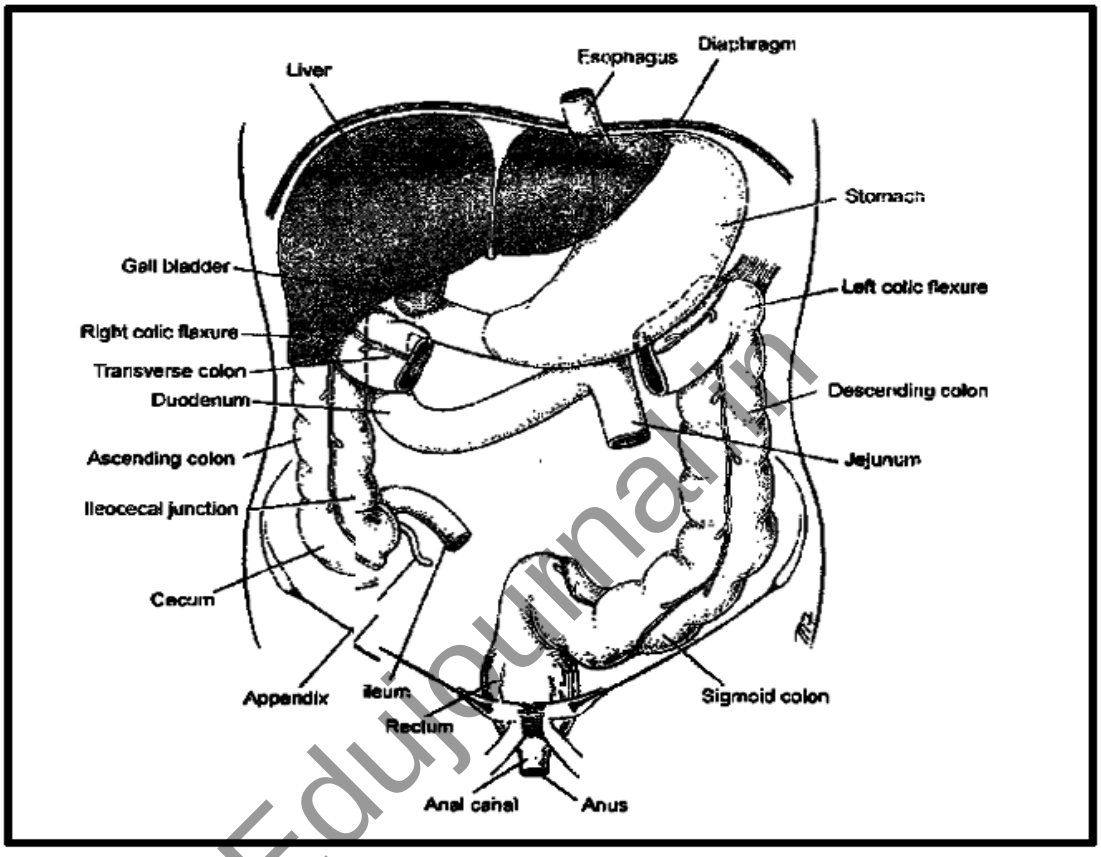
(iii) Palatine Tonsils (= Faucial Tonsils) : – Refer to the oropharynx. The Palatine tonsils are often infected **(tonsillitis)** leading to sort throat.

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 : :



OESOPHAGUS :

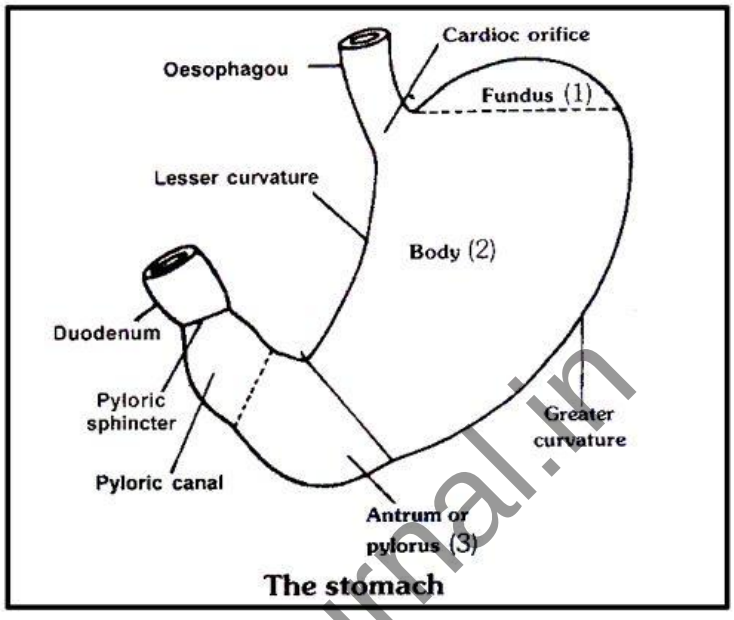
Two apertures are found in central part of Buccopharyngeal cavity

- 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)



The stomach

(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.

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.

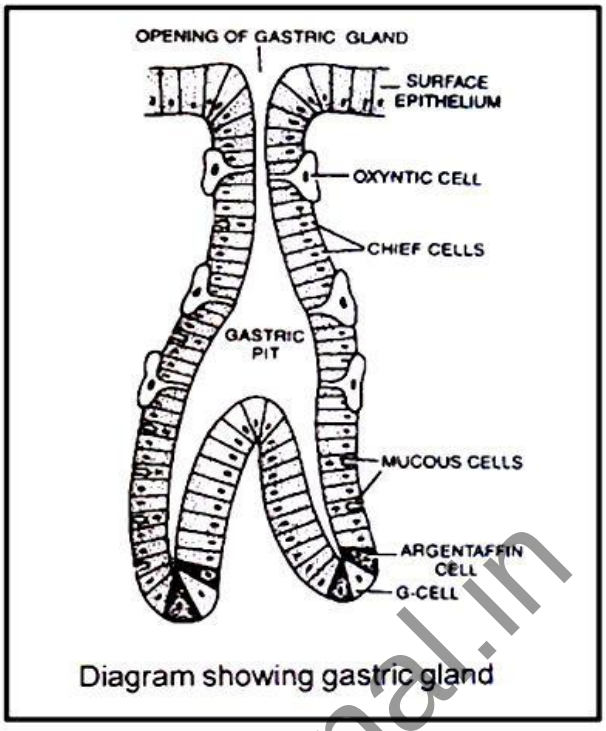


Diagram showing gastric gland

(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 parietal cells as they lie against the basement membrane. They secrete hydrochloric acid and **Castle intrinsic factor**.

(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.

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

(i) Duodenum (ii) Jejunum (iii) Ileum

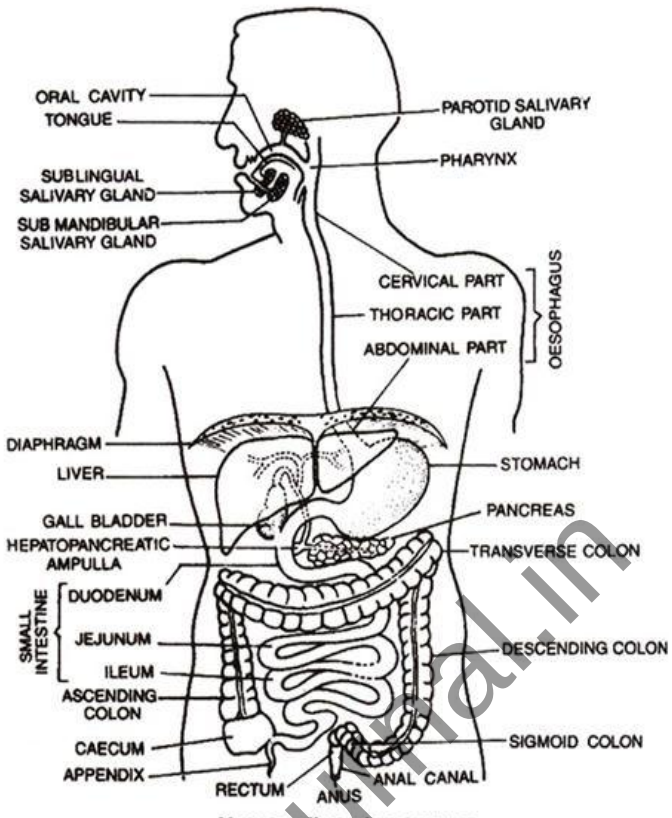
First part is **duodenum**, it is 25 cm long, c-shaped in humans and has opening of hepatopancreatic duct (bile duct + pancreatic duct)

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.

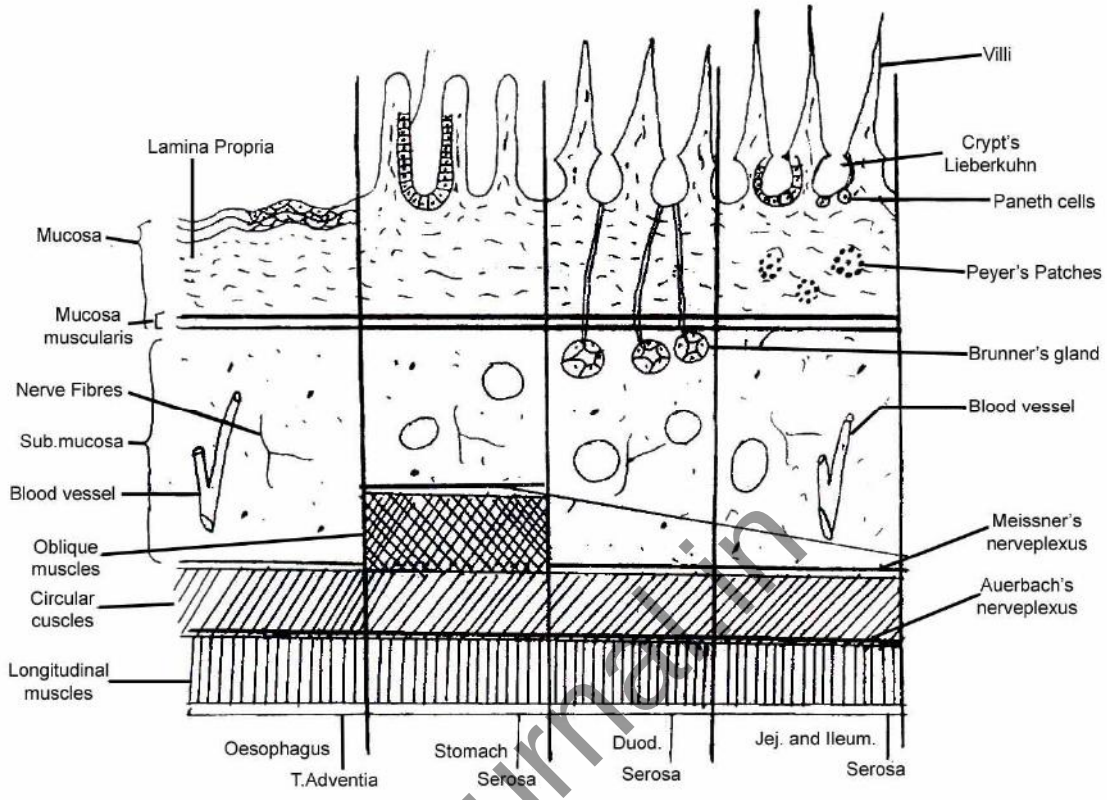
Next parts of small intestine are **jejunum** and **ileum**. The wall of intenstine has thin layers of longitudinal and circular muscles.Mucosa has folds **plicae circulare** (**folds of Kerkrings** or **Valvulae conniventes**) and **villi** towards lumen of the intestine. Epithelial cells lining the 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**.

(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 pelvic 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**.



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.

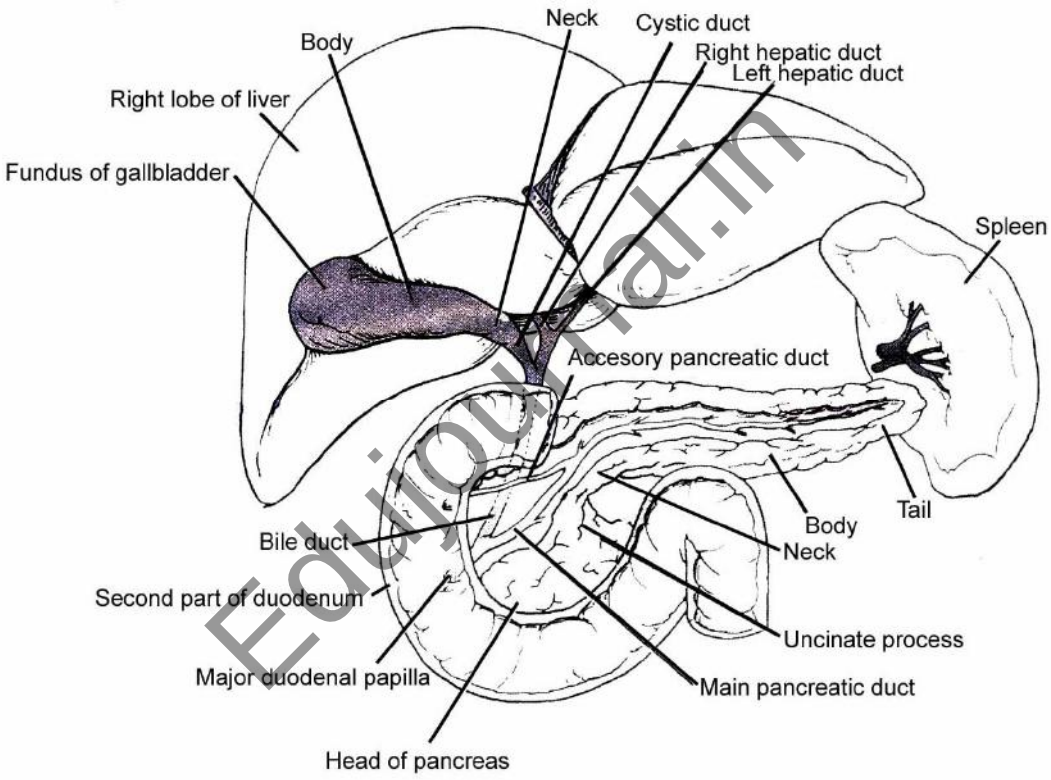
Nerve supply :

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 : :

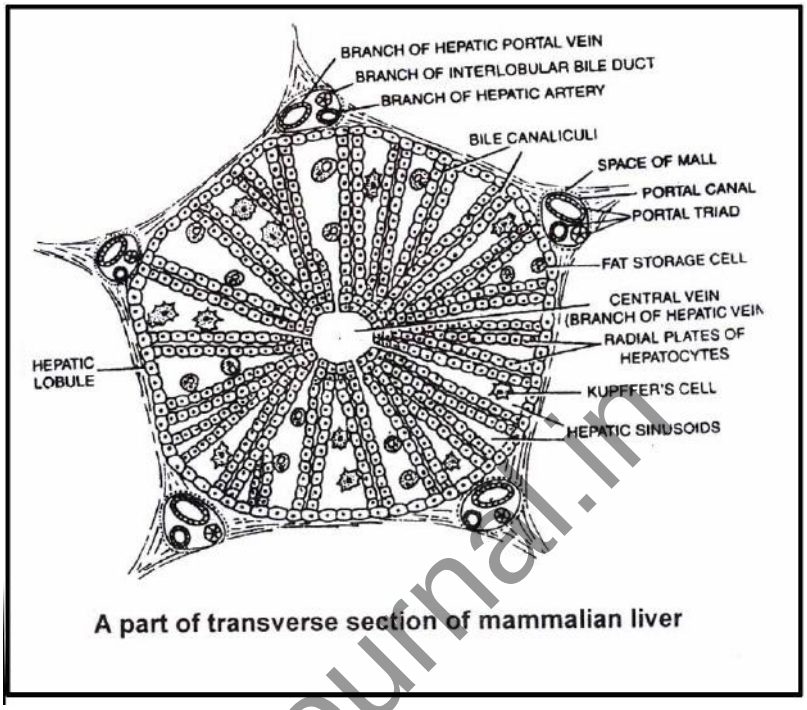


In human liver is made up of four lobe. Left lobe is small right proper lobe is large, two addition lobe quadrate and caudate lobe are also found on posterior side of right proper lobe.

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.**

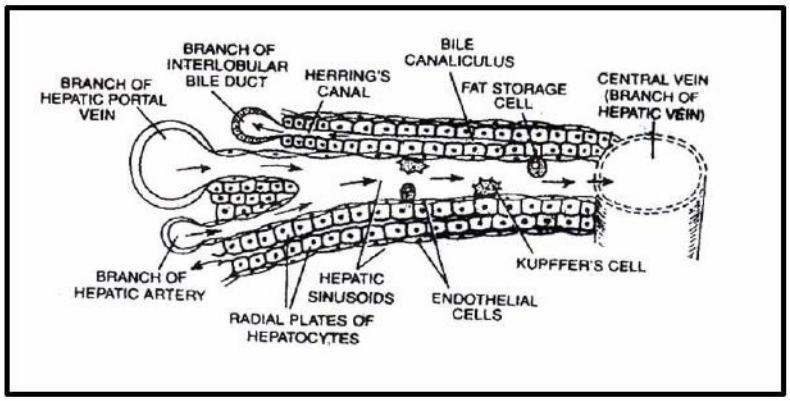


A part of transverse section of mammalian liver

- 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.

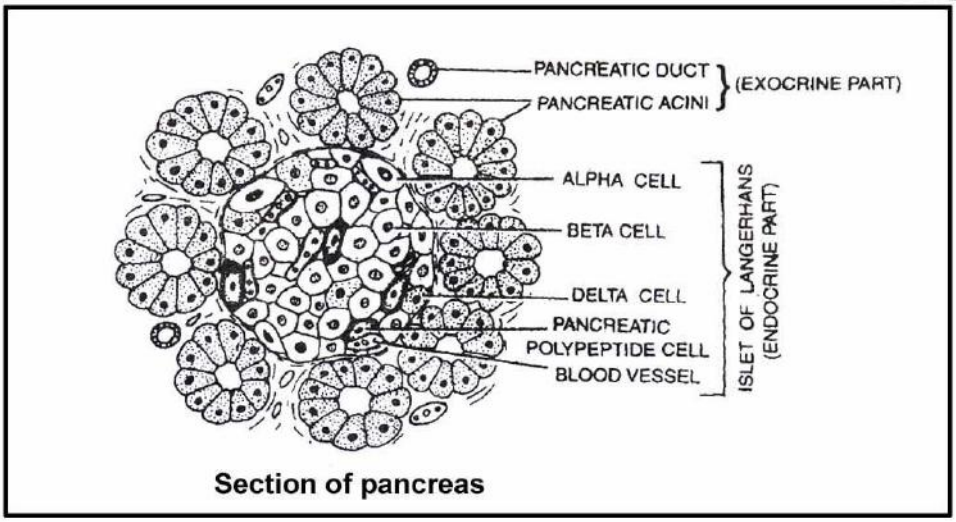
FUNCTION OF LIVER : (Liver is known as chemical factory of the body)

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.
   - **(I) 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
   - **(II) Glycogenolysis –** The conversion of glycogen into glucose back when glucose level in blood falls down is called glycogenolysis.
   - **(III) 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.
   - **(IV) 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.

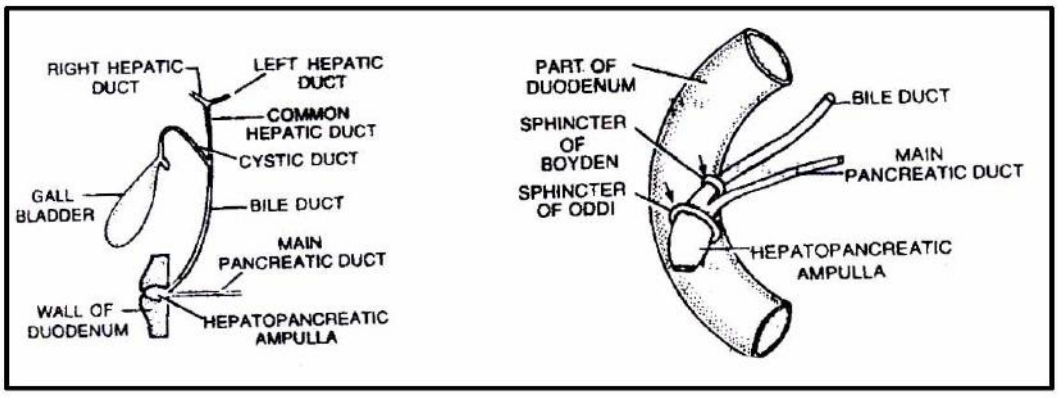
5. **Purification of blood –** The spleen and liver separate dead blood cells and bacteria from the blood. Kupffer cells in liver and phagocytes in spleen perform this function.
6. **Synthesis of plasma proteins–** Many types of proteins are present in blood plasma. Except gamma globulins all type of 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)



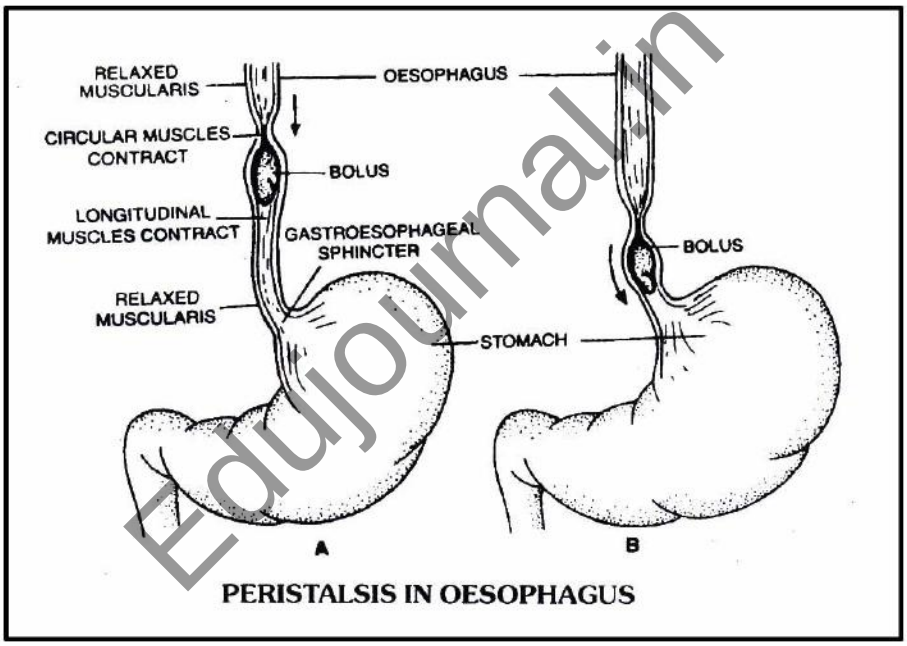
- In rabbit, bile duct and pancreatic duct both are separately open into Duodenum.
- Bile duct opens into proximal limb of duodenum and is controlled by **sphincter choledocus**.

- 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 ::

(I) 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 pushes 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.

(II) 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–

1. **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.
2. **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.
3. **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. $\text{Nucleoproteins} \xrightarrow{\text{HCl}} \text{Nucleic acid} + \text{protein.}$

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

(III) 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 secretion of enzymatic part of pancreatic juices.
   * Secretin promotes the secretion 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, Na_2CO_3, $NaHCO_3$ 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–

$$\text{Tripsinogen} \xrightarrow[\text{Enterokinase or Entero peptidase}]{Ca^{++}} \text{Trypsin}$$

$$\text{Chymotrypsinogen} \xrightarrow{\text{Trypsin}} \text{Chymotrypsin}$$

Enterokinase 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.

(IV) 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**

sucrose $\xrightarrow{\text{Sucrase}}$ Glucose + Fructose

Sucrase – It is also known as invertase. It converts sucrose into **glucose** and **fructose.**

Maltase – It convers maltose sugar into **Glucose** molecules.

maltose $\xrightarrow{\text{maltase}}$ Glucose + Glucose

Lactase – This enzymes is found only in mammals. It converts milk sugar lactose into **Glucose** and **Galactose.**

Lactose $\xrightarrow{\text{Lactase}}$ Glucose + Galactose

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) Nucleotides $\xrightarrow{\text{Nucleotidase}}$ Nucleosides + Phosphate

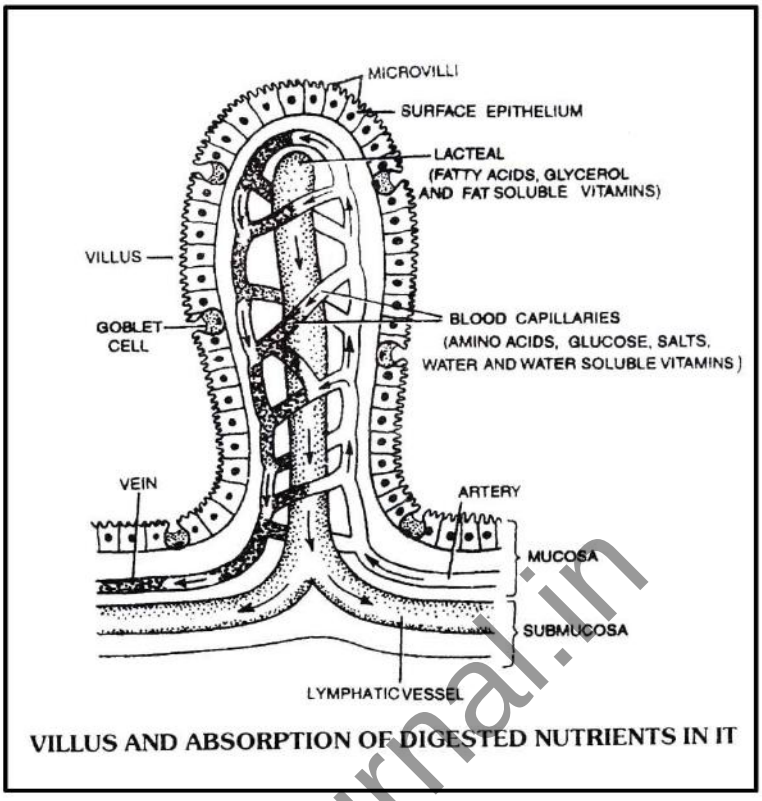
(ii) Nucleosides $\xrightarrow{\text{Nucleosidase}}$ Pentose + Nitrogen base

* maximum digestion of carbohydrates is done in duodenum, but its digestion is completed in Jejunum.

(V) DIGESTION IN CAECUM

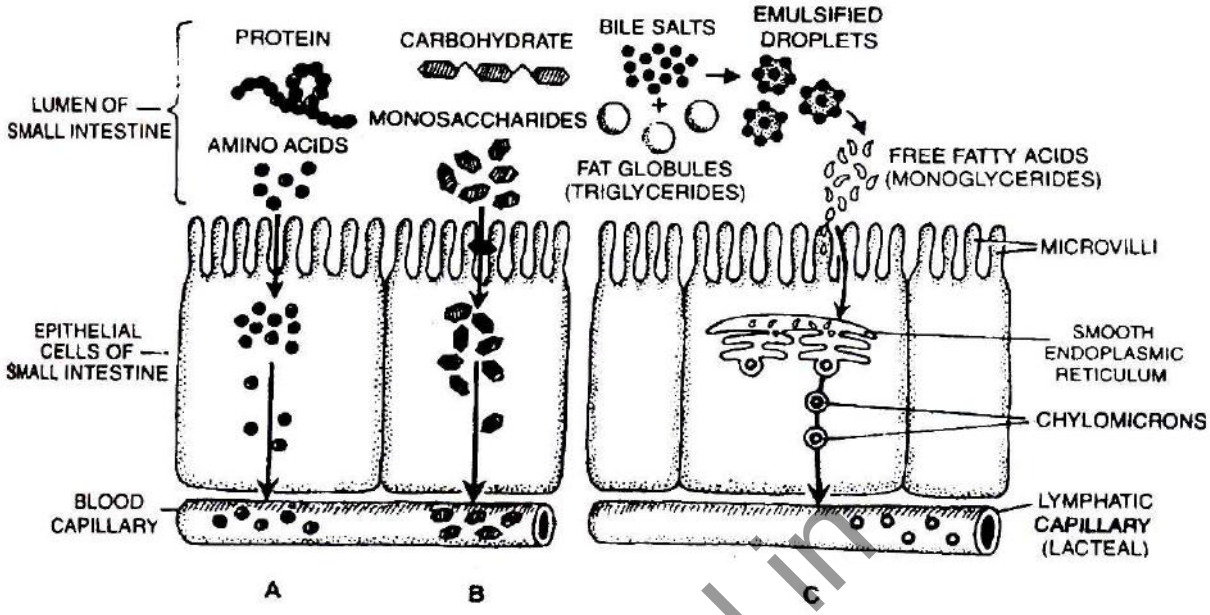
In herbivores, the symbiotic bacteria and protozoans present in the caecum help in digestion of cellulose into glucose. So the digestion of cellulose takes place in caecum by the process of **decompostion.** This **decomposition** process is very slow. So very less amount of cellulose is digested at 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



VILLUS AND ABSORPTION OF DIGESTED NUTRIENTS IN IT

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.



Epithelial cells of small intestine showing absorption of nutrients. (A) Absorption of a aminoacid. (B) Absorption of monosaccharides. (C) Absorption of fatty aicds.

Role of Some Major Gastrointestinal Peptide Hormones in Digestion

Hormone	Source Secretion	Stimulus to	Target/Action
Gastrin	Polyric stomach and duodenum/G-cells	Vagus nerve activity, peptides and proteins in stomach	Secretory cells and muscles of stomach, secretion of HCl and stimulation of gastric mobility.
Cholecystokinin (CCK)	Upper small intestine (Duodenum)	Food (Fatty chyme and amino acids) in dudenum	Gall bladder, contraction of gall bladder (Bile release)
Secretin	Intestinal wall (Duodenum)	Food and strong acid in stomach and intestine	Pancreas, secretory cells and muscles of stomach, secretion of water and bicarbonate ($NaHCO_3$), inhibition of gastric motility
Gastric Inhibitory Peptide (GIP)	Upper small intestine (Duodenum)	Monosaccharides and fats (fatty chyme) in duodenum	Gastric mucosa and muscles, inhibition of gastric secretion and mobility/motility (slowing food passage)

An Overview of the Action of Major Enzymes in Human

Enzyme	Site of Action	Substrate	Products of Action

Salivary Juice (Salivary Gland)

Salivary amylase of Ptyalin	Mouth and stomach Buccal cavity	Starch	Disaccharides (few)

Gastric Juice (Stomach)

Pepsinogen : pepsin	Stomach	Proteins	Large peptides

Pancreatic Juice (Pancreas)

(a)	Pancreatic α-amylase (Duodenum)	Small intestine	Starch	Disaccharides
(b)	Trypsinogen : trypsin	Small intestine	Proteins	Large peptides
(c)	Chmotrypsin	Small intestine	Proteins	Large peptides
(d)	Elastase	Small intestine	Elastin	Oligopeptides
(e)	Carboxypeptidases	Small intestine	Large peptides	Amino-acid
(f)	Aminopeptidase	Small intestine	Large peptides	Oligopeptides
(g)	Lipase	Small intestine	Triglycerides fatty acids, glycerol	Monoglycerides
(h)	Nulease	Small intestine	Nucleic acids	Nucleotides

Intestinal Juice (Small Intestine)

(a)	Enteropeptidase or enterokinase	Duodenum	Trypsinogen	Trypsin
(b)	Peptidase	Duodenum	Oligopeptides	Amino acids
(c)	Disaccharidases	Duodenum	Disaccharides	Monosaccharides
(d)	Nucleotidase	Duodenum	Nucleotides phosphoric acid	Nucleosidases
(e)	Nucleosidases	Duodenum	Nucleosides pyrimidines	Sugars, purines

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.

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.

(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 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.

(4) 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.

** 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.

Compound stomach -

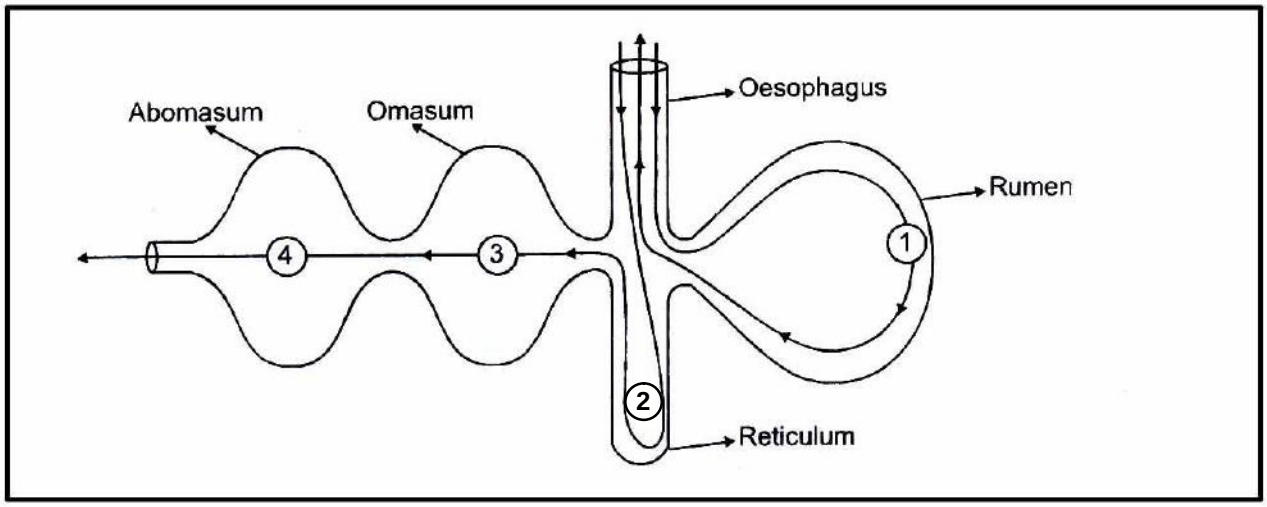
Stomach of Runinant made of 4 chambers :

Rumen → largest

Reticulum → Smallest

Omasum

Abomasum → true stomach



Gastric juice-secreted by Abomasum. So it is called true stomach. Inner surface of Rumen and Reticulum lined by keratinised epithelium. Symbiotic bacteria found in Rumen and Reticulum. Voluntary muscles are found in Rumen and Oesophagus. Hence reverse peristalsis are found in Rumen and oesophagus which is controlled by will power of animal. Omasum is absent in Camel and Deer.

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

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.

PROTEIN ENERGY MALNUTRITION

(1) Kwashiorkor –

- it is a protein deficiency disease.
- it commonly affects infants and children between 1 to 3 year of age.

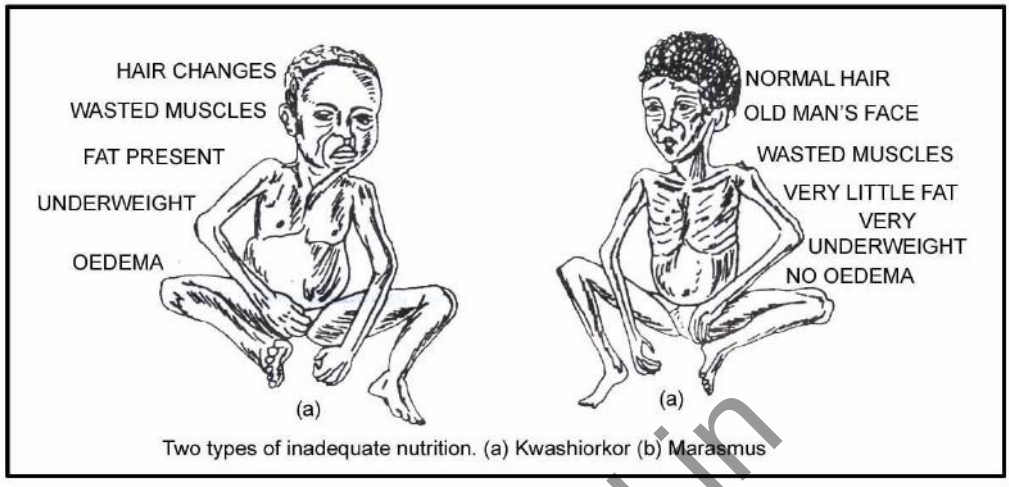
Symptoms – Underweight, stunted growth, poor brain development, loss of appetite, anaemia, oedema on lower leg and face.

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	**Carbohydrates**	

and milk	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**	**Energetic**
	Fats and oil	
Flesh (meat, chicken, fish), milk, pulses, cereals, egg (albumen and yolk) and cheese	**Proteins**	**Constructive**
	Amino acids	
Table salts, pickles and butter	**Minerals**	
	Sodium	
Table salts, pickles and butter	Chlorine	
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)	

SOME IMPORTANT MINERAL AND THEIR FUNCTIONS

Mineral	Functions
Calcium	Component of bone and teeth ; essential for normal blood clotting , needed for normal muscle and nerve function.
Chlorine	Principal anion of interstitial fluid ; important in fluid and acid-base balance.
Copper	Component of enzyme for melanin synthesis; essential for haemoglobin synthesis.
Iodine	Component of thyroid hormone. Its deficiency causes goiter.
Iron	Components of respiratory pigments (like haemoglobin and myoglobin), respiratory enzymes (like cytochromes) and oxygen transport enzymes. It's deficiency causes anaemia.
Phosphorus	Important structural component of bones, DNA and RNA; essential in energy transfer, storage of energy (ATP) and other metabolic activites; maintains normal blood pH (buffer action.)
Potassium	Principal cation in the cytoplasm; controls nerve excitability and muscle contraction. Dietary deficiency causes rickets among children.
Sodium	Principal cation of interstitial fluid; maintains fluid balance ; essential for conduction of nerve impulse.
Sulphur	Components of hormones (e.g. insulin) ; necessary for normal metabolism.
Zinc	Component of at least 70 enzymes, like carbonic anhydrase, and some

NUTRITIONAL DISORDERS DUE TO DEFICIENCY OF DIETARY COMPONENT

PROTEIN

Nutrient	Name of Disease	Deficiency symptoms
Protein	Kwashiorkor	Wasted muscles, thin limbs, retarded growth of body and brain, oedema, pot belly and diarrhoea.
Protein and calorie	Marasmus	Impaired growth and replacement of tissue proteins, thin limbs and prominent ribs (emaciated body), dry, wrinkled and thin skin, diarrhoea.

MINERALS

Nutrient	Name of Disease	Name of Disease
Iodine	Goitre	Swelling of the thyroid gland, reduced mental function, increased risk of stillbirths, abortions and infant deaths. .
Iron	Anaemia, failure to mature RBC	Low haemoglobin condition, weakness, tiredness, reduced learning ability, increased risk of infection and even death during childbirth.

VITAMINS

Nutrient	Name of Disease	Name of Disease
Retinol (A)	Night blindness	Dry, keratinized epithelia of skin, respiratory and urinogenital tracts, especially among children.
Calciferol (D)	Rickets (Osteomalacia)	Weak and soft bones, distorted skeletal, poor muscular development.
Tocopherol (E)	Anaemia	RBC devoid of haemoglobin or maintains erythrocytes.
Menadione (K)	Severe bleeding	Slow or delayed blood clotting and haemorrhage (blood loss)
Ascorbic acid (C)	Scurvy (failure to form connective tissue)	Bleeding gums, loose teeth, anaemia, painful and swollen joints, delayed healing of wounds, and emaciation,
Thiamine (B_1)	Beriberi	Loss of appetite, fatigue, muscle atrophy, paralysis, mental confusion, cardiac oedema.
Ribofavin (B_2)	No specific disease	Digestive disorder, burning sensation of the skin and eyes, lesions at the corners of the mouth, headaches, mental depression.
Pyridoxine (B_6)	No specific disease	Dermatitis, impairment of antibody synthesis.
Cyanocobalamine (B_{12})	Pernicious anaemia	Large, immature and nucleated RBC devoid of haemoglobin.
Folic acid (Pteroglutamic acid)	Macrocytic anaemia, malformed RBC	Impairment of antibody synthesis, stunted growth.
niacin (nicotinic acid, nicotinamide)	Pellagra and canine (dog) disease (black tongue)	Scaly, pigmented skin, irriation of the GI tract (diarrhoea)
.Biotin (Vit-H) or (B_4 or B_7)	Dermatitis	Scaly skin, muscle and pains and weakness.

SOME IMPORTANT VITAMINS AND THEIR FUNCTIONS

FAT SOLUBLE VITAMINS	
Vitamin	**Functions**
Retinol (A)	Principal component of retinal pigments; promotes normal vision, growth of bones and teeth maintenance of epithelial tissue.
Calciferol (D)	Absorption of Ca^{2+} from small intestine, needed for growth maintenance of bone (synthesised in human skin in presence of sunlight)
Tocopherol (E)	Inhabit oxidation of unsaturated fatty acids and vitamin A.
Naphthoquinone (K)	Essential for coagulation of blood (proudcued by intestinial bacteria).

WATER SOLUBLE VITAMINS

Vitamin	**Functions**
Ascorbic Acid (C)	Synthesis of collagen, bone matrix, tooth dentine and other extracellular materials, metabolism of may amino acids ; helps body to with stand injury from burns and acts as antioxidant.
Cyanocobalamine (B_{12})	Important for nucleoprotein synthesis and formation of RBC (produced by intestinal bacteria).
Biotin (B_7)	Coenzyme needed for protein and fatty acid synthesis, CO_2 fixation and transamination .
Folic Acid (folacin, pteroglutamic acid)	Coenzyme needed for nucleoprotein synthesis and formation of RBC.
Niacin	Coenzyme in hydrogen transport (NAD, NADP).
Pantothenic Acid	Component of coenzyme A (CoA).
Pyridoxine (B_6)	Coenzyme for amino and fatty acid metabolism.
Riboflavin (B_2)	Flavoproteins in oxidative phosphorylation.
Thiamine (B_1)	Formation of carboxylase enzyme involved in decarboxylation (citric acid cycle).

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

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 keratinization 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.

Deifciency disease – Bleeding or delayed blood clotting. (Hypoprothrombinemia).

Source – Carrot, tomato, liver, cabbage etc.

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.
- **Defi disease –** Beri-Beri, Wernicke's encephalopathy. Anorexia, constipation, weak-Heart and muscle atrophy.

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.

Defi. Disease – 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.

Defi. Disease – 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.

Defi. Disease – 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.**

Defi disease – 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

Defi. Disease – 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.

Defi. Disease – 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).

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 If a man is allowed to live exclusively on the diet of milk, egg & bread he would suffer from - **[ST-1971]**

(1) Rickets (2) Beri-Beri
(3) Night blindness (4) Scurvey

Q.2 Deficiency of vitamin A causes – **[ST-1973]**

(1) Retarted growth
(2) Scurvy
(3) Beri-Beri
(4) Rickets

Q.3 Islets of langerhans are – **[ST-72]**

(1) Modified lymph glands
(2) Ductless glands in pancreas
(3) Specialized area in pituitary
(4) Small tubules in kidney

Q.4 Scurvy is a disease caused by – **[ST-72,73]**

(1) A virus (2) Deficiency of Vit E
(3) Def. of Vit. C (4) Def. of Vit. D

Q.5 Bilirubin and bilivirdin are found in – **[ST-73,CPMT-73]**

(1) Blood (2) Bile
(3) Saliva (4) None of these

Q.6 Vitamins are – **[ST-73, CPMT-73]**

(1) Inorganic substances and can't be synthesised by animals.
(2) Inorganic substances and can be synthesised by animals.
(3) Organic substances which cannot mostly be synthesised by animals.
(4) Organic substances which can mostly be synthesised by animals.

Q.7 Which of the following is the best source of Vit-A **[ST-73]**

(1) Carrot (2) Apple
(3) Peanuts (4) Honey

Q.8 Herbivorous animals can digest cellulose because **[ST-1973, CPMT-71, AIMS-81]**

(1) Their molar and premolar teeth can crunch and grind the food.
(2) Bacteria present in their caecum help in digestion of cellulose.
(3) Gastric Juice has digestive enzyme for cellulose digestion.
(4) Alimentary Canal is very long.

Q.9 Vitamin necessary for blood clotting – **[ST-73,77,CPMT-76,91,AFMC-83,BHU-83]**

(1) A (2) E
(3) C (4) K

Q.10 Dental formula of adult man is – **[ST-74, 76, CPMT-74, 81, BHU-81]**

(1) $\frac{2,1,2,3}{2,1,2,3}$ (2) $\frac{2,1,2,3}{2,1,2,2}$
(3) $\frac{2,1,2,3}{2,1,2,4}$ (4) $\frac{2,1,3,2}{2,1,3,2}$

Q.11 Islets of Langerhans are found in – **[ST-74, 75,CPMT-71,82,91]**

(1) Testis (2) Adrenal
(3) Pancreas (4) Ovary

Q.12 Vit-K is required for – **[ST-74,82,91]**

(1) Regulation of Ca and P metabolism
(2) Respiration
(3) Carbohydrate metabolism

(4) Synthesis of prothrombin in liver required

Q.13 Man needs carbohydrates as a source of energy and gets these from – **[ST-74]**

(1) Starch (2) Cellulose
(3) Both (4) None of these

Q.14 To keep people healthy, strong and energetic and long lived, it is necessary to provide them – **[ST-74]**

(1) high energy food
(2) large amt. of food
(3) Balanced diet
(4) Initiative and spirit

Q.15 Beri-Beri is caused due to – **[CPMT-71, BHU-83]**

(1) Def. of Vit B_1 (2) Def. of Vit B_2
(3) Det. of Vit. B_{12} (4) Def. of Vit C

Q.16 Ascorbic acid is the – **[CPMT-75,86]**

(1) Vit-A (2) Vit-C
(3) Vit-E (4) Biotin

Q.17 Which one of these are most essential for body growth and formation of new cells – **[ST-75, CPMT-71,77,85]**

(1) Sugar (2) Fats
(3) Nucleic acid (4) Protein

Q.18 The most common concentrated source of proteins for vegetarians in our country is – **[ST-76]**

(1) Potatoes (2) Meat
(3) Eggs (4) Pulses

Q.19 Casien present in milk, which is – **[ST-76]**

(1) Bacterium (2) Sugar
(3) Protein (4) Fat

Q.20 Rumen of a cow is a part of its – **[ST-76]**

(1) Intestine (2) Stomach
(3) Caecum (4) Rectum

Q.21 The largest gland in human body is – **[CPMT-71]**

(1) Pancreas (2) Liver
(3) Thyroid (4) Pituitary

Q.22 Amylase enzyme acts on the – **[ST-77,CPMT-96]**

(1) Starch (2) Protein
(3) Fat (4) Cane sugar

Q.23 Sucrose is found in - **[ST-77]**

(1) Milk (2) Honey
(3) Sugarcane (4) Orange

Q.24 Vit A from carotene is synthesised in – **[BHU-77]**

(1) Spleen (2) Skin
(3) Pancreas (4) Liver

Q.25 Which one of the Carbohydrate is monosaccharide – **[ST-1977]**

(1) Glucose (2) Sucrose
(3) Starch (4) Cellulose

Q.26 Vitamin promoting wound healing is – **[BHU-78]**

(1) B (2) A
(3) D (4) C

Q.27 Night blindness is caused due to deficiency of Vit – **[BHU-1978,80,81,82]**
(1) B (2) C
(3) D (4) A

Q.28 The digestion of cellulose in rabbit and other herbivorous mammals takes place in – **[CPMT-71,75,77, AIMS-1981]**
(1) Vermiform appendix
(2) Colon
(3) Caecum
(4) Ileum

Q.29 Ptyalin is secreted by – **[CPMT-71]**
(1) Stomach (2) Salivary gland
(3) Pancreas (4) Bile

Q.30 Ptyalin, an enzyme work in saliva in – **[CPMT-71]**
(1) Alkaline medium
(2) Almost Neutral medium
(3) Acidic medium
(4) All medium

Q.31 Liver cells secrete – **[CPMT-71,75]**
(1) Amylopsin (2) Trypsin
(3) Lipase (4) Bile and no enzyme

Q.32 Which should not be eaten too much during hot months – **[CPMT-71]**
(1) Vitamins (2) Fats
(3) Mineral salts (4) Proteins

Q.33 To get ample supply of Carbohydrates, one should eat – **[CPMT-71]**
(1) Meat (2) Gram
(3) Carrots (4) Rice

Q.34 Peristalsis found in different parts of alimentary canal. In which one of these there is least peristalsis – **[CPMT-71]**
(1) Stomach (2) Duodenum
(3) Rectum (4) Oesophagus

Q.35 In Colon, constrictions of its wall form a series of small pockets called – **[CPMT-71]**
(1) Haustra
(2) Crypts of lieberkuhn
(3) Zymog en Cells
(4) Taenial

Q.36 Milk protein is curdled into calcium paracaseite by – **[CPMT-71, BHU-79]**
(1) Maltose (2) Rennin
(3) Trypsin (4) Lactose

Q.37 The enzyme invertase hydrolise – **[CPMT-72]**
(1) Glucose into sucrose
(2) Sucrose into glucose and fructose
(3) Starch into maltose
(4) Starch into sucrose

Q.38 Diastema is – **[CPMT-72]**
(1) A part of pelvic girdle in rabbit
(2) A type of tooth in rabbit
(3) Space in teeth lines in mammals
(4) Structure in eye of rabbit

Q.39 Vermiform appendix is a part of – **[CPMT-72]**
(1) Alimentary Canal
(2) Nervous System
(3) Vascular System
(4) Reproductive System

Q.40 From the point of ontogeny, liver is –

[CPMT-73]

(1) Ectodermal
(2) Endodermal
(3) Mesodermal
(4) Ectodermal and endodermal

Q.41 Amino acids are absorbed in – **[CPMT-74]**

(1) Blood capillaries of villi
(2) Wall of rectum
(3) Lacteals and blood capillaries of villi
(4) Lacteals of villi

Q.42 Digestion of Carbohydrate is affected by – **[CPMT-75,77,79]**

(1) Amylopsin (2) Lipase
(3) Erepsin (4) Pepsin

Q.43 Trypsinogen is secreted by – **[CPMT-75]**

(1) Pancreas (2) Stomach
(3) Liver (4) Ileum

Q.44 Proteins are broken down into amino acids in – **[NCERT-73]**

(1) Buccal Cavity (2) Stomach
(3) Intestine (4) Rectum

Q.45 Which reserve a starving man first consumes – **[CPMT-75,85,88]**

(1) Fat (2) Protein
(3) Glycogen (4) Vitamin

Q.46 Ptyalin cannot work in stomach, because it becomes – **[CPMT-76]**

(1) Inactive due to HCl
(2) Inactive due to Renin
(3) Inactive due to Pepsin
(4) None of these

Q.47 What is the important function of bile – **[NCERT-75, 77, BHU-78,79, CPMT-82]**

(1) For digestion by emulsification of fats
(2) Elimination of Excretory products
(3) For digestion by enzymes
(4) Coordination of digestive activities

Q.48 Meat, Milk and egg mainly supply us with– **[CPMT-76]**

(1) Hormones (2) Carbohydrates
(3) Proteins (4) Fats

Q.49 Protein are mainly required in the body for– **[CPMT-77]**

(1) Growth (2) Repair
(3) Both of these (4) None of these

Q.50 Some proteolytic enzymes are – **[CPMT-77]**

(1) Trypsin, Erepsin, Pepsin
(2) Amulase, lypase, Zymase
(3) Ampylopsin, Steapsin, Ptyalin
(4) Urease, dehydrogenase, Zymase

Q.51 Bacteria entering with contaminated food are killed in stomach by – **[CPMT-77,81]**

(1) Pepsin
(2) Renin
(3) Sodium bicarbonate
(4) HCl

Q.52 Succus entericus is secreted by – **[BHU-77, CPMT-85]**

(1) Gastric glands
(2) Islets of langerhans
(3) Crypts of leiberkuhn & brunner's gland
(4) Goblet Cells

Q.53 Glycogen is stored in – **[CPMT-77]**

(1) Blood (2) Liver
(3) Lungs (4) Kidney

Q.54 Chymotrypsin is – **[BHU-77]**
(1) Proteolytic enzyme
(2) Fat digestive Enzyme
(3) Vitamin
(4) Hormone

Q.55 Emulsification of fats by bile takes place in– **[BHU-77]**
(1) Duodenum (2) Liver
(3) Stomach (4) Intestine

Q.56 Excess amino acids are deaminated & converted into urea in – **[CPMT-78]**
(1) Kidneys (2) Liver
(3) Spleen (4) Pancreas

Q.57 Secretin hormone is produced in – **[CPMT-78,80,83,84]**
(1) Stomach and stimulates gastric glands
(2) Intestine and stimulates Pancreatic glands
(3) Liver and stimulates gall bladder
(4) Intestine and stimulates crypts of lieberkuhn

Q.58 Digestion of Carbohydrates, Proteins and fats completes in – **[BHU-79]**
(1) Stomach (2) Liver
(3) Small intestine (4) Colon

Q.59 A person deficient in Rhodoplin (visual pigment) should take – **[CPMT-79]**
(1) Tomatoes (2) Radish
(3) Carrot (4) Guava

Q.60 Total number of teeth in rabbit is – **[CPMT-79]**
(1) 43 (2) 24
(3) 28 (4) 32

Q.61 pH of stomach in Rabbit is about – **[CPMT-79]**
(1) 7 (2) 2.5
(3) 8 (4) 11

Q.62 Number of teeth which are monophyodont in man is – **[CPMT-79]**
(1) 4 (2) 22 (3) 32 (4) 12

Q.63 Rennin is found in – **[BHU-78, AFMC-79]**
(1) Liver
(2) Kidney
(3) Pancreatic Juice
(4) Gastric Juice in stomach

Q.64 Absorption of digested food chiefly occurs in – **[BHU-79]**
(1) Stomach (2) Colon
(3) Small Intestine (4) Large Intestine

Q.65 Pancreatic juice takes part in digestion of – **[CPMT-80]**
(1) Proteins Carbohydrate and fats
(2) Proteins and fats
(3) Protein, Carbohydrate
(4) Proteins only

Q.66 The enzyme trypsinogen is secreted by – **[CPMT-80]**
(1) Duodenum (2) Pancreas
(3) Liver (4) Stomach

Q.67 Enzyme pepsin acts upon food at a pH of about - **[CPMT-81]**
(1) 3 to split proteins
(2) 2 to split carbohydrate

(3) 7 to change protein into peptones
(4) 2 to change protein in amino acids

Q.68 Rickets is caused by the def. of – **[AFMC-80]**
(1) Vit A (2) Vit C
(3) Vit D (4) Vit B

Q.69 Which vitamins are water soluble – **[BHU-80]**
(1) Vit B & C (2) VitA & C
(3) Vit D (4) Vit A & B

Q.70 Which is the sources of vitamin 'C' – **[BHU-80]**
(1) Banana (2) Potato
(3) Orange (4) Mango

Q.71 Our food mainly contains – **[AFMC-80]**
(1) Carbohydrates (2) Cellulose
(3) Sucrose (4) Glucose

Q.72 Which one is differ from the category of other three – **[CPMT-81]**
(1) Gastrin (2) Glucagon
(3) Secretin (4) Ptyalin

Q.73 Which disease is caused due to the prolonged deficiency of Nicotinic acid – **[CPMT-81]**
(1) Pellagra (2) Rickets
(3) Scurvy (4) Beri-Beri

Q.74 How many teeth in man grow twice in life– **[CPMT-81]**
(1) 20 (2) 28
(3) 30 (4) 32

Q.75 A Carbohydrate splitting enzyme is secreted by – **[CPMT-81]**
(1) Liver
(2) Zymogen cells of gastric glands
(3) Spleen
(4) Crypts of Lieberkuhn

Q.76 The cells of the epithelial lining in the vertebrate stomach are not damaged by HCl because of – **[NCERT-81]**
(1) Mucus secretion covering the epithelium
(2) Neutrilizatioin of HCl by alkaline gastric juice
(3) HCl being to dilute
(4) Crypts of Lieberkuhn

Q.77 Stomach is the main site for the digestion of **[CPMT-81]**
(1) Fats (2) Carbohydrate
(3) Protein (4) All of these

Q.78 The hormone involved in the discharge of pancreatic juice in mammal is called –
(1) Gastrin **[CPMT-82]**
(2) Secretin
(3) Secretin & CCK
(4) Enterogastrin

Q.79 Function of HCl in stomach is to – **[CPMT-83]**
(1) Kill micro-organism of food
(2) Facilitate absorption of food
(3) Dissolve enzymes secreted by gastric glands
(4) Active trypsinogen to trypsin

Q.80 Presence of which of these in intestine of rabbit distinguishes it from stomach – **[CPMT-82]**

(1) Digestive glands
(2) Villi
(3) Sub mucosa
(4) Serosa

Q.81 Which is sweet in taste but is not sugar – **[CPMT-83]**

(1) Starch (2) Saccharine
(3) Lactose (4) Protein

Q.82 Enzyme maltase in human gut acts on food at a pH of - **[CPMT-83]**

(1) More than seven to change starch into maltose
(2) Less than 7 to change starch into maltose
(3) More than 7 to change maltose into glucose
(4) Less than 7 to change maltose into glucose

Q.83 Simple sugar of blood is – **[CPMT-83]**

(1) Galactose (2) Lactose
(3) Sucrose (4) Glucose

Q.84 Pernicious anaemia is caused by deficiency of vitamin – **[CPMT-88, BHU-83]**

(1) C (2) B_1
(3) B_{12} (4) B_6

Q.85 The structure which prevents entry of food into wind pipe during swallowing in mammals is – **[CPMT-84,91]**

(1) Larynx (2) Glottis
(3) Epiglottis (4) Pharynx

Q.86 Another substance of the category of glucose, sucrose and maltose is – **[CPMT-84]**

(1) Myoglobin (2) Starch
(3) Amino acids (4) Haemoglobin

Q.87 A person with bleeding gums should daily take – **[CPMT-84]**

(1) Milk (2) Carrots
(3) Lemons (4) Butter

Q.88 During prolonged starvation, body derives nutrition from storage of – **[CPMT-84]**

(1) Liver and adipose tissue
(2) Spleen
(3) Liver and lungs
(4) Subcutaneous fat and Pancreas

Q.89 Rickets is disease of which category – **[CPMT-84]**

(1) Infective disease
(2) Deficiency disease
(3) Communicable disease
(4) Inheritable disease

Q.90 Intake of food is called – **[CPMT-85]**

(1) Ingestion
(2) Deficiency disease
(3) Communicable disease
(4) Inheritable disease

Q.91 Thiamine is another name for – **[CPMT-85]**

(1) Vit B_2 (2) Vit A
(3) Vit B_1 (4) Vit B Complex

Q.92 Which of the following is a common passage in swallowing food and breathing – **[CPMT-85]**
(1) Pharynx (2) Larynx
(3) Glottis (4) Gullet

Q.93 Total number of incisor teeth in rabbit is – **[CPMT-85,BHU-77]**
(1) 8 (2) 6
(3) 10 (4) 4

Q.94 Enterokinase activates which of the following – **[CPMT-86]**
(1) Pepsinogen (2) Trypsin
(3) Pepsin (4) Trypsinogen

Q.95 Maximum digestion of food take place in – **[CPMT-86]**
(1) Stomach (2) Jejunum
(3) Colon (4) Duodenum

Q.96 Absence of which of these in bile will make fat digestion difficult – **[CPMT-87]**
(1) Cholesterol (2) Salts
(3) Pigment (4) HCl Acids

Q.97 Pancreatic juice is released into – **[CPMT-87]**
(1) Duodenum (2) Ileum
(3) Stomach (4) Jejunum

Q.98 Satiety and thirst centres are located in – **[CPMT-87]**
(1) Forebrain (2) Optic lobes
(3) Hypothalamus (4) Medulla

Q.99 Vit D is also called – **[CPMT-87]**
(1) Calciferol (2) Ascorbic acid
(3) Retinol (4) Folic Acid

Q.100 Animals which eat their own faeces are called – **[CPMT-88]**
(1) Omnivorous (2) Herbivorous
(3) Coprophagus (4) Carnivorous

Q.101 The hardest constituent of the tooth is – **[DPMT-87]**
(1) Enamel (2) Dentine
(3) Bone (4) Pulp

Q.102 The three secretions meeting the food in small intestine are – **[CPMT-89]**
(1) Bile juice, pancreatic juice and intestinal juice
(2) Pancreatic, intestinal and gastric juice
(3) Bile, Pancreatic and gastric juice
(4) Bile, gastric juice and Saliva

Q.103 Which one of the following hormone inhibits the secretion of gastric juice – **[CPMT-89]**
(1) Gastrin (2) Duocrinin
(3) CCK (4) Enterogasterone

Q.104 The mineral element whose deficiency in human body may leads to goitre is – **[CPMT-89]**
(1) Iodine (2) Fluorine
(3) Calcium (4) Sodium

Q.105 The enzyme that catalyse the changing of emulsified oils to fatty acids and glycerol is– **[CPMT-89]**
(1) Pepsin (2) Lipase
(3) Amylase (4) Sucrose

Q.106 Point out the one – **[MP-PMT-90]**
(1) Rennin (2) Secretin
(3) Calcitoin (4) Oxytocin

Q.107 Which one is not an enzyme of digestive system – **[CPMT-90]**
(1) Enterokinase (2) Amylase
(3) Trypsin (4) Enterogasterone

Q.108 Mainly Secretin stimulates the production of – **[AIPMT-90, CPMT-90]**
(1) Saliva (2) Gastrin
(3) Bile (4) Pancreatic juice

Q.109 Peyer's patches produce - **[RPMT-87, CPMT-90]**
(1) Enterokinase (2) Lymphocyte
(3) Mucous (4) Trypsin

Q.110 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.111 Def. of Vit E brings about – **[CPMT-91]**
(1) Scurvy
(2) Beri-Beri
(3) Slow clotting of blood
(4) Impotence

Q.112 Which teeth are absent in rabbit – **[CPMT-91]**
(1) Incisor (2) Canine
(3) Molar (4) Premolar

Q.113 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.114 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.115 Pancreatic lipase acts upon – **[CPMT-91]**
(1) Glycogen (2) Triglycerides
(3) Disaccharides (4) Polypeptides

Q.116 Types of teeth in Rabbit – **[CPMT-91]**
(1) Thecodont (2) Acrodont
(3) Pleurodont (4) Homodont

Q.117 In whose milk percentage of lactose is highest – **[CPMT-92]**
(1) Human mother (2) Cow
(3) She buffalo (4) She goat

Q.118 Which of these will leave the stomach first in Man – **[CPMT-92]**
(1) Bear (2) Proteins
(3) Fats (4) Carbohydrates

Q.119 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.120 In frog, the surface of attachment of tongue is – **[CPMT-92]**
(1) Hyoid apparatus
(2) Pterygoid

(3) Palatine
(4) Sphenoid

Q.121 Which pairing is not correct –
(1) Vit D-rickets
(2) Vit K-Sterlity
(3) Thiamine-Beri-Beri
(4) Niacin-Pellagra

Q.122 Bow-Shaped legs in children are due to deficiency of Vitamin –
(1) D (2) A (3) B (4) C

Q.123 Bile is formed in – **[CPMT-92]**
(1) Gall bladder (2) Liver
(3) Spleen (4) Blood

Q.124 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.125 Enzyme trypsinogen is changed to trypsin by – **[JKCEE-92, RPMT-90]**
(1) Gastrin (2) Enterogastrone
(3) Enterokinase (4) Secretin

Q.126 Castle's intrinsic factor is connected with internal absorption of – **[AMU-92]**
(1) Pyridoxine (2) Riboflavin
(3) Thiamine (4) Cobalamine

Q.127 Aminopeptidase, a digestive enzyme produces – **[AMU-92]**
(1) Dipeptides (2) Smaller peptides
(3) Peptones (4) Amino acids

Q.128 Highest BMR occurs in – **[AMU-92]**
(1) Elephant (2) Rabbit
(3) Human (4) Whale

Q.129 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.130 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.131 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.132 Maximum number of enzymes occur in – **[CPMT - 93]**
(1) Omnivores (2) Herbivores
(3) Carnivores (4) None of the above

Q.133 Cholestrol is synthesised in -
(1) Brunner's gland
(2) Liver
(3) Spleen
(4) Pancreas

Q.134 Excessive intake of alcohol caused – **[MP-PMT-93]**
(1) Jaundice (2) Dermatitis
(3) Liver Cirrhosis (4) Lung Fibross

Q.135 Rennin acts on -
(1) Milk changing casein into calcium paracaseinate at 7.2 – 8.2 PH
(2) Proteins in stomach
(3) Fat in intestine
(4) Milk changing casein into calcium paracascinate at 1-3 PH

Q.136 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.137 Lacteals take part - **[CPMT-94]**
(1) Digestion of Milk
(2) Absorption of fat
(3) Digestion of lactic acid
(4) None of the above

Q.138 Muscular contraction of Alimentary canal are – **[MP-PMT-94]**
(1) Circulation (2) Deglutition
(3) Churning (4) Peristalsis

Q.139 Vit-D is produced in human body by – **[J.K.M. CEE-94]**
(1) Muscles (2) Nerves
(3) Skin (4) None of these

Q.140 Fatty acids and glycerol are first absorbed by – **[AFMC-94]**
(1) Lymph Vessels
(2) Blood
(3) Blood Capilaries
(4) Hepatic portal Vein

Q.141 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.142 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.143 Which of the following is absorbed in ileum – **[BHU-95]**
(1) Fat (2) Bile salts
(3) Vit-K (4) Carbohydrate

Q.144 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.145 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.146 Posterior part of soft palate, hangs down in pharynx, called - **[RPMT-88]**
(1) Palatine (2) Tonsils
(3) Velum Palati (4) Jacobson's organ

Q.147 Nasal chambers and buccal cavity are separated by - **[RPMT-86]**
(1) By uvula (2) By palate
(3) By Palatine (4) None of these

Q.148 Cheek teeth are - **[RPMT-86]**
(1) Incisors and Canines
(2) Canines and Premolars
(3) Premolars and Molar
(4) Canines and Molars

Q.149 Presence of water amount in enamel cell is- **[RPMT-90]**
(1) 90 – 92 % (2) 75 – 80 %
(3) 40 – 50 % (4) ≈ 3%

Q.150 Jacobson's organs are related with – **[RPMT-90]**
(1) With touch (2) With pressure
(3) With smell (4) With hearing

Q.151 In which animal tongue control the temperature – **[RPMT-90]**
(1) Rabbit (2) Dog
(3) Man (4) Cow

Q.152 How many lobes of liver are present in rabbit – **[RPMT-84]**
(1) 2 (2) 4 (3) 5 (4) 6

Q.153 In which part of stomach mainly digestion occurs - **[RPMT-84]**
(1) Cardiac Region (2) Fundic Region
(3) Pyloric Region (4) All above

Q.154 Largest gland of body – **[RPMT-90]**
(1) Pancreas (2) Duodenum
(3) Liver (4) Thyroid

Q.155 Which food substance is absorbed during digestion - **[RPMT-91]**
(1) Carbohydrates (2) Proteins
(3) Vitamins (4) Fats

Q.156 Harmful Prussic acid changed into neutral potassium sulfocyanide in -
(1) Bone marrow (2) Liver
(3) Spleen (4) Lymph glands

Q.157 Insulin in secreted by pancreatic cells – **[RPMT-89]**
(1) α-cells (2) β-cells
(3) Delta cells (4) Gama Cells

Q.158 Which substance of saliva destroy the harmful bacteria - **[RPMT-91]**
(1) Cerumin (2) Chyme
(3) Lysozyme (4) Secretin

Q.159 Hormone which control the secretion of intestinal juice is - **[RPMT-88]**
(1) Enterogasterone
(2) Enterocrinin
(3) Duo-crinin
(4) Both (2) and (3)

Q.160 Parietal cells of mucosa in stomach is secretes :- **[RPMT-89]**
(1) Mucin (2) Pepsin
(3) HCl (4) All of these

Q.161 Human is unable to digest dietary : -
(1) Glycogen (2) Maltose
(3) Dextrin (4) Cellulose

Q.162 Pepsinogen is converted to pepsin by : -
(1) Low PH (2) Trypsinogen
(3) Chymotrypsin (4) Enterokinase

Q.163 Glucose is transported to cell by : -
(1) Na^+ Symport (2) K^+ Symport
(3) Na^+ Antiport (4) K^+ Antiport

Q.164 Mucus is secreted by the : -
(1) Stomach (2) Duodenum
(3) Large intestine (4) All of the above

Q.165 In which Hormone causes contraction of the gall bladder : -
(1) Secretion (2) Gastrin
(3) Villikinin (4) Cholecysotkinin

Q.166 Water absorption is mainly occur in : -
(1) Colon (2) Intestine
(3) Gastrium (4) Appendix

Q.167 Cephalic phase of gastric secretion is mediated by : -
(1) Neurohormone (2) Parasympathetic
(3) Sympathetic (4) Gastrin

Q.168 One of the following is not a constituent of saliva : -
(1) Bicarbonate (2) Lysozyme
(3) Glucose (4) Immunoglobulin

Q.169 Hydrochloric acid is secreted by the : -
(1) Paneth cells (2) Goblet cells
(3) Chief cells (4) Parietal cells

Q.170 What statement is wrong about bile : -
(1) Is necessary for fat digestion
(2) Is stored in the gall bladder
(3) Is important only for normal digestion of sugar
(4) None of above

Q.171 Which of the following is absorbed in proximal intestine : -
(1) Iron (2) Sodium
(3) Bile salts (4) Vitamin B_{12}

Q.172 Which of the following is not a function of liver : -
(1) Deamination
(2) Bile storage
(3) Synthesis of plasma protein
(4) Storage of fat soluble vitamin

Q.173 In Humanbeing sphincter of oddi is situated in : -
(1) Common bile duct
(2) Ampulla of vater
(3) Main pancreatic duct
(4) Common hepatic duct

Q.174 Dermatitis, diarrhoea and dementia are seen in deficiency of : -
(1) Thiamine (2) Riboflavin
(3) Niacin (4) Folate

Q.175 Which of the following vitamin is an main antioxidant -
(1) A (2) B_6 (3) C (4) E

Q.176 β-Carotene is : -

(1) Preformed Vit. A (2) Provitamin A
(3) Synthetic Vit. A (4) None

Q.177 The vitamin that is useful in cancer is vitamin : -
(1) A (2) B-Complex
(3) C (4) E

Q.178 Substances which are not related with hepaticportal circulation : -
(1) L-Amino acid (2) Fatty acid
(3) Glucose (4) Fructose

Q.179 Contraction in gall bladder stimulated by : - **[AIPMT-98]**
(1) CCK (2) PZ
(3) Secretin (4) Enterogasterone

Q.180 Enamel of teeth is secreted by : -**[AIPMT-98]**
(1) Ameloblast (2) Odontoblast
(3) Osteoblast (4) Osteoclast

Q.181 Deficiency of protein leads to : - **[AIPMT-98]**
(1) Rickets (2) Scurvy
(3) Kwashiorker (4) Carotenemia

Q.182 Lactose composed of : - **[AIPMT-98]**
(1) Glucose + galactose
(2) Glucose + fructose
(3) Glucose + glucose
(4) Glucose + mannose

Q.183 Vitamin which induces maturation of R.B.C. : - **[AIPMT-98]**
(1) B_1 (2) A (3) B_{12} (4) D

Q.184 Lower jaw composed of in Rabbit : - **[AIPMT-98]**
(1) Dentry (2) Maxilla
(3) Premaxilla (4) Palatine

Q.185 Which of the following stimulates the secretion of gastric juice : - **[AIPMT-98]**
(1) Gastrin (2) Enterogasterone
(3) Secretin (4) Hepatocrinin

Q.186 CCK and secretin secreted by : - **[AIPMT-99]**
(1) Stomach (2) Ileum
(3) Duodenum (4) Colon

Q.187 Suspensory ligaments are found in : - **[AIPMT-99]**
(1) Brain (2) Eyes
(3) Liver (4) Pancreas

Q.188 In stomach after physical and chemical digestion food is called : - **[AIPMT-99]**
(1) Chyme (2) Chyle
(3) Amino acid (4) Bolus

Q.189 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.190 Fully digested food reaches to liver by : - **[AIPMT-99]**
(1) Hepatic portal vein
(2) Hepatic artery
(3) Hepatic vein
(4) All the above

Q.191 Pantothenic acid & Biotin associated with : **[AIPMT-99]**

(1) Vitamin D (2) Vitamin B complex
(3) Vitamin K (4) Vitamin E

Q.192 Which one is wrong pair : - **[AIPMT-99]**
(1) Scurvy – Vitamin C
(2) Rickets – Vitamin D
(3) Night blindness (Xerophthalmia) – Vitamin A
(4) Beriberi – Vitamin K

Q.193 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.194 A person who is eating rice his food contains the component is : -
(1) Cellulose (2) Starch
(3) Lactose (4) Protein

Q.195 In mammals milk is digested by action of : **[AIPMT-2000]**
(1) Rennin
(2) Amylase
(3) Intestinal bacteria
(4) Invertase

Q.196 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.197 Which one correctly matched : -**[AIPMT-2001]**
(1) Vit. E – Tocopherole
(2) Vit. D – Riboflavin
(3) Vit. B – Calciferole
(4) Vit. A – Thiamine

Q.198 Most abundant organic compound on earth is - **[AIPMT-2001]**
(1) Protein (2) Cellulose
(3) Lipids (4) Steroids

Q.199 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.200 Vitamin B_7 is also called : -
(1) Thiamine (2) Biotin
(3) Niacin (4) Pyridoxine

Q.201 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.202 Fluoride pollution mainly affects : - **[AIPMT-2003]**
(1) Brain (2) Heart
(3) Teeth (4) Kidney

Q.203 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.204 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.205 Which hormones induce secretion of succus entericus : - **[RPMT-2000]**

(1) Insulin
(2) Secretin and cholycystokinin
(3) Glucagon
(4) Secretin

Q.206 In both chordates and non-chordates intestine develops from : - **[RPMT-2000]**

(1) Pharyngeal pouch
(2) Ectoderm
(3) Endoderm
(4) Mesoderm

Q.207 Which pollutant accumulates in liver and kidney : - **[RPMT-2000]**

(1) Cu (2) Hg
(3) Pb (4) Cd

Q.208 A Rabbit eats a lot of gram. Then its digestion starts in : - **[RPMT-2001]**

(1) Mouth (2) Stomach
(3) Duodenum (4) Ileum

Q.209 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.210 Which of the following is a disaccharide : - **[RPMT-2002]**

(1) Glucose (2) Fructose
(3) Sucrose (4) Galactose

Q.211 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.212 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.213 Hydrolysis of lipid yields : - **[RPMT-2002]**

(1) Fats
(2) Fatty acids and glycerol
(3) Mannose and glycerol
(4) Maltose and fatty acid

Q.214 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.215 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.216 Which cells of mucous layer of stomach secrete pepsinogen **[RPMT-2003]**
(1) Chief cell (2) Goblet cell
(3) Parietal cell (4) Oxyntic cell

Q.217 Glucose and galactose unite to form **[RPMT-2003]**
(1) Maltose (2) Sucrose
(3) Isomaltose (4) Lactose

Q.218 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.219 Numbers of pairs of salivary glands present in Rabbit : - **[RPMT-2004]**
(1) One (2) Three
(3) Four (4) Five

Q.220 Vitamin–C is : - **[RPMT-2004]**
(1) Ascorbic acid (2) Citric acid
(3) Phosphoric acid (4) Glutamic acid

Q.221 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.222 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.223 Duodenum has characteristic Brunner's glands which secrete -
(1) Estrogen
(2) Prolactin, parathormone
(3) Estradiol, progesterone
(4) None

Q.224 Gastric enzyme pepsin reacts only in acidic medium with in a limited pH concentration. It varies :
(1) 1.20 to 1.80 (2) 1.00 to 1.50
(3) 2.00 to 2.50 (4) 1.50 to 2.60

Q.225 Stomach in vertebrates is the main site for digestion of : **[CPMT 19982; AFMC 1985; DELHI PMT 1984]**
(1) Proteins (2) Carbohydrates
(3) Fats (4) Nucleic acids

Q.226 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.227 Brunner's gland are found in which of the following layers : **[AIPMT 1992, 99; CPMT 1993, 99; MP PMT 1998, 2001, 03; AFMC 03]**
(1) Submucosa of stomach
(2) Mucosa of ileum
(3) Submucosa of duodenum
(4) Mucosa of oesophagus

Q.228 The glucose is converted into glycogen in liver and stored in : **[CPMT 1974, 95; MP**

PMT 1994, 95 DELHI PMT 1982, 85; AFMC 1982]

(1) Liver
(2) Liver and muscles
(3) Liver and spleen
(4) Spleen and muscles

Q.229 The chief function of bile is to :
[CPMT 1975, 77, 82 BHU 2003]
(1) Digest fat by enzymatic action
(2) Emulsify fats for digestion
(3) Eliminate waste products
(4) Regulate digestion of proteins

Q.230 The toxic substance are detoxicated in the human body by : **[AIIMS 2001]**
(1) Lungs (2) Kidney
(3) Liver (4) Stomach

Q.231 Crypts to Leiberkuhn are found in between the villi. They secrete : **[MP PMT 2003]**
(1) Glucagon (2) Succus entericus
(3) Insulin (4) None

Q.232 Function of HCl in stomach is to :
[MP PMT 1994; CPMT 1982, 84, 95]
(1) Kill micro-organisms of food
(2) Facilitate absorption of food
(3) Dissolve enzymes
(4) Activate pepsinogen to pepsin

Q.233 Parotid salivary gland are present :
[MP PMT 1993; AMFC 1986, 87]
(1) Below the tongue
(2) Below the external auditory canal
(3) Below the eye orbit
(4) In the angle between two jaws

Q.234 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.235 In rabbit, the digestion of cellulose takes place in :
[DELHI PMT 1982, 85 MP PMT 2000]
(1) Colon (2) Ileum
(3) Caecum (4) Rectum

Q.236 The muscular contraction in the alimentary canal is known as :
[AFMC 1984; MP PMT 1994; RPMT 1999]
(1) Systole (2) Diastole
(3) Peristalsis (4) Metachronal

Q.237 How many teeth in man grows twice in life:
[BHU 1986; JIPMER [Med.]2001; AFMC 2002]
(1) 32 (2) 28
(3) 20 (4) 12

Q.238 End products of protein hydrolysis are :
[NCERT 1964, RPMT 2002]
(1) Mixture of amino acids
(2) Sugars
(3) Peptides
(4) 25 amino acid

Q.239 Ptyalin is an enzyme of
[AFMC 1987; MP PMT 1994; CPMT 2003]
(1) Salivary juice (2) Pancreatic juice
(3) Intestinal juice (4) None of these

Q.240 The hormone 'Secretin' stimulates secretion of **[CPMT 1990; AIPMT 1990; MP PMT 1996; 2000: Pb.PMT 1999, 2000 BHU 2000]**

(1) Pancreatic juice (2) Bile juice
(3) Salivary juice (4) Gastric juice

Q.241 Kupffer cells are found in :
[CPMT 1999; 2003; JIPMER [Med.] 2001; MP PMT 2001, 02]
(1) Liver (2) Kidney
(3) Heart (4) Blood

Q.242 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.243 Brunner's glands are present in :
[AIPMT 1999; CPMT 99; MP PMT 2001; AFMC 03]
(1) Ileum (2) Duodenum
(3) Stomach (4) Oesophagus

Q.244 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.245 If a man is allowed to live exclusively on the diet of milk, egg & bread he would suffer from -
(1) Vitamins or proximate principles of food
(2) Micronutrients or protective principles of food
(3) Macronutrients or proximate principles of food
(4) Macronutrients of protective principles of food

Q.246 The link between the tongue and the buccal floor is
(1) Labial frenulum
(2) Lingual frenulum
(3) Lingual papilla
(4) Sulcus terminalis

Q.247 Regurgitation of food from stomach is prevented by
(1) Pyloric sphincter
(2) Cardiac sphincter
(3) Circular muscle
(4) Muscularis mucossae

Q.248 First and largest chamber in stomach of ruminants like cattle, buffalo, sheep, goat and camel is
(1) Reticulum (2) Rumen
(3) Omasum (4) Abomasum

Q.249 Before opening into the duodenum, hepatopancreatic ampulla is having a thickening called
(1) Plica circulares
(2) Sacculus rotundus
(3) Sphincter of boyden
(4) Sphincter of oddi

Q.250 Lamina propria is associated with which part of the alimentary canal ?
(1) Mucosa
(2) Submucosa
(3) Muscularis externa
(4) Serosa

Q.251 When a piece of bread is chewed it tastes sweet because
(1) The sugar contents are drawn out
(2) Saliva converts starch into maltose
(3) It does not taste sweet
(4) The taste buds are stimulated by chewing

Q.252 People who eat excess of maize in their diet suffer from
(1) Pellagra (2) Rickets

(3) Beri-beri (4) Pernicious anaemia

Q.253 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.254 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.255 Which one of the following enzymes carries out the initial step in the digestion of milk in humans ? **[AIPMT-2011]**
(1) Trypsin (2) Pepsin
(3) Rennin (4) Lipase

Q.256 The purplish red pigment rhodopsin contained in the rods type of photo receptor cells of the human eye, is a derivative of – **[AIPMT-2011]**
(1) Vitamin A (2) Vitamin B_1
(3) Vitamin C (4) Vitamin D

Q.257 One of the constituents of the pancreatic juice while proured into the duodenum in humans is : **[AIPMT MAINS-2011]**
(1) Enterokinase (2) Trypsinogen
(3) Chymotrypsin (4) Trypsin

Q.258 Which one of the following correctly represents the normal adult human dental formula ? **[AIPMT MAINS-2011]**
(1) $\frac{3}{3},\frac{1}{1},\frac{3}{3},\frac{3}{3}$ (2) $\frac{3}{3},\frac{1}{1},\frac{3}{2},\frac{1}{1}$
(3) $\frac{2}{2},\frac{1}{1},\frac{3}{2},\frac{3}{3}$ (4) $\frac{2}{2},\frac{1}{1},\frac{2}{2}\frac{3}{3}$

STATE PMT EXAMS EXERCISE # 2

Q.1 Chymotrypsinogen is produced by **[Uttarachal 2004]**
(1) Liver (2) Pancreas
(3) Stomach (4) Duodenum

Q.2 Scurvy is caused due to deficiency of vitamin : **[Uttarachal 2005]**
(1) 'B' complex (2) C
(3) K (4) D

Q.3 Contraction of gall bladder is carried by : **[Uttarachal 2004]**
(1) citric acid + acetyl Co-A
(2) gastrin
(3) cholecystokinin
(4) none of these

Q.4 In human teeth, which help in cutting **[Bihar 2004]**
(1) Canine (2) Incisor
(3) Molar (4) Premolar

Q.5 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.6 Fatty liver syndrome is due to excessive intake of **[Bihar 2003]**
(1) Morphine (2) Alcohol
(3) Tobacco (4) both 1 and 2

Q.7 Enterogastrone is present in :
(1) Stomach (2) Small intestine
(3) Oesophagus (4) Both 1 and 2

Q.8 Carnesial teeth are modified for : **[Bihar 2006]**

(1) Crushing (2) Tearing
(3) Grinding (4) Cutting

Q.9 Glisson's capsules are present in **[UP CPMT 2003]**
(1) LIver (2) Lung
(3) Kidney (4) Stomach

Q.10 Osteomalacia occurs due to the deficiency of **[UP CPMT 2001]**
(1) Vitamin A (2) Vitamin B
(3) Vitamin C (4) Vitamin D

Q.11 Pulp cavity of teeth is lined by **[UP CPMT 2002]**
(1) Odontoblast (2) Chondroblast
(3) Osteoblast (4) Amyloblast

Q.12 Secretion of gastric juice is controlled by **[UP CPMT 2002]**
(1) Gastrin (2)Chlolecystokinin
(3) Enterogastrin (4) None of these

Q.13 Enzyme present in saliva is **[UP CPMT 2003]**
(1) Maltase (2) Ptyalin
(3) Sucrase (4) Invertase

Q.14 Which of the following metal is present in vitamin B_{12} **[UP CPMT 2003]**
(1) Cobalt (2) Copper
(3) Zinc (4) Magnesium

Q.15 Kupffer cells are present in **[UP CPMT 2003]**
(1) Liver (2) Pancreas
(3) Small intestine (4) Large intestine

Q.16 Teeth of rabbits are **[UP CPM 2004]**
(1) Thecodont (2) Diphyodont
(3) Heterodont (4) All of these

Q.17 Crypts of lieberkuhn are present in : **[UP CPMT 2006]**
(1) Intestine (2) Stomach
(3) Oesophagus (4) All of these

Q.18 Succus entericus is also called : **[UP CPMT 2006]**
(1) Gastric juice (2) Intestine juice
(3) Bile juice (4) Saliva

Q.19 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.20 Deamination occurs in **[UP CPMT 2007]**
(1) Kidney
(2) Liver
(3) Nephron
(4) Both 1 and 2

Q.21 Digestion of protein is completed in **[UP CPMT 2007]**
(1) Stomach
(2) Duodenum
(3) Ileum
(4) Duodenum and ileum

Q.22 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.23 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.24 bile secretion is proportional to the concentration of **[MP PMT 2007]**
(1) Protein
(2) Fat
(3) Carbohydrate
(4) None of these

Q.25 Secretion of pancreatic juice is stimulated by **[MP PMT 2007]**
(1) Gastrin (2) Secretion
(3) Enterogastrone (4) Enterokinase

Q.26 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.27 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.28 Where the lysozymes are found **[MP PMT 2004]**
(1) In saliva and tears both
(2) In tears
(3) In saliva
(4) In mitochondria

Q.29 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.30 Which of the following is different from other : **[MP PMT 2005]**
(1) Gastrin (2) Ptyalin
(3) Glucagon (4) Secretin

Q.31 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.32 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.33 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.34 The chemical name of vitamin D is **[MP PMT 2005]**
(1) Riboflavin (2) Ascorbic acid
(3) Niacin (4) Calciferol

Q.35 From which of the following pepsin is secreted **[MP PMT 2007]**
(1) Lungs (2) Stomach
(3) Salivary gland (4) Sebaceous gland

Q.36 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.37 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.38 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.39 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.40 Bilirubin and Biliverdin are present in : **[MP PMT 2001]**

(1) Pancreatic Juice
(2) Saliva
(3) Bile juice
(4) Intestinal juice

Q.41 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.42 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.43 Marasmus disease is caused due to **[MP PMT 2001]**

(1) Protein deficiency
(2) Obesity
(3) Dwarfism
(4) Deficiency of vitamins

Q.44 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.45 Specific cells found in liver are :**[MP PMT 2001]**

(1) hepatic cells
(2) beta cells
(3) Kupffer's cells
(4) Islets of Langerhans

Q.46 Which of the following does not belong to vitamin B group : **[MP PMT 2002]**

(1) Riboflavin
(2) Nicotin
(3) Cyanocobalamine
(4) Tocopherol

Q.47 Deficiency of which vitamin causes night blindness : **[MP PMT 2002]**

(1) Vitamin C (2) Vitamin B
(3) Vitamin A (4) Vitamin D

Q.48 Certain B vitamins are : **[MP PMT 2002]**

(1) Enzymes
(2) Co-enzymes
(3) Hormone
(4) Digestive substance

Q.49 Deficiency of thiamine causes : **[MP PMT 2002]**

(1) Beri-beri (2) Rickets
(3) Caries (4) Pellagera

Q.50 Anti-sterility vitamin is : **[MP PMT 2002]**

(1) Vitamin B_{12} (2) Vitamin D
(3) Vitamin E (4) Vitamin A

Q.51 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.52 Secretin hormone stimulates : **[MP PMT 2007]**

(1) Gastric glands
(2) Pancreas
(3) Gall bladder
(4) Crypts of Lieberkuhn

Q.53 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.54 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.55 The crypts of lieberkuhn secret : **[MP PMT 2003]**

(1) gastrin
(2) rennin
(3) cholecystokinin
(4) succus entricus

Q.56 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.57 In adults the deficiency of vitamin D causes: **[MP PMT 2003]**

(1) Rickets (2) Beri-beri
(3) Scurvy (4) Osteomalacia

Q.58 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.59 Brunner's glands are located in : **[MP PMT 2003]**

(1) Oesophagus (2) Duodenum
(3) Intestine (4) Stomach

Q.60 Which of the following inhibits secretion of gastric juice : **[MP PMT 2003]**

(1) Enterogasterone
(2) Gastrin
(3) CCK
(4) PZ

Q.61 Pepsinogen is secreted from : **[MP PMT 2002]**

(1) argentaffin cells (2) goblets cells
(3) chief cells (4) parietal cells

Q.62 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.63 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

EXERCISE # 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 :** Maximum absorption of food occur in jejunum
Reason : Villi & microvilli abundantly present in small intestine

Q.2 **Assertion :** Intrinsic plexus of alimentary canal regulate the peristalsis movement of alimentary canal
Reason : Muscles of alimentary canal are multiunit type

Q.3 **Assertion :** The second largest digestive gland in our body is pancreas
Reason : Pancreas function both as an exocrine & endocrine gland

Q.4 **Assertion :** Bile juice is stored mainly in the gall bladder
Reason : Gall bladder is necessary for digestion

Q.5 **Assertion :** Small intestine is very l9ong and has plica circulares & villi
Reason : All these increase internal surface area of small intestine for efficient food absorption.

Q.6 **Assertion :** The alcohol in alcohol addict person is converted into protein in the liver
Reason : Liver cells can produce protein from alcohol by fermentation

Q.7 **Assertion :** Vitamins are not essential for healthy life.
Reason : Vitamin does not regulate metabolism

Q.8 **Assertion :** G - cells of gastric gland secrete intrinsic castle's factor.
Reason : This factor help in vita. B_2 absorption.

Q.9 **Assertion :** The second largest digestive gland in our body is liver.
Reason : Liver functions as in endocrine gland.

Q.10 **Assertion :** Tonsils are also located in the digestive tract.
Reason : Tonsils produce digestive enzymes.

Q.11 **Assertion :** Removal of gall bladder does affect the protein digestive.
Reason : Bile juice break the peptide bond.

Q.12 **Assertion :** Gastric glands occur throughout the alimentary canal
Reason : Gastric juice inhibits movement food through the alimentary canal

Q.13 **Assertion :** Faeces are brown coloured
Reason : Faeces contain brown pigment named urobilin formed by reduction of bile pigment

Q.14 **Assertion :** Small intestine is very short and has longitudinal fold
Reason : All these decrease the internal surface area of small intestine for food absorption

Q.15 **Assertion :** Tonsils are located near the of the alimentary and respiratory tract
Reason : Tonsils produces digestive enzymes

Q.16 **Assertion :** Mucous glands occur throughout the alimentary canal
Reason : Mucous substances facilitate movement of food through the alimentary canal

Q.17 **Assertion :** Vitamins are essential for healthy life.
Reason : Vitamins regulate metabolism.

Q.18 **Assertion :** In human, maximum digestion occurs in duodenum.
Reason : Amupla of vater opens in duodenum.

Q.19 **Assertion :** Chief cells of gastric gland secrete intrinsic castle's factor.
Reason : This factor help in vita. B_2 absorption.

Q.20 **Assertion :** Emulsification is necessary for the digestion of fat.
Reason : After fats are emulsified, the action of enzyme amylase gets significantly increase.

Q.21 **Assertion :** Abomassum of alimentary canal of reminant animals harbour numerous bacteria & protozoa.
Reason : Bacteria & protozoa help in the secretion of gastric juice in abomassum.

Q.22 **Assertion :** Vitamin 'C' occurs only in animal tissue.
Reason : The vegetarian patients are suggested to take carrot & green vegetables when they suffer from Vita. 'C' deficiency.

Q.23 **Assertion :** Pancreatic amylase digest protein to amino acids.
Reason : Pancreatic amylase the peptide bond of protein.

Q.24 **Assertion :** Digestion is necessary for the absorption of all macro elements.
Reason : Digestion makes large complex molecule to simple smaller molecule which can be easily absorbed.

Q.25 **Assertion :** Rumen is regarged as the true stomach in ruminant animal.
Reason : Fermentation of protein takes place in Rumen.

Q.26 **Assertion :** Carbohydrates are more suitable for the production of energy in the body than protein and fats.
Reason : Carbohydrate can be stored in epithelial tissue as glycogen for use in the production of energy, whenever necessary.

Q.27 **Assertion :** Gastrectomy causes iron deficiency anaemia
Reason : Hydrochloric acid secreted by oxyntic cells converts ferric into ferrous and iron is absorbed as ferrous ions.

Q.28 **Assertion :** Cholagogues are substance that cause contraction of gall bladder.
Reason : These substance cause release of CCK-PZ from duodenum.

Q.29 **Assertion :** Aptyalism patients have higher than normal incidences of dental caries.
Reason : Aptyalism is caused by the action of Parasympathetic nervous system.

ANSWER KEY

EXERCISE # 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	1	2	3	2	3	1	2	4	1	3	4	1	3	1
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	2	4	4	3	2	2	1	3	4	1	4	4	3	2	2
Ques.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	2	4	3	1	2	2	3	1	2	1	1	1	3	3
Ques.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	1	3	3	1	4	3	2	1	1	2	2	3	3	3
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	2	4	4	3	1	2	1	3	1	3	1	4	1	1	4
Ques.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	1	3	2	1	2	2	3	4	3	3	2	3	1	2	1
Ques.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Ans.	3	1	2	4	4	2	1	3	1	3	1	1	4	1	2
Ques.	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	1	4	4	2	2	4	2	2	3	2	1	1	1	3	1
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Ans.	2	1	2	1	3	4	2	2	2	2	3	1	2	3	4
Ques.	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Ans.	2	2	4	3	1	4	2	2	1	2	3	2	3	4	3
Ques.	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
Ans.	2	3	2	3	3	2	2	3	4	3	4	1	1	4	4
Ques.	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	2	2	3	4	3	1	2	2	3	4	2	1	2	1	1
Ques.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
Ans.	3	1	3	1	1	3	2	1	1	1	2	4	1	2	1
Ques.	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
Ans.	1	1	2	3	2	4	3	4	4	4	3	3	2	3	3
Ques.	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
Ans.	3	4	2	3	4	1	4	1	3	1	4	4	4	4	1
Ques.	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
Ans.	2	3	2	2	3	2	4	2	1	3	3	3	1	1	1
Ques.	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255
Ans.	1	2	2	2	2	2	2	2	4	1	2	1	4	1	3
Ques.	256	257	258												
Ans.	1	2	4												

EXERCISE # 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2	3	2	2	2	4	1	1	4	1	1	2	1	1
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	4	1	2	1	4	4	3	4	2	2	2	2	1	2	2
Ques.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	1	4	4	2	1	1	2	2	3	1	3	1	2	3
Ques.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	3	2	1	3	4	2	2	2	4	1	4	2	2	1
Ques.	61	62	63												
Ans.	3	1	3												

EXERCISE # 3

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	