

## Chapter 5.1

# Digestion and Absorption

Animals are not able to synthesise their own food, therefore they depend on ready-made food for their nutritional requirements. The term nutrition refers to the sum total of all the processes related with the conversion of the raw foodstuff into the stuff of the body to supply energy for different metabolic activities and also for the repair and growth. In other word we can define nutrition as the process by which an organism derives energy to work and other materials, required for growth and maintenance of the various activities of life.

**Food intake :** Different organisms obtain food in different ways but carry out similar chemical reactions to utilize it. To take food, protozoans use pseudopodia, flagella or cilia; sponges and mussels, a current of water; Hydra, tentacles beset with stinging cells; planarians and earthworms, a muscular pharynx; flukes and leeches, oral sucker; insects and other arthropods, mouth parts of various kinds; and seastars and sea urchins, tube feet. Sharks capture prey with the jaws; frog and lizard with the tongue; birds with beaks of sorts; rabbit and hare use forepaws, lips and teeth; cattle, lips and teeth; carnivores, claws and teeth; giraffes, tongue; elephants, proboscis (trunk); humans, monkeys and apes use hands.

### Digestion

The process by which complex food is converted into simplest food with the help of digestive enzymes (Hydrolytic enzymes) is called digestion. Hence process of digestion is a hydrolytic process.

#### Types of digestion

(1) **Intracellular :** When the process of digestion occurs within the cell in the food vacuole. Examples : Protozoa, Porifera, Coelenterata and free living platyhelminthes.

(2) **Extracellular :** When the process of digestion occurs outside the cell. Examples : Coelenterates and phylum platyhelminthes to phylum chordata.

#### Digestive system of human

Digestion in vertebrates occurs in the digestive tract or alimentary canal. The various parts involved in digestion can be broadly grouped in two groups –

- (i) Digestive tract or alimentary canal
- (ii) Digestive glands

#### Digestive tract or alimentary canal

On the basis of the embryonic origin, the alimentary canal of vertebrates can be divided into three parts –

(1) **Fore gut / Stomodaeum :** Ectodermal. It includes buccal cavity / oral cavity, pharynx, oesophagus, stomach and small part of duodenum.

(2) **Mid gut / Mesodaeum :** Endodermal. It includes small intestine, and large intestine.

(3) **Hind gut / Proctodaeum :** Ectodermal. It includes anal canal and anus.

#### Parts of alimentary canal and its histology

##### Mouth

The mouth is a transverse slit bounded by two movable lips or labia, upper lip and lower lip. Upper lip has small ridges on the sides, a tubercle in the middle and a vertical groove (philtrum) above.

##### Vestibule

It is a narrow space between lips and gums in front and gums and cheeks on the sides. Its lining contains mucous glands. In the vestibule, a small median fold of mucous membrane, the superior labial frenulum, connects the middle of the upper lip to the gum and usually a similar but smaller inferior labial frenulum connects the middle of the lower lip to the gum.

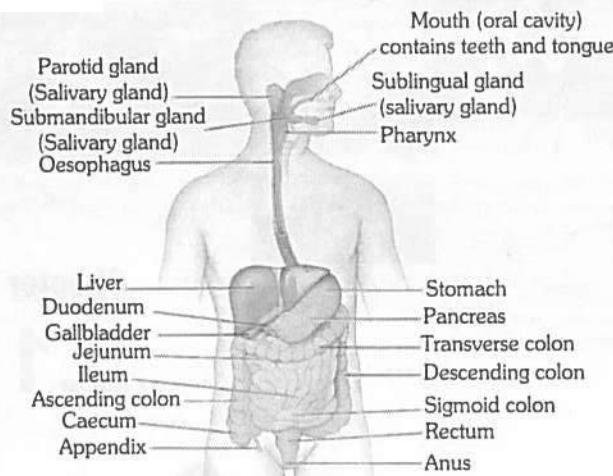


Fig : 5.1-1 Human Alimentary canal

### Buccopharyngeal cavity

It includes anterior buccal cavity lined by stratified squamous epithelial cells and posterior pharyngeal cavity lined by columnar epithelial cells. It is distinguished into three regions. Pharynx is a vertical canal beyond the soft palate. The food and air passages cross here. Pharynx may be divided into three parts; Nasopharynx, Oropharynx and Laryngopharynx.

Main structures of Buccopharyngeal cavity are –

(1) **Palate** : The roof of buccal cavity is called Palate. In crocodiles and mammals horizontal shelf like processes of premaxilla and maxilla and the palatine bones of upper jaw fuses and forms a secondary palate which separates the buccal cavity from nasal cavity. Palate is distinguished into three regions –

(i) **Hard palate** : Anterior, bony portion formed of maxilla and palatine bones in human and premaxilla, maxilla and palatine bones in rabbit. Hard palate have transverse ridges called palatine rugae. Such rugae or ridges are more developed in carnivorous mammals because their function is to firmly grip the food and prevent it from slipping out the cavity.

(ii) **Soft palate** : Posterior soft part, made up of connective tissue and muscles.

(iii) **Vellum palati/uvula** : Posterior most part of soft palate, which hangs in the region of pharynx. It closes the internal nostrils during deglutition.

(2) **Palatine glands** : Numerous mucous glands. Chiefly present in soft palate, secretes mucous for lubrication.

(3) **Naso-palatine duct** : One pair, present in rabbit, extends from nasal passage to the buccal passage, contains Jacobson's organ concerned with olfaction.

(4) **Vibrissae** : A tuft of hairs on upper lip of rabbit.

(5) **Hare-cleft** : A cleft on the upper lip of rabbit, which makes it bilobed.

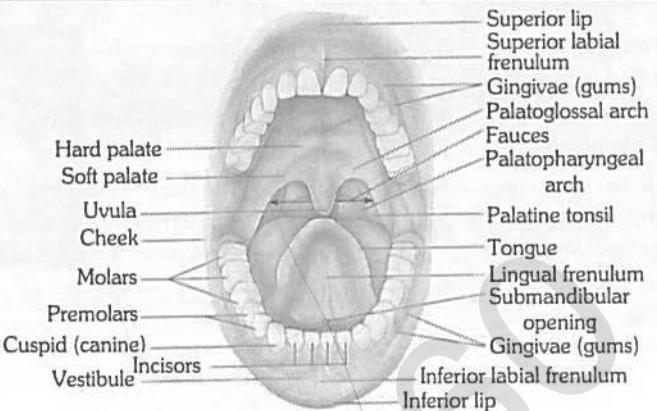


Fig : 5.1-2 Structures of the Oral cavity

(6) **Tongue (linguae)** : Ectodermal, single, pinkish, oval, elongated highly muscular (mesodermal) and protrusible present on the floor of buccopharyngeal cavity the cells present are stratified squamous epithelial cells. A furrow termed the sulcus terminalis divides the oral part and pharyngeal part of the tongue. The limbs of the sulcus terminalis run laterally and forward from a median pit, named the foramen caecum.

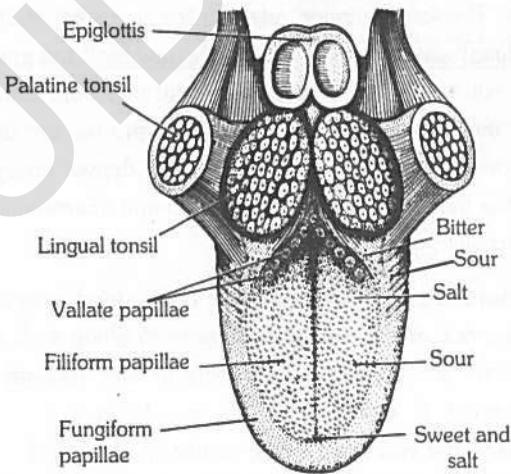


Fig : 5.1-3 Locations of papillae and areas of taste on the tongue

Posterior part of tongue (endodermal) is attached with hyoid, middle one with the floor of buccopharyngeal cavity with the help of frenulum lingum and anterior part is free. The tongue is provided with two specialized structures viz. lingual papillae and lingual glands or Weber's gland. Lingual glands are the mucous glands, which secrete mucus. Lingual papillae are numerous, minute projections chiefly present on the dorsum of the tongue. All these lingual papillae can be grouped as simple lingual papillae and taste papillae. Taste papillae are of following types –

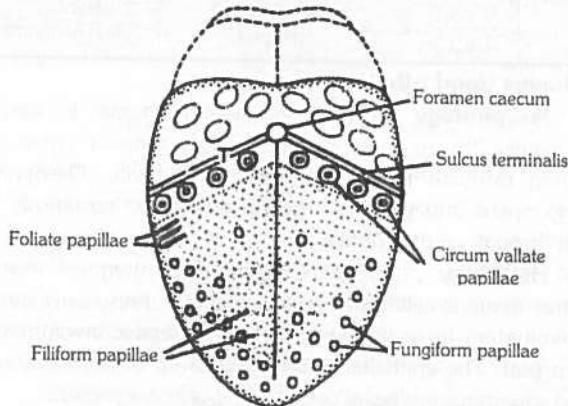
(i) **Circumvallate** : Circular largest 8-12 in number, present in the posterior part of the tongue extending from one side to another. They possess taste buds. These are the largest of all the papillae.

(ii) **Fungiform** : Mushroom shaped (Fungi – shaped), numerous, present at the anterior margins and tip of the tongue. They have 200 taste buds.

(iii) **Foliate** : Leaf like flat, less 8-10 in number, present at the posterior margin of the tongue. They are absent in human and found in rabbit.

(iv) **Filiform** : Conical shaped, smallest and most numerous distributed throughout tongue. They are without taste buds.

Hence, in human taste is recognized with the help of circumvallate and fungiform taste papillae. In man the anterior end of tongue feels sweet taste, posterior part feel bitter taste, sides feel sour taste and a small part behind the anterior end feel salty taste.



**Fig : 5.1-4 Dorsal surface of human tongue, showing three kinds of papillae and some other associated structures**

**Functions of tongue :** Important function of tongue are as follows –

- Acts as universal toothbrush, as it helps in tooth cleaning.
- Helps in speaking.
- Helps in deglutition.
- Helps in mixing saliva with food.
- Acts as a curry comb in many animals, hence help in body cleaning.
- Helps in taste detection.
- In dog helps in regulation of body temperature. The phenomenon is called as "Panting".
- In frog and other animals, it helps in prey capturing

(7) **Teeth** : Teeth is a living structure. On the basis of embryonic origin, teeth in vertebrates are of following two types –

(i) **Horny/ectodermal/epidermal/false teeth** : The teeth which develops only from ectoderm. Examples – Cyclostomes, tadpole larva of frog, prototherian mammals etc.

(ii) **True teeth** : The teeth which develops from both ectoderm and mesoderm. Examples – Fishes, amphibians, reptiles, eutherian mammals etc.

**Differentiation of teeth** : Morphologically, teeth can be distinguished as homodont or heterodont.

(i) **Homodont** : When all the teeth are structurally and functionally similar. Examples – Vertebrates except metatherian and eutherian mammals.

(ii) **Heterodont** : When the teeth are different in structure and functions. They are distinguished into four types incisors, canines, premolars and molars. Examples – metatherian and eutherian mammals.

(a) **Incisors** : These are the front teeth borne by the premaxillae in upper jaw and tips of dentaries in lower jaw. They are single-rooted monocuspid and long, curved and sharp-edged. They are adapted for cutting or cropping and biting.

(b) **Canines** : There is one pointed canine in each maxillary of upper jaw and each dentary of lower jaw next to the incisors. They are meant for piercing, tearing and offence and defence. They are single rooted and monocuspid.

(c) **Premolars** : They have one root (only in upper first PM two roots) and two cusps (bicuspid). They are meant for crushing, grinding and chewing.

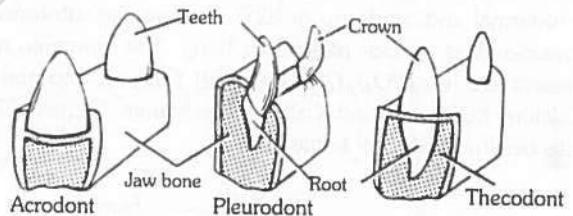
(d) **Molars** : They have more than two roots (upper molars have three roots and lower molars have two roots) and 4 cuspid.

**Attachment of teeth** : On the basis of attachment of teeth at their bases with the jaw bones, teeth can be differentiated into –

(i) **Acrodont** : Teeth are attached to the free surface or summit of the jaw bone, as in a shark or frog. Such teeth are apt to break off easily but are replaced.

(ii) **Pleurodont** : In this condition, common in urodeles and lizards, teeth are attached to the inner side of jaw bone by their base as well as one side.

(iii) **Thecodont** : Such teeth are characteristic of mammals. Teeth have well developed roots implanted in deep individual pits or sockets called alveoli or theca, in the jaw bone. These type of teeth also present in crocodilians, fossil toothed bird (Archaeopteryx).



**Fig : 5.1-5 Methods of attachment of teeth on jaws**

**Succession of teeth** : According to their replacement (succession), teeth can be divided into 3 categories: polyphyodont, diphysodont and monophyodont.

(i) **Polyphyodont** : In lower vertebrates, teeth can be replaced an indefinite number of times during life. e.g., – Fishes, amphibia, reptilia.

(ii) **Diphysodont** : In most mammals teeth develop during life in two successive sets, a condition known as diphysodont. Teeth of the first set are known as deciduous teeth or milk teeth or lacteal teeth whereas the second set is called permanent teeth.

(iii) **Monophyodont** : In some mammals such as platypus, marsupials, moles, sirenians, toothed whale etc. only one set of teeth develops known as monophyodont condition.

#### Types of cheek teeth

(i) **Bunodont** : Crown with small, blunt and round cusps as in man, monkey, pig etc. found in mixed diet mammals.

(ii) **Secodont** : With sharp cutting edges for tearing flesh as in carnivores.

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(iii) **Lophodont** : Only one cusp is present with transverse ridges called lophos, e.g., Elephant.

(iv) **Selenodont** : With vertical crescentic cusps as in grazing mammals like cow, sheep and goat. Selenodont teeth are two types –

(a) **Brachydont** : Normal low crowned selenodont teeth with large roots are termed brachydont. e.g. Ground squirrel, cattle.

(b) **Hypsodont** : In large grazing mammals teeth are elongated, prism shaped with high crown and low roots. e.g. Horse.

**Structure of teeth** : Teeth divided into three parts –

(i) **Root** : Inner most, attached to the bone with the help of cement (hyaluronic acid).

(ii) **Neck** : Middle, small, covered with gum. Gum provides strength to the teeth.

(iii) **Apex or crown** : External exposed part of teeth. Longest part, white in colour.

A small cavity present inside teeth called as pulp cavity or dentine pulp cavity. It contains blood vessels, lymphatic vessels, nerve fibres, connective tissue etc. and provides nutrition to odontoblast cells or osteoblast cells. The odontoblast cells are mesodermal in embryonic origin forming immediate covering of the pulp cavity. The cells secrete dentine/ivory. Bulk of tooth in a mammal is formed of dentine. Dentine is a layer of inorganic substances (62-69%), which surrounds the odontoblast cells. It is mesodermal in origin. Enamel, secreted by Ameloblast/Enameloblast cells, forms the outermost covering. It is ectodermal and made up of 92% of inorganic substances, hence considered as hardest part of the body. The inorganic substances present are  $[Ca_3(PO_4)_2, Ca(OH)_2, H_2O]$  Calcium phosphate (85%), Calcium hydroxide and Calcium Carbonate. Cement/Cementum attaches the tooth root to the bone.

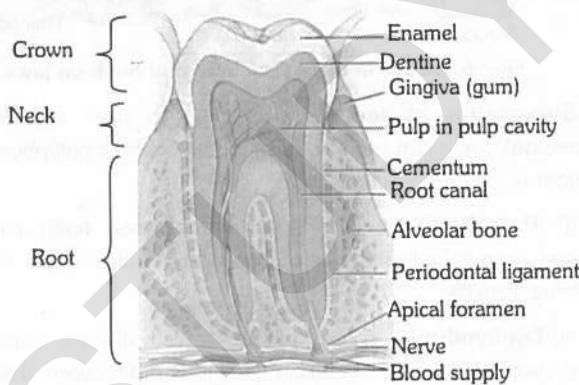


Fig : 5.1-6 Structure of tooth

**Dental formula** : Each mammalian species is characterized by its own specific dentition with a definite number and arrangement of teeth. Hence, dentition is of taxonomic importance. It is expressed by a dental formula as below –

$$\text{Rabbit : } i \frac{2}{1}, c \frac{0}{0}, pm \frac{3}{2}, m \frac{3}{3} = \frac{8}{6} \times 2 = 28 \text{ or briefly,}$$

$$\frac{2033}{1023} = \frac{2+0+3+3}{1+0+2+3} \times \frac{2}{2} = \frac{16}{12} = 28$$

(i = incisors; c = canines; pm = premolars; m = molars)

Table : 5.1-1 Dental formulae of some common mammals

Horse and pig	$\frac{3.1.4.3}{3.1.4.3} \times 2 = 44$	Cat	$\frac{3.1.3.1}{3.1.2.1} \times 2 = 30$
Dog	$\frac{3.1.4.2}{3.1.4.3} \times 2 = 42$	Squirrel	$\frac{1.0.2.3}{1.0.1.3} \times 2 = 22$
Lemur	$\frac{2.1.3.3}{2.1.3.3} \times 2 = 36$	Rat	$\frac{1.0.0.3}{1.0.0.3} \times 2 = 16$
Man (adult set)	$\frac{2.1.2.3}{2.1.2.3} \times 2 = 32$	Elephant	$\frac{1.0.0.3}{0.0.0.3} \times 2 = 14$
Cow	$\frac{0.0.3.3}{3.1.3.3} \times 2 = 32$	Human set (milk set)	$\frac{2.1.0.2}{2.1.0.2} \times 2 = 20$

### Oesophagus (food tube)

(1) **Morphology** : Single, ectodermal, dorsal to trachea, approximately 25 cm long. passes through thoracic cavity and opens into stomach present in abdominal cavity. Oesophagus anteriorly opens into pharynx through gullet and posteriorly into stomach through cardiac orifice.

(2) **Histology** : Serosa is absent but outermost layer of connective tissue is called as tunica adventitia. Muscular layer are striated/voluntary in anterior region and unstriated/involuntary in posterior part. The epithelial lining is made up of non-keratinized stratified squamous epithelial cells. Goblet cells are present.

Oesophagus lack digestive glands but multicellular glands are found, which extends upto submucosa. Due to the presence of these submucosal mucous glands, submucosa of oesophagus is thickest than other parts of alimentary canal.

**Function** : Conduction of food.

### Stomach

(1) **Structure** : Single oval, elongated, unilobed present within abdominal cavity below diaphragm. It consists of three parts as cardiac/fundic (anterior), corpus/body (middle, chief part) and pyloric (posterior part) in human, whereas in rabbit stomach is bilobed and consists of three parts as cardiac (Anterior), fundic (middle, chief part) and pylorus (posterior). Two types of valves are present in the stomach viz. Cardiac sphincter valve between oesophagus and stomach and pyloric sphincter valve between stomach and duodenum. In new born baby cardiac sphincter is much less developed that is why regurgitation of gastric contents is very common. Inner surface of stomach is raised into numerous longitudinal folds called gastric rugae. In case of ruminant mammals (cud chewing mammals) oesophagus consists of only skeletal or voluntary muscles.

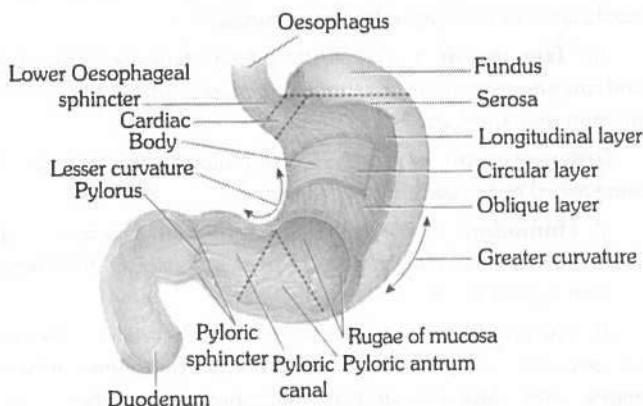


Fig : 5.1-7 Human Stomach

(2) **Histology** : Outermost layer is serosa. Muscular layer is three layered with outer longitudinal, middle circular and inner oblique. Muscles are involuntary and unstriated. Epithelial lining is made up of simple columnar epithelial cells and specialized cells present in the gastric glands. The nomenclature of gastric glands is according to the parts of the stomach. Various types of gastric glands and the cells present in them are as follows –

(i) **Anterior part** : Cardiac gastric glands in rabbit and human. Cells present are mucous neck cells secreting mucus.

(ii) **Middle part** : Fundic gastric/Main gastric glands in rabbit and corpus in human has at least four distinct types of cells –

(a) **Peptic or zymogenic or chief or central cells** : Secretes two digestive proenzymes pepsinogen and prorennin.

(b) **Oxytic or parietal cells** : Secretes HCl and castle's intrinsic factor required for the absorption of vitamin B<sub>12</sub>. Hyperacidity is abnormally high degree of acidity due to the secretion of large quantity of HCl i.e. gastric juice.

(c) **Mucous neck cells** : Secretes alkaline mucus.

(d) **Argentaffin cells or Kultschitsky or enterochromaffin cells** : Responsible for the secretion of vasoconstrictor serotonin.

(iii) **Posterior part** : Pyloric gastric glands in rabbit and human-cells are mucous neck cells secreting mucus and some cells, called "gastrin" or "G" cells, secrete a hormone, named gastrin, which increases the motility of gastric wall and stimulates gastric glands for active secretion.

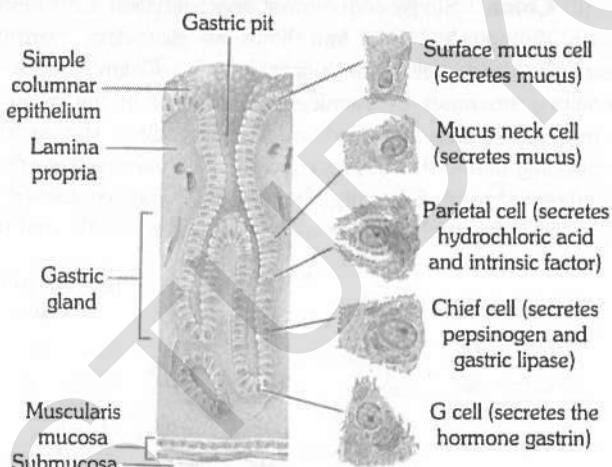


Fig : 5.1-8 L.S. Gastric gland

#### Functions

- (1) Storage of food.
- (2) Trituration or churning of food to mix with gastric juice.
- (3) Functions of gastric juice (discussed along with gastric juice).

**Stomach of ruminants (cud-chewing mammals)** : The stomach of cattle have four parts, as rumen (paunch), reticulum(honeycomb), omasum (psalterium) and abomasum (rennet). Some authors believe that first three chambers are parts of

the oesophagus, the fourth chamber is the real stomach secreting HCl and enzymes. The embryological studies have proved that all the chambers are parts of the real stomach. Camel and deer lack omasum. Reticulum is the smallest part and its cells are provided with water pockets for the storage of metabolic water.

In the rumen, food undergoes mechanical and chemical breakdown. Mechanical breakdown results from through churning brought about by muscular contractions and aided by cornified surface of villi. Chemical breakdown is caused by symbiotic microorganisms (bacteria and ciliates) that release enzyme cellulase, which act on cellulose and simplify it into short-chain fatty acids, such as acetic acid, butyric acid, propionic acid. This is called microbial digestion.

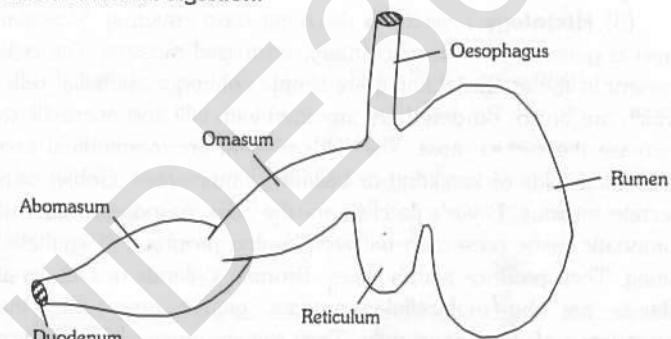


Fig : 5.1-9 The compound stomach of a ruminant

#### Small intestine

(1) **Structure** : Endodermal, longest part of alimentary canal present in the abdominal cavity, supported by a peritoneal membrane called mesentery. Wall of jejunum and ileum has circular or spiral internal fold called fold of kerckring or valvulae conniventes. Also numerous finger like projection called villi project from the wall of lumen, increasing internal surface area about ten times. The distal end of ileum leads into the large intestine by ileo-caecal valve in man but in rabbit sacculus rotundus and ileo-coecal valve both are present.

(2) **Parts** : It is approximately 3 metres in human. It is divisible into three parts duodenum, jejunum and ileum.

Table : 5.1-2 Parts of small intestine

Duodenum (Proximal part)	Jejunum (Middle part)	Ileum (Posterior part)
25 cm. Long Forming U-shaped loop before leading to jejunum, pancreas lies in the loop.	About 1 m long and about 4 cm. wide. Wall is thicker and more vascular. Villi thicker and tongue-like. Plicae best developed. Peyer's patches are lacking.	About 2 m long and about 3.5 cm. wide. Wall is thinner and less vascular. Villi thinner and finger-like. Plicae less developed. Peyer's patches are present.

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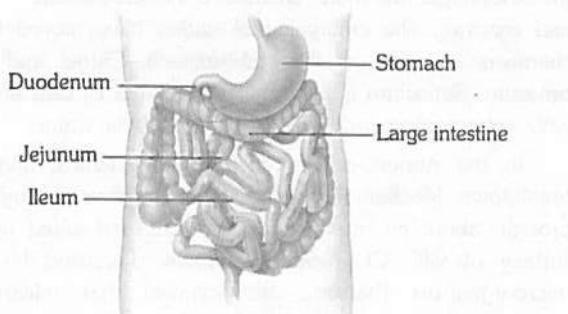


Fig : 5.1-10 Human intestine

(3) **Histology** : Serosa is the outer most covering. Muscular layer is generalized with involuntary, unstriated muscles. The cells present in the epithelial lining are simple columnar epithelial cells, which are brush- bordered i.e. provided with villi and microvilli to increase the surface area. The folds present are longitudinal and are called folds of kerckring or valvulae conniventes. Goblet cells secrete mucus. Peyer's patches are the oval, rounded masses of lymphatic tissue present in between lamina propria and epithelial lining. They produce lymphocytes. Brunner's glands or Duodenal glands are the multicellular mucous glands present in the submucosa of duodenum only. They secrete mucus. In addition there are also found granular arogyrophil cell.

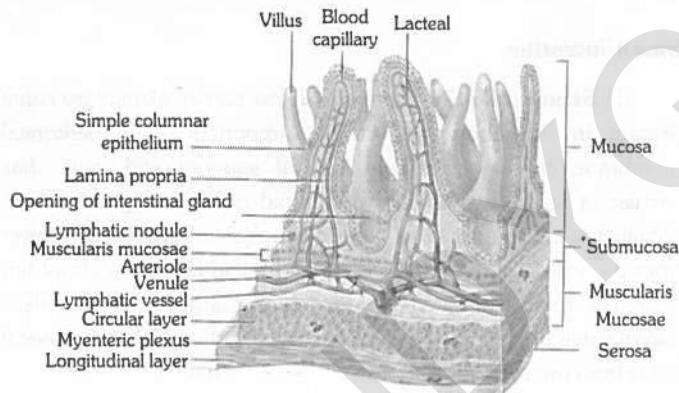


Fig : 5.1-11 Three dimensional view of layers of small intestine showing villi

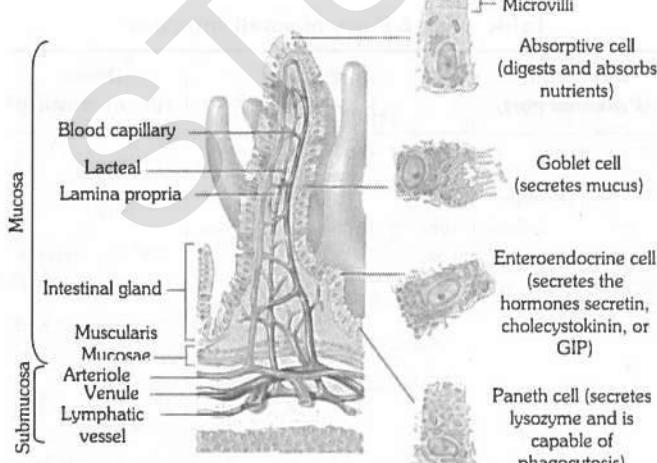


Fig : 5.1-12 Enlarged villus showing located, capillaries intestinal glands and cell types

(4) **Glands of small intestine** : Various glands found in small intestine. Each gland has three types of cells : (1) Undifferentiated epithelial cell (2) Zymogenic cell (paneth cell) and (3) Argentaffin (Enterochromaffin cell).

Table : 5.1-3 Glands of small intestine

Brunner's glands	Peyer's patches	Crypts of Leibekuhn
Found in duodenum only. Mucus secreting gland as so known as mucus gland.	These are lymph nodules. They produce lymphocytes. Lymphocytes are phagocytic in nature which destroy harmful bacteria.	Known as intestinal gland. Found in duodenum and ileum only. Secrete succus entericus i.e. intestinal juice. Formed by folding of lamina propria.

**Function** : Digestion and absorption of food.

### Large intestine

The name large intestine is due to large diameter (4-6 cm).

(1) **Structure** : Endodermal, approximately 1.5-1.75 metre long.

(2) **Parts** : They are following –

(i) **Caecum** : Spirally coiled 6 cm long in human and 45 cm long in rabbit. Its posterior end is present as a blind sac in abdominal cavity called vermiform appendix. Vermiform appendix is vestigial but contains lymphatic tissue. Caecum in human is concerned with passage of food whereas in rabbit it is concerned with cellulose digestion and conduction of food.

(ii) **Colon** : Single endodermal approximately 1.3 m long in human distinguished into four limbs as ascending, transverse, descending and pelvic or sigmoid limb. Colon posses two specialized structures as Taeniae coli (present in the middle of colon) and Haustra, (dilated sac-like or pockets like structures surrounding taeniae). Colon is concerned with absorption of water of undigested food, 5%, salts, vitamins etc. hence concerned with faeces formation. Colon bacteria also synthesized vit.  $B_{12}$  and K.

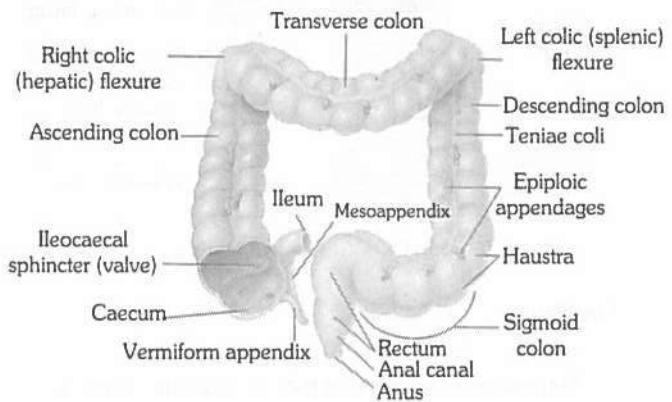


Fig : 5.1-13 Anterior view of large intestine showing major regions

(iii) **Rectum** : Single small dilated sac like in human whereas large beaded in rabbit. It is concerned with storage of faeces. Rectum has strong sphincter muscle in its wall. The sphincter keeps the canal as well as anus, closed when not used for defecation.

(iv) **Function :** Absorption of water from undigested food.

**Anal canal and anus :** Anal canal connects rectum with anus and it is about 3 cm. long. Anus is the terminal inferior opening of alimentary canal, which is guarded by an internal involuntary sphincter and an external voluntary sphincter.

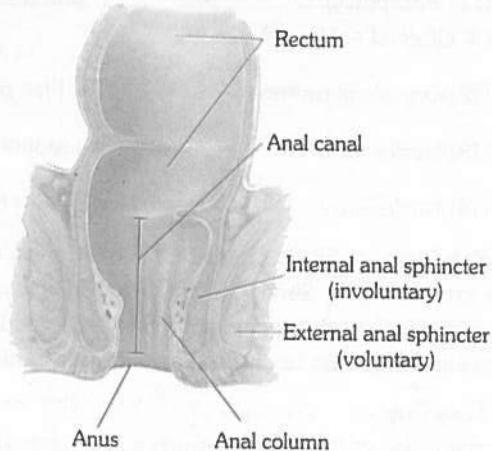


Fig : 5.1-14 Frontal section of anal canal

#### Digestive glands

The various types of digestive glands present in mammals are salivary glands, gastric glands, intestinal glands, pancreas and liver. The digestive glands secrete digestive juices. Parasympathetic nervous system increases the secretion of digestive juice whereas sympathetic nervous system decreases it.

(a) **Salivary glands :** The three pairs of salivary glands present in humans are as follows –

(1) **Parotid :** One-pair, largest salivary gland present below pinna. A stenson's duct arises from each gland, opening in vestibule between the 2<sup>nd</sup> molar teeth of upper jaw and cheeks. Parotid glands secrete enzymes. Viral infection of parotid glands causes "Mumps" (by paramyxo virus).

(2) **Sub-mandibular / sub-maxillary :** One-pair, present at the junction of upper and lower jaw in cheek region. A wharton's duct arises from each gland and opens on lower jaw. These are seromucous glands.

(3) **Sub-lingual :** One-pair, present in the floor of buccopharyngeal cavity. These are mucous glands 6-8 ducts, called ducts of rivinus or Bartholin's duct arises from these glands and opens below tongue on the floor of buccopharyngeal cavity.

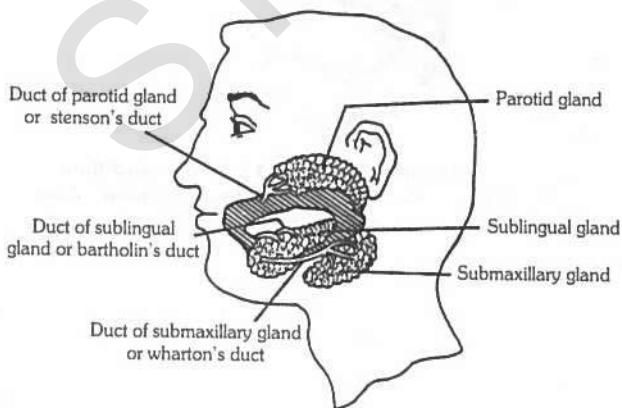


Fig : 5.1-15 Location of salivary glands in man

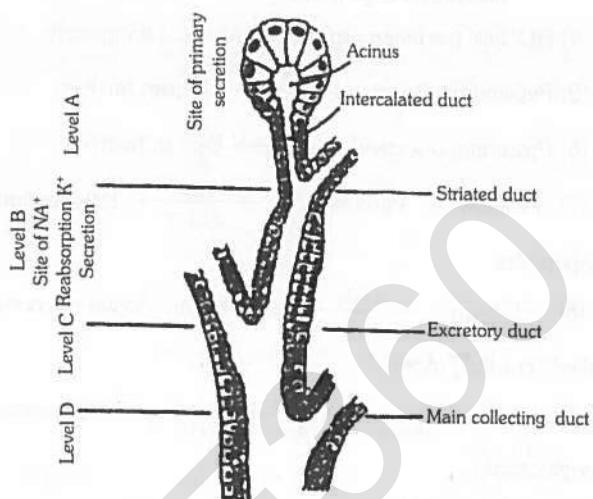


Fig : 5.1-16 An acinus of salivary gland

**Saliva / salivary juice :** The secretion of salivary glands is called saliva or salivary juice. Some of the characteristics are as follows –

(1) Amount : 1.0-1.5 litre/day

(2) Chemical nature : Slightly acidic.

(3) pH : 6.3 – 6.8

(4) Control of secretion : Autonomic reflex (parasympathetic nervous system increases salivation while sympathetic nervous system inhibit secretion.)

(5) Chemical composition : Water (99.5%), mucous (acts as lubricant), salts (NaCl, NaHCO<sub>3</sub> etc.), enzymes (ptyalin, lysozyme) etc.

**Functions :** Salivary juice and its enzymes –

(1) Makes the medium slightly acidic for the action of its enzyme.

(2) Help in taste detection, deglutition, speaking etc.

(3) Starch  $\xrightarrow[\text{(Salivary amylase)}]{\text{Ptyalin/Diastase}}$  Maltose + Isomaltose + Limit dextrin.

(4) Bacteria (living)  $\xrightarrow{\text{Lysozyme}}$  Bacteria killed.

**Gastric glands :** There are approximately 35 million of gastric glands present in human stomach and grouped into three categories as already described along with stomach. The gastric gland secretes gastric juice.

#### Gastric juice

(1) Amount : 2-3 liters/day.

(2) Chemical nature : Highly acidic

(3) pH : 1.0 – 3.5 (due to presence of HCl)

(4) Control of secretion : By gastric hormone.

(5) Chemical composition : Water (99%), mucous, inorganic salts, castle's intrinsic factor, HCl ( 0.5%, conc.) and enzymes prorennin and pepsinogen and gastric lipase.

#### Functions of gastric juice and its enzymes

(1) Inactivates the action of ptyalin.

(2) Makes the medium acidic for the action of gastric enzymes.

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(3) HCl kills micro organisms.

(4) HCl kills the living organism (prey etc.) if ingested.

(5) Pepsinogen (inactive)  $\xrightarrow{HCl}$  Pepsin (active).

(6) Prorennin (inactive)  $\xrightarrow{HCl}$  Rennin (active).

(7) Proteins + Peptones  $\xrightarrow[\text{pH } 1-3]{\text{Pepsin}}$  Polypeptides + Oligopeptides.

(8) Casein (milk protein)  $\xrightarrow[\text{Ca}^{2+}]{\text{Rennin}}$  Paracaseinate Above phenomenon is called "curdling of milk".

(9) Lipids  $\xrightarrow[\text{negligible in human stomach acts at pH 4-6}]{\text{Gastric Lipase}}$  Triglycerides + Monoglycerides.

(10) HCl is antiseptic.

(11) It act as preservative.

**Lactose intolerance :** Among mammals, man alone takes milk even after becoming adult. In some humans, secretion of lactase decreases or ceases with age. This condition is called lactose intolerance. Lactose intolerant persons fail to digest lactose of milk. In their large intestine, lactose is fermented by bacteria, producing gases and acids.

**Intestinal glands :** Intestinal glands in mammals is a collective name for crypts of Lieberkühn (secretes alkaline enzymatic juice) and Brunner's glands (secretes mucus). Intestinal glands secrete intestinal juice.

### Succus entericus (intestinal juice)

(1) Amount : 1.5 – 2.0 l/day.

(2) Chemical nature : Alkaline.

(3) pH : 7.6-8.3

(4) Control of secretion : Nervous and hormonal (Enterocrinin Duocrinin etc.)

(5) Chemical composition : Water (99%), mucus, inorganic salts, enzymes etc.

### Function of Intestinal juice and its enzymes.

(1) Inhibits the action of gastric enzymes.

(2) Makes the medium alkaline for the action of its enzymes.

(3) Starch  $\xrightarrow{\text{Amylase}}$  Maltose + Isomaltose + limit dextrin.

(4) Maltose  $\xrightarrow[\text{(}\alpha\text{-glucosidase)}]{\text{Maltase}}$  Glucose + Glucose.

(5) Isomaltose  $\xrightarrow{\text{Isomaltase}}$  Glucose + Glucose.

(6) Lactose (milk sugar)  $\xrightarrow[\text{(\beta-galactosidase)}]{\text{Lactase}}$  Glucose + Galactose.

(7) Sucrose (cane sugar)  $\xrightarrow[\text{(\beta-fructosidase)}]{\text{Sucrase / Invertase}}$  Glucose + Fructose.

(8) Polypeptides + Oligopeptides  $\xrightarrow[\text{(Amino-peptidase)}]{\text{Erepsin}}$  Amino acids.

(9) Trypsinogen (inactive)  $\xrightarrow{\text{Enterokinase}}$  Trypsin (active).

(10) Lipids  $\xrightarrow{\text{Lipase}}$  Fatty acids + Glycerol + Monoglycerides.

(11) Phospholipids  $\xrightarrow{\text{Phospholipase}}$  phosphorous + Fatty acids + Glycerol + Monoglycerides.

(12) Organic phosphate  $\xrightarrow{\text{Phosphatase}}$  Free phosphate.

(13) Nucleic acid  $\xrightarrow{\text{Polynucleotidase}}$  Nucleotides.

(14) Nucleosides  $\xrightarrow{\text{Nucleosidase}}$  Nitrogenous bases.

**Pancreas :** Single, endodermal, flat, leaf-like yellowish, heterocrine (mixed) gland, present between the ascending and descending limb of duodenum and opens into duodenum through pancreatic duct. It can be divided into following parts –

**Exocrine :** It is the major part (about 99%) of pancreas. The exocrine tissue of the pancreas consists of rounded lobules (acini) that secrete an alkaline pancreatic juice. The juice is carried by the main pancreatic duct, also called duct of Wirsung, into the duodenum through the hepatopancreatic ampulla (ampulla of vater). An accessory pancreatic duct, also named duct of Santorini, may sometimes lead directly into the duodenum.

**Endocrine :** Minor part (1% only) also called as islets of Langerhans scattered in the exocrine part. It consist of four various type of cells, as  $\alpha$ (A) cells,  $\beta$ (B) cells,  $\delta$ (D) cells and F or PP cells.  $\alpha$ -cells secretes glucagon hormone,  $\beta$ -cells secretes insulin hormone and  $\delta$  cells secrets somatostatin. The PP or F-cells secrete pancreatic polypeptide hormone to control somatostatin. The secretion passes directly into blood.

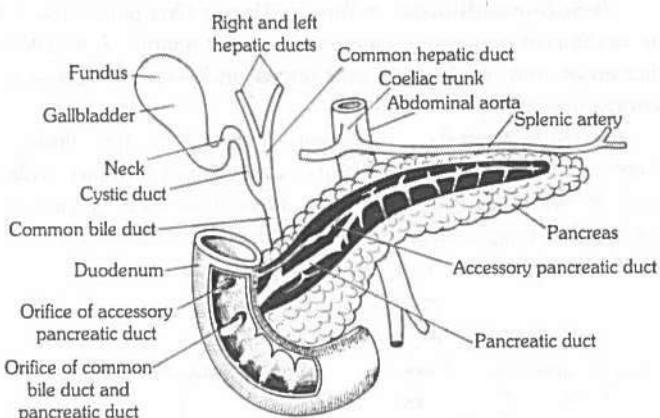


Fig : 5.1-17 The gallbladder and pancreas and their systems of ducts. Both empty into the duodenum, often by a common orifice

### Pancreatic juice

(1) Amount : 1-1.5 l/day

(2) Chemical nature : alkaline

(3) pH : 7.1-8.2

(4) Control of secretion : Hormonal and normal mechanism.

Secretin hormones stimulate the production of more alkaline pancreatic juice but low in enzyme content. Pancreozymin or Cholecystokinin stimulates the production of enzyme rich pancreatic juice.

(5) Chemical composition : Water (99%), enzymes and salts.

#### Functions of pancreas and its enzymes

(1) The islets of Langerhans secrete insulin and glucagon hormones.

(2) The exocrine part of pancreas secretes pancreatic juice.

(3) Elastase : It act upon elastin protein.

(4) Trypsinogen  $\xrightarrow[\text{Intestinal juice}]{\text{Enterokinase of}}$  Trypsin.

(5) Trypsinogen  $\xrightarrow[\text{(Autocatalysis)}]{\text{Trypsin}}$  Trypsin.

(6) Chymotrypsinogen  $\xrightarrow[\text{Autocatalysis}]{\text{Trypsin}}$  chymotrypsin.

(7) Polypeptides + peptones  $\xrightarrow[\text{(Pancreatic protease)}]{\text{Trypsin}}$  Tripeptides

+ Dipeptides + Oligopeptides.

(8) Starch  $\xrightarrow[\text{(Pancreatic amylase)}]{\text{Amylopsin}}$  Maltose + Isomaltose + limit dextrin.

(9) Emulsified Lipids  $\xrightarrow[\text{(Pancreatic lipase)}]{\text{Steapsin}}$  Fatty acids + Glycerol + Monoglycerides.

(10) Nucleic acid  $\xrightarrow{\text{Nuclease}}$  Nucleotides + Nucleosides.

(11) Nucleic acid  $\xrightarrow{\text{Nucleosidase}}$  Purines + Pyrimidines.

(12) Polypeptides  $\xrightarrow{\text{Chymotrypsin}}$  Oligopeptides.

#### Liver

(1) **Structure :** The liver is largest and heaviest gland in the body. Its upper and anterior surfaces are smooth and curved to fit the under surface of the diaphragm; the posterior surface is irregular in outline. It consists of three lobes in frog: right, left and median; five lobes in rabbit: left lateral, left central, spigelian, right central and caudate; four lobes in man: right, left, quadrates and caudate lobe. It is divided into two main lobes : right and left lobes separated by the falciform ligament.

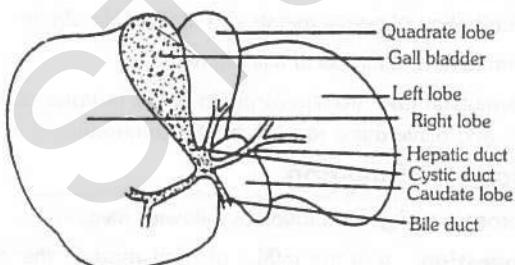


Fig : 5.1-18 Liver of man (ventral view)

A pear-shaped sac, the gall bladder is attached to the posterior surface of the liver by connective tissue. The right and left hepatic ducts join to form the common hepatic duct. The latter joins the cystic duct, which arises from the gall bladder. The cystic duct and

common hepatic duct join to form common bile duct or ductus cholangiochus which passes downwards posteriorly to join the main pancreatic duct to form the hepatopancreatic ampulla (ampulla of Vater). The ampulla opens into the duodenum. The opening is guarded by the sphincter of Oddi. The sphincter of Boyden surrounds the opening of the bile duct before it is joined with the pancreatic duct. The basic structural and functional unit of the liver is the hepatic lobule.

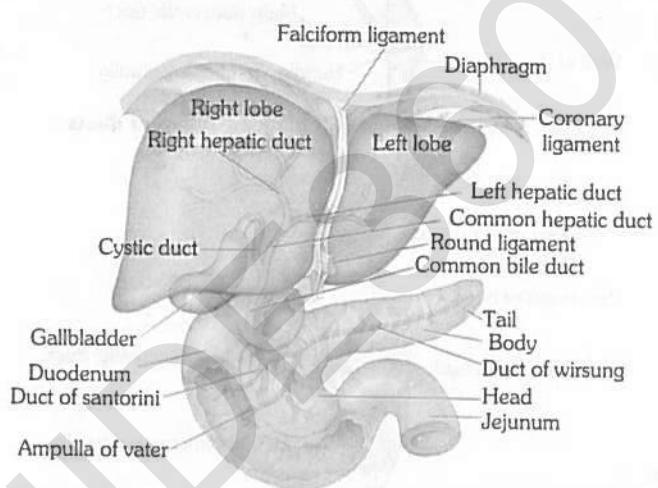


Fig : 5.1-19 Relation of Pancreas to the liver, gallbladder and duodenum

Each lobule is composed of plates of polyhedral, glycogen-rich cells, the hepatocytes, arranged radially around a central vein. Between the plates are radial blood sinusoids. At the periphery of the lobules, the branches of portal vein, hepatic artery, bile ducts, and lymphatics course together. A network of tubular spaces between the hepatocytes represents the bile canaliculi. At the periphery of the lobule the bile canaliculi empty into small Hering's canals walled by cuboidal epithelium. These canals lead into bile ducts walled by columnar epithelium. The sinusoids are lined by incomplete endothelium with scattered phagocytic Kupffer cells, that eat bacteria and foreign substances.

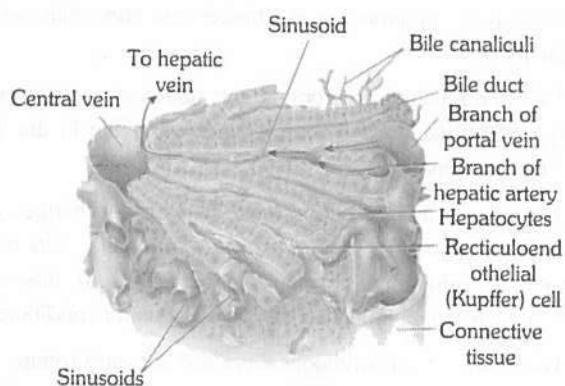
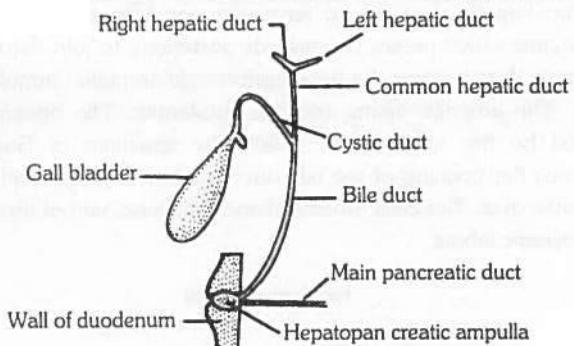


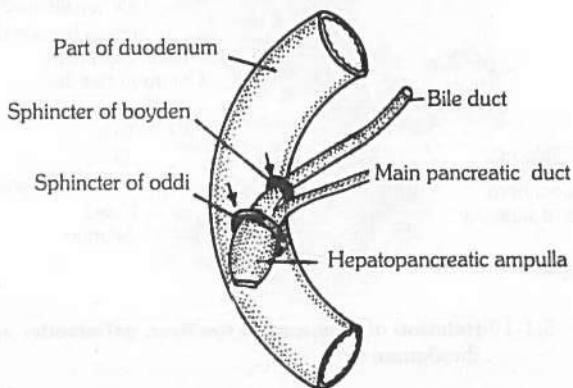
Fig : 5.1-20 Histology of a lobule

**Gall bladder :** The gall bladder is a slate-blue, pear-shaped sac connected with an omentum or ligament. Its distal part is called fundus, while the narrow part, continued as cystic duct, is called the neck.

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**Fig : 5.1-21 Showing gall bladder, different ducts and hepatopancreatic ampulla**



**Fig : 5.1-22 Showing sphincter of boyden and sphincter of oddi**

**Functions of liver :** Liver, the largest gland of vertebrate body, is an essential organ, which performs many functions –

(1) It secretes bile which is a complex watery fluid containing bile salts (Na taurocholate and Na glycocholate), bile pigments (biliverdin and bilirubin), cholesterol, mucin, lecithin and fats etc. It breaks and emulsifies the fat.

(2) In the liver, haemoglobin of the worn out erythrocytes breaks down to bile pigments bilirubin and biliverdin. The bile pigments are also converted in the bowel into stercobilin which colours the faeces.

(3) Excess quantities of carbohydrates (glucose) are converted to glycogen (Glycogenesis) in the presence of insulin in the liver cells, and stored therein.

(4) Glycogen is a reserve food material, which is changed into glucose (Glycogenolysis) and released into the blood at concentrations maintained constant by the liver. In this way, blood-sugar level is maintained under diverse dietary conditions.

(5) Under abnormal conditions, liver can convert proteins and fats into glucose by complex chemical reactions. Formation of this "new sugar" i.e. from non-carbohydrate sources, is called gluconeogenesis.

(6) If the level of blood-glucose rises beyond normal even after glycogenesis and catabolism, the excess glucose is converted into fat and stored in the liver. The process is termed lipogenesis.

(7) Amino acids resulting from protein digestion finally come into the liver from the intestine. They are partly released into the blood for distribution and protein synthesis, partly transaminated into other amino-acids and deaminated.

(8) In the embryo, red blood cells are manufactured by the liver. In the adult, liver stores inorganic salts of iron, copper and vitamin  $B_{12}$  (anti-anaemic factor) and thus helps in the formation of red blood cells and haemoglobin.

(9) Liver functions as a store-house for blood and regulates blood-volume.

(10) Fibrinogen, prothrombin and certain other blood coagulation factors are formed in the liver. Heparin is an intravascular anticoagulant that is stored in the liver.

(11) The plasma proteins serum albumin and serum globulin are synthesized by the liver from the amino acids.

(12) Liver synthesizes vitamin A from the provitamins A (carotenoid pigments). Liver cells also store fat-soluble vitamins A, D, E and K. Besides, it is the principal storage organ for vitamin  $B_{12}$ .

(13) The liver is the site of detoxification of different toxic substances either produced in the body or taken along with food.

(14) It is the main heat producing organ of the body.

(15) Kupffer cells in the liver sinusoids phagocytose and remove bacteria, worn-out blood elements and foreign particles.

(16) Liver is an important site of lymph formation.

### Bile/chole

(1) Amount : 800-1000 ml daily. On the average about 700 ml.

(2) Source : Secreted by hepatic cells

(3) Storage site : Gall bladder

(4) Colour : Greenish-blue

(5) Chemical nature : Alkaline

(6) pH : 7.6-8.6

### Functions of bile

(1) Emulsification of fats.

(2) Helps in absorption of fat-soluble vitamins.

(3) Increases alkalinity to make the medium suitable for enzymatic action.

(4) Elimination of heavy metals such as Cu, Hg, Zn etc.

(5) Elimination of excess of bile pigments.

(6) Stercobilin and urobilin (urobilin found in urine) is formed by bilirubin and biliverdin is responsible for colouration of faeces.

### Physiology of digestion

The process of digestion involves following steps –

(1) **Ingestion :** It is the intake of food most of the animals capture the prey/food with the help of mouth or tongue.

(2) **Mastication :** The process occurs in the buccopharyngeal cavity of mammals with the help of teeth. During this process food is broken down into small pieces, which increases its surface area. In frog teeth are not meant for mastication but prevents the escape of prey from mouth.

(3) **Deglutition / swallowing** : The passage of food from buccopharyngeal cavity to oesophagus/stomach. In mammals bolus of the masticated food is formed in buccopharyngeal cavity which easily slides into oesophagus. It is a voluntary reflex mechanism. Peristalsis is alternative contraction and relaxation of circular and longitudinal muscles produces the wave of contraction due to which the food passes from front to backward direction in the lumen of alimentary canal. The phenomenon is called as peristalsis. Beside alimentary canal, it is also found in vas deference, ureter etc. Peristalsis is maximum in oesophagus and minimum in rectum.

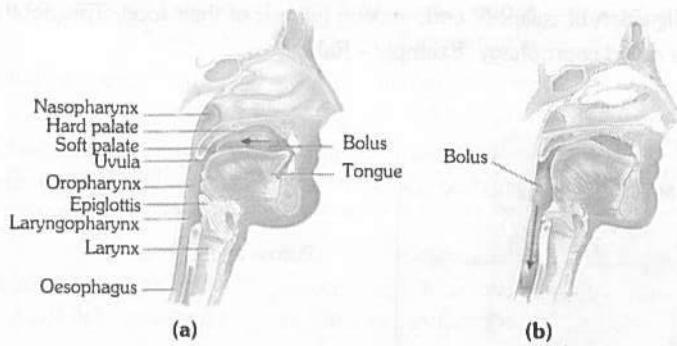


Fig : 5.1-23 Deglutition (swallowing); (a) Position of structures before swallowing, (b) During the pharyngeal stage of swallowing

Antiperistalsis is the peristaltic wave occurring in the reverse direction. It occurs in alimentary canal and results in vomiting. The phenomenon is called as "Regurgitation".

(4) **Digestion** : The process by which complex food is converted into simple food with the help of digestive enzymes. The process of digestion in mammals starts in buccopharyngeal cavity.

(i) **Digestion in buccopharyngeal cavity** : In buccopharyngeal cavity of mammals only starch is digested which is 5% of total food or 20-30% of carbohydrates.

(ii) **Digestion in stomach** : Chiefly proteins are digested in stomach.

(iii) **Digestion in small intestine** : All three component carbohydrates, proteins and fats digested in small intestine with the help of enzymes secreted by pancreas and intestinal glands.

(5) **Absorption** : Ingestion and digestion are the first two phases of the physiological processes occurring in the alimentary tract. The third phase is that of absorption by which the digested nutrients are absorbed through the wall of gut into blood.

(i) **Absorption from the mouth** : Normally, there is no absorption from the mouth, but a few drugs may be absorbed into the blood through the mucous membrane, if allowed to dissolve under the tongue, e.g., isoprenaline, glyceryl trinitrate.

(ii) **Absorption from the stomach** : In the stomach, absorption takes place to a limited degree. The only substances normally absorbed from the stomach are some water, glucose and considerable amounts of alcohol. These substances are absorbed through the walls of the stomach into the venous circulation. Although iron absorption takes place in the small intestine, it is dissolved out of foods most effectively in the stomach in the presence of HCl.

(iii) **Absorption from the small intestine** : The small intestine is the main absorptive organ. About 90% of the ingested foodstuffs are absorbed in the course of passage through the small intestine.

There are two general pathways for the transport of materials absorbed by the intestine; the veins of the hepatic portal system which lead directly to the liver; and the lymphatic vessels of the intestinal area, which eventually lead to the blood by way of the lymphatic system and the thoracic duct.

**Absorption of carbohydrates** : The products of carbohydrate digestion are absorbed from the intestine into blood of the portal venous system in the form of monosaccharides, chiefly the hexoses (glucose, fructose, mannose and galactose).

**Absorption of amino acids and protein** : It is probable that under normal circumstances the dietary proteins are almost completely digested to their constituent amino acids and that these end products of protein digestion are then actively transported from the intestine into the portal blood. Surplus amino acids are also withdrawn from portal blood by liver cells and deaminated into ammonia and keto acids. The ammonia is converted to urea and released into blood for excretion by kidneys, while the keto acids are converted to glucose or pyruvic acid and utilized for energy-production or for storage as glycogen and fat.

**Absorption of fats** : The dietary fat is digested, by the action of the pancreatic lipase present in the intestine, partially into glycerol and fatty acids and partially to split products such as monoacyl glycerols. These products of fat digestion enter the mucosal cells of the small intestine in the forms of micelles, fatty acids and glycerol.

By the lacteals, the fat is carried to the cisterna chyli (meaning 'the receiver of the chyle') and then by the thoracic (lymph) duct to the left brachiocephalic vein, where it enters the blood. The lymph reaching the thoracic duct from the intestines contains an excess of fat giving it a milky appearance. It is called chyle. In this way, fatty acids and glycerol are eventually brought into the blood stream and so, by a circuitous route, to the liver. In the liver, they are reorganized and recombined to form human fat.

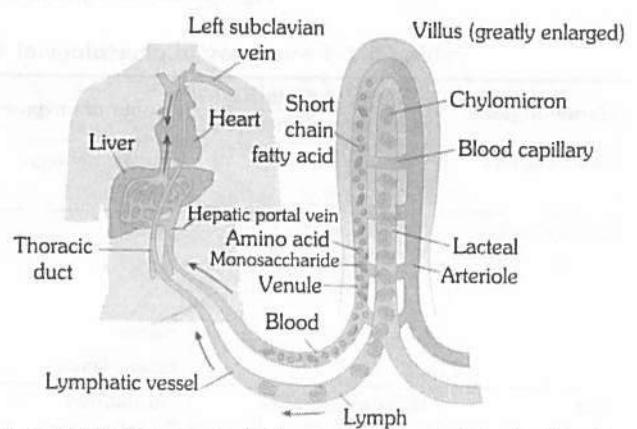


Fig : 5.1-24 Movement of absorbed nutrients into the blood and lymph

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**Absorption of vitamins :** Water-soluble vitamins like members of B complex (except B<sub>12</sub>) and vitamin C readily diffuse across the walls of the intestine into the blood. The fat-soluble vitamins A, D, E and K are dissolved in micelles, which enter the mucosal cells of the intestine, by simple diffusion. The absorption of these fat-soluble vitamins is markedly decreased in the absence of bile.

(iv) **Absorption in large intestine :** About 100-200 ml. of the water of undigested food is absorbed in the colon. It helps in maintaining the body water level. Some amount of mineral salts and vitamins are also absorbed. The symbiotic bacteria (*E. coli*) present in the large intestine, converts the inactive vitamins into active forms (i.e., they synthesizes vitamins (vitamin B complex and vitamin K) which are absorbed.

(6) **Assimilation :** Conversion of absorbed food into active cytoplasm within cell is called as assimilation.

(7) **Faeces formation :** The phenomenon occurs in colon due to absorption of water, salts, minerals and vitamins. The peristalsis in colon also helps in faeces formation.

(8) **Egestion / defaecation :** The elimination of faeces from the alimentary canal is called egestion or defaecation. The faeces is waste matter discharged from the alimentary canal.

**Pseudo-rumination or coprophagy :** Animals swallows night faeces and recycle it through the gut to complete the digestion of cellulose and, making full use of their food. This habit is called coprophagy. Example – Rabbit.

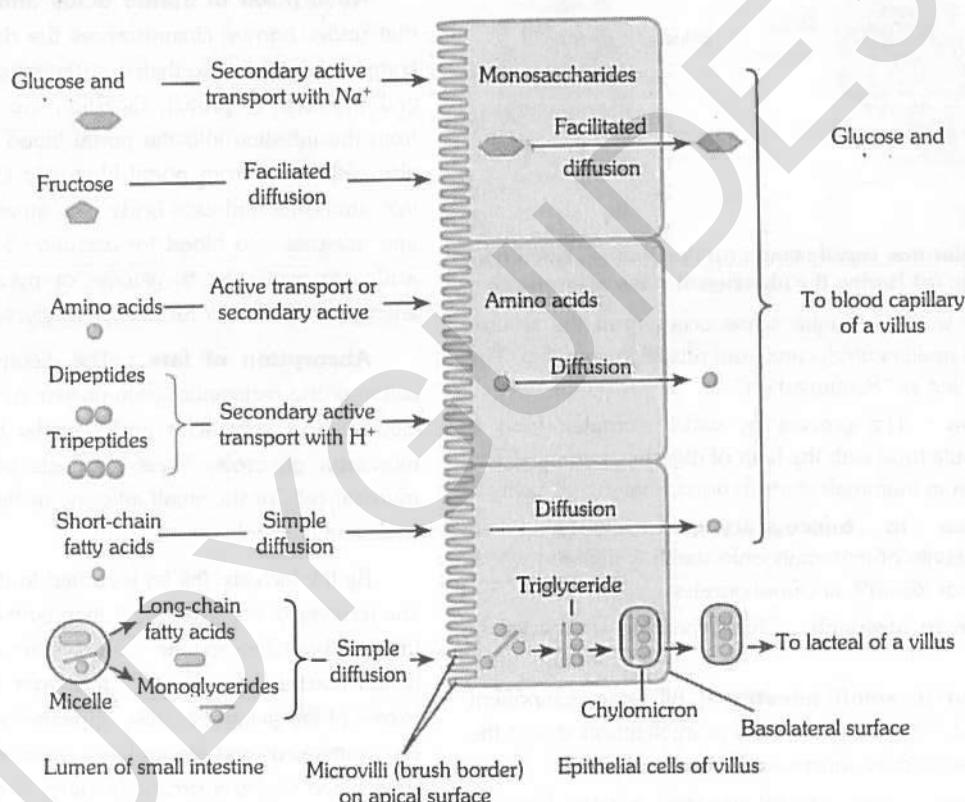


Fig : 5.1-25 Absorption of digested nutrients in the small intestine

Table : 5.1-4 Summary of physiology of digestion Major gastrointestinal enzyme in mammals

Name of gland	Name of digestive juice & optimum pH	Name of enzyme	Site of action	Substrates	Products
Salivary glands	Saliva (6.3 – 6.8)	Ptyalin / Salivary amylase	Mouth	Starch, dextrins, glycogen	Dextrins, maltose, isomaltose and limit dextrin.
Gastric glands	Gastric Juice (1-3)	Pepsin	Stomach	Proteins, casein (Milk)	Peptones, paracasein (curd). Proteoses
		Rennin Gastric lipase	Stomach Stomach	Casein Fats	Paracasein Fatty acid and Glycerol.
Liver	Bile juice (7.6-8.6)	No enzymes	Duodenum	Fat	Makes the food alkaline, emulsifies fat and kills the harmful bacteria.

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Liver	Bile ( 7.6 – 8.6)	No enzyme but useful digestive juice, provides alkaline medium, stops the action of HCl. Emulsifies fats and kills harmful bacteria.			
Pancreas	Pancreatic Juice (7.1 – 8.2)	Amylase/Diastase	Small intestine	Starch, dextrins, glycogen.	'Limits' dextrins, maltose, isomaltose.
		Trypsin	Small intestine	Proteins, Chymotrypsinogen (inactive) procarboxy peptidases (inactive) Fibrinogen (blood) Casein (milk)	Peptides, Chymotrypsin (active) carboxy peptidases (active) Elastase (active), Fibrin (clot) Paracasein (curd)
		Chymotrypsin	Small intestine	Peptones	Peptides
		Carboxypeptidases	Small intestine	Peptides	Smaller peptides and Amino acids.
		Lipase / Steapsin	Small intestine	Triglycerides	Mono-glycerides, fatty acids
		DNAase RNAase	Small intestine Small intestine	DNA RNA	Deoxyribonucleotides Ribonucleotides
Intestinal glands	Intestinal Juice (7.5–8.3)	Enteropeptidase (enterokinase)	Small Intestine	Trypsinogen (inactive)	Trypsin (active)
		Aminopeptidase	Small Intestine	Peptides	Smaller peptides and amino acid
		Dipeptidases	Small Intestine	Dipeptides 'Limit dextrins'	Amino acids
		Isomaltase	Small Intestine	Isomaltose	Glucose
		Maltase	Small Intestine	Maltose	Glucose
		Sucrase/Invertase	Small Intestine	Sucrose	Glucose, fructose
		Lactase	Small Intestine	Lactose	Glucose, galactose
		Lipase	Small Intestine	Triglycerides	Monoglycerides, fatty acids
		Nucleotidase	Small Intestine	Nucleotides	Nucleosides, inorganic phosphate
		Nucleosidase	Small Intestine	Nucleosides	Purine, pyrimidine, pentose, phosphate
		Phosphorylases		Phosphate	

(9) **Hormonal control of digestion :** Activities of digestive tract are coordinated by nervous and endocrine systems. Sight and smell of food stimulates nervous system which induces the salivary glands to produce large quantity of saliva, stomach to release its

hormone gastrin and intestine to produce intestinal hormones. Other hormones are produced in sequential order. All of them are polypeptide hormones.

**Table : 5.1-5 Gastrointestinal hormones in mammals**

Hormone	Source	Stimulus for secretion	Target organ	Action
Gastrin	Mucosa of pyloric stomach	Distension of stomach on food entry	Stomach	Stimulates secretion of gastric juice. Constricts cardiac sphincter.
Enterogastrone	Duodenal epithelium	Chyme entry into duodenum	Stomach	Slows gastric contractions to delay its emptying. Stops secretion of gastric juice.
Secretin	Duodenal epithelium	Acidic chyme entry into duodenum	Pancreas  Liver  Stomach	Release of sodium bicarbonate in pancreatic juice.  Steps up secretion of bile.  Inhibits secretion of gastrin.
Cholecystokinin (Pancreozymin)	Duodenal epithelium	Presence of fats in duodenum	Pancreas  Gall Bladder	Release of enzymes in pancreatic juice.  Release of bile from gall bladder.
Villikinin	Intestinal epithelium	Food in small intestine	Intestine	Accelerates movements of villi.
Duocrinin	Intestinal epithelium (Duodenal mucosa)	Acidic chyme in intestine	Intestine (Brunner's gland)	Release of viscous mucus from Brunner's glands.
Enterocrinin	Intestinal epithelium (Duodenal mucosa)	Acidic chyme in intestine	Intestine (crypts of Lieberkuhn's)	Release of enzymes from Lieberkuhn's crypts.

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### Nutrition

The substance used for nutrition are called nutrients. Nutrology is the study of food and their use in diet and therapy.

#### Types of nutrition

(1) **Autotrophic / Holophytic** : The individuals, which synthesizes their own food. It can be grouped into two following categories –

(i) **Photoautotrophs** : The individual, which synthesizes their own food from  $CO_2$  and  $H_2O$  in presence of sunlight. Examples – Green plants, euglena, green sulphur bacteria, chlorobium.

(ii) **Chemoautotrophs** : The individuals which synthesizes their food with the help of chemical. Examples – Sulphur bacteria, nitrite bacteria, nitrate bacteria, nitrosomonas, nitrifying bacteria-nitrosomonas, nitrobacter etc.

(2) **Heterotrophic** : The animals derive organic food materials by consuming bodies or products of other living or dead plants or animals. Heterotrophs are of following three types on the basis of their mode of feeding.

(i) **Holotrophic or Holozoic** : These individuals ingest mostly solid food. Example – Animals.

(ii) **Saprotrophic or Saprobiotic** : They feed on dead organic matter. They absorb food through their body surface, organic fluids formed due to putrefaction of dead organism. Example – Bacteria, fungi, some protozoans etc.

(iii) **Parasitic** : These individuals derive their food from the body of their host. These may live inside or upon the bodies of their hosts, or may only periodically visit them for feeding. e.g., Ectoparasites (Lice) and endoparasites (Ascaris, Taenia solium).

(3) **Myxotrophic nutrition** : They carry out autotrophic as well as heterotrophic nutrition. Example – Euglena.

#### Modes of animal nutrition

On the basis of food, holozoic or holotrophic or ingestive nutritionally animals are classified into following –

(1) **Herbivorous** : The animal which exclusively feeds on plants. Their length of alimentary canal is more as compared to others. Examples – Tadpole larva of frog, rabbit, cow, horse, sheep etc.

(2) **Carnivorous** : The animal which kills and feeds on other animals. The length of their alimentary canal is minimum. Examples – Tiger, lion etc.

(3) **Omnivorous** : The animal which can take both plant and animal product as food. They have maximum type of digestive enzymes. Example – Human, Dog, Prawn.

(4) **Insectivorous** : The animal which feeds on insects. Example – Frog, Common bats, wall lizards.

(5) **Sanguivorous** : The animal which feeds on blood of other animal. Examples – Leech, body louse, mosquito, vampire bat etc.

(6) **Carrión Eaters (Scavengers)** : They feeds on dead animals also termed as scavangers. Examples – Hyaena, neltura, kites etc.

(7) **Cannibalus** : Organisms which feeds on its own species. Examples – Cockroaches, some fishes, frog, snakes etc.

(8) **Detritus** : Animals feed chiefly upon organic matters present in the humus. Examples – Earthworm.

(9) **Coprophagus or pseudorumination or refection** : Animals which feeds on their own faeces. Example – Rabbit, Guinea pig

(10) **Larvivorous** : Feeds on larva. Example – Gambusia (mosquito fish) and Dragon fly.

(11) **Frugivorous** : Feeding on fruits. Example – Parrot, Bat, Squirrel.

(12) **Food robbers** : Feed upon food formed in alimentary canal. Example – Ascaris, Taenia solium.

(13) **Filter feeder** : Paramecium, Unio, Sponge.

#### Feeding mechanism

(1) **Feeding mechanism in liquid feeders (fluid feeders)** are as follows –

(i) **Diffusion** : Many parasitic organisms (protozoans, tapeworm) absorb the dissolved organic food through general body surface.

(ii) **Pinocytosis (cell drinking)** : Ingestion of liquid food by invagination through surface of body. Pinocytosis channels are formed at body surface to enclose the fluid food from surrounding medium. Lower ends of channels are pinched off as pinocytic vesicle or pinosomes.

(iii) **Blood sucking** : Their mouthparts are modified for sucking blood. Examples – Vampire bat, mosquito etc.

(2) **Feeding mechanism in microphagous animals (filter feeders)** : The food of such animals (paramecium, sponges, corals, bivalves, tadpole etc.) is suspended in water fluid and they have filtering devices (clusters of pseudopodia, cilia, flagella, sheets of mucous etc.) or feeding on small microscopic animals like – Amoeba, Paramecium etc.

#### Nutritional requirements

(1) **Food** : All living organism needs food. Animals are unable to synthesize their own food hence they obtain it from outside sources. Animals require food for three main purposes, such as food as a fuel which provides energy and material for body maintenance, food for movement of body includes muscles contraction etc., food for growth as well as for the synthesis of body substances.

(2) **Components of food** : These are of following types –

(i) **Carbohydrates** : They are made up of  $C : H : O$ , having  $H$  and  $O$  in the ratio of 2 : 1 and the general formula is  $(CH_2O)_n$ . They are the chief source of energy. The source of carbohydrates in our food is cereals and pulses.

Table : 5.1-6 Types and examples of carbohydrates

Types of carbohydrate	Examples
Monosaccharides	Glucose (the main blood sugar) Fructose (found in fruits) Galactose (in milk sugar) Deoxyribose (in DNA) Ribose (in RNA)
Disaccharides	Sucrose (table sugar) = glucose + fructose Lactose (milk sugar) = glucose + galactose Maltose = glucose + glucose
Polysaccharides	Glycogen, the stored form of carbohydrate in animals Starch, the stored form of carbohydrate in food Cellulose, part of cell walls in plants; not digested by humans but aids movement of food through intestines

### Specific features

- (1) Storage amount : 900 gm approx.
- (2) Storage site : Chiefly liver and muscles.
- (3) Daily requirement : 500 gm approx.
- (4) Source : Chiefly cereals (rice, wheat, maize), pulses, potato, fruits, sugarcane, milk, honey, sugar etc.
- (5) Caloric value : 4.1 k cal./gm
- (6) Physiological value : 4.0 k cal./gm

### Functions of carbohydrates

- (1) Carbohydrates, especially glucose, are the main respiratory fuels.
- (2) Ribose and deoxyribose sugars are components of nucleic acids (DNA and RNA). Galactose is a structural component of medullary sheath.
- (3) Monosugars act as monomers for the formation of disaccharides and polysaccharides.
- (4) Starch and glycogen, serve as reserve fuel.
- (5) Excess of glucose may also be changed into fats (lipogenesis) and stored in liver, adipose tissue and mesenteries.
- (6) Glucose has antiketogenic role as it prevents the incomplete oxidation of fats and formation of ketonic bodies in the blood.
- (7) Glucose spares the amino acids for protein synthesis.
- (8) Sucrose is the major form in which sugar is transported in the plant body. Sucrose is storage sugar of sugarcane and sugar beet.
- (9) Cellulose, hemicellulose etc. are the main components of cell wall of plants.
- (10) Chitin is main component of cell wall of fungi and exoskeleton of crustaceans.
- (11) Heparin prevents the blood clotting inside the blood vessels (Anticoagulants).
- (12) Glycoproteins form a protective layer, glycocalyx, on intestinal cells.
- (13) Hyaluronic acid acts as a lubricating fluid in the synovial joints between the limb bones.
- (14) Blood antigens like A, B and Rh-factor are glycoproteinaceous and provide immunity to the individual.
- (15) Sugars are also important components of some glycoproteinaceous hormones like FSH (Follicular stimulating hormone), LH (Luteinizing hormone) etc. FSH controls gametogenesis while LH controls the ovulation and formation of corpus luteum.
- (16) Carbohydrates may be changed into amino acids.
- (17) Oligosaccharides of cell membrane help in cellular recognition.
- (18) Cellulose forms roughage of food which stimulates the secretion of digestive juices. It also helps in peristalsis.
- (19) Cellulose nitrate is used in explosives.
- (20) Carboxy-methyl cellulose is used in cosmetics and medicines.
- (21) Cellulose acetate is used in preparing cellulose plastics, shatter-proof glass, fabrics etc.

(ii) **Lipids and fats** : Fats and all fat like substances are called lipids. They are composed of C, H and O. They are insoluble in water but soluble in ether, alcohol, chloroform etc.

**Table : 5.1-7 Types of lipids in the body**

Types of Lipid	Functions
Triglycerides (fats and oils)	Protection, insulation, energy storage.
Phospholipids	Major lipid component of cell membranes.
<b>Steroids</b>	
Cholesterol	Minor component of all animal cell membranes; precursor of bile salts, vitamin D, and steroid hormones.
Bile salts	Needed for absorption of dietary lipids.
Vitamin D	Helps regulate calcium level in the body; needed for bone growth and repair.
Adrenocortical hormones	Help regulate metabolism, resistance to stress, and salt and water balance.
Sex hormones	Stimulate reproductive functions and sexual characteristics.
Eicosanoids	Have diverse effects on blood clotting, inflammation, immunity, stomach acid secretion, airway diameter, lipid breakdown, and smooth muscle contraction.
<b>Other Lipids</b>	
Fatty acids	Catabolized to generate adenosine triphosphate (ATP) or used to synthesize triglycerides and phospholipids.
Carotenes	Needed for synthesis of vitamin A. which is used to make visual pigments in the eyes.
Vitamin E	Promotes wound healing, prevents tissue scarring, contributes to the normal structure and function of the nervous system, and functions as an antioxidant.
Vitamin K	Required for synthesis of blood-clotting proteins.
Lipoproteins	Transport lipids in the blood, carry triglycerides and cholesterol to tissues, and remove excess cholesterol from the blood.

### Specific features

- (1) Source : Butter, ghee, liver oil, vegetable cooking oil etc.
- (2) Daily requirement : 50 gm.
- (3) Storage site : Subcutaneous fat, adipose cells.
- (4) Caloric value : 9.45 k cal/gm.
- (5) Actual value : 9.0 k cal/gm.

### Functions of lipids

- (1) The fats acts as concentrated fuel. The caloric fuel value of 1 gm of fats is 9.45 kcal, while the physiological fuel value of 1 gm of fats is 9.0 kcal (37 kJ), which is about 2.25 times more than the energy provided by same amount of glucose.
- (2) The fats are also highly suitable for storage as the reserve food material. It is mainly stored in the liver, beneath the skin, in the brown deposits and in the fat bodies. Normally, the fats constitute about 4% of liver by weight.
- (3) Fats stored in the subcutaneous tissue insulate the body against the loss of heat energy, so conserve the body heat. Thus, fats help in homeothermy.

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(4) Medullary sheath is formed of white fatty substance, myelin, which insulates the nerve fibres and prevents the loss of energy.

(5) Fats forms the protective shock absorbing cushions around a number of organs like the eye balls, kidneys (renal fat), ovaries, etc.

(6) These help in the absorption of fat-soluble vitamins like A, D, E and K.

(iii) **Proteins** : They are composed of C. H. O. N and some in addition contain S and P. They are complex, versatile, macromolecules with very high molecular weight. Their unit is amino acids. Out of the 20 amino acids, required in human to build proteins, half of them are essential and rest are non-essential amino acid. Essential amino acids are those, not synthesized by human body and are present in food. The non-essential amino acids are those which can be synthesized by human body.

**Table : 5.1-8 Types of amino acids**

Dispensable or Essential amino acids	Non-dispensable or Nonessential amino acids
Arginine	Glycine
Histidine	Alanine
Isoleucine	Serine
Leucine	Aspartic acid
Methionine	Asparagine
Phenylalanine	Cystine
Threonine	Glutamic acid
Tryptophan	Glutamine
Lysine	Proline
Valine	Tyrosine

Arginine and histidine are considered semi indispensable amino acids. These two are not essential in the adult organisms.

**Classification of proteins** : They are following types –

**(1) On the basis of structure of molecules**

(i) **Fibrous** : Examples – Collagen, myosin, keratin, fibrin of coagulated blood etc.

(ii) **Globular** : Examples – Albumin, globulin, haemoglobin, enzymes, snake venom etc.

**(2) On the basis of their chemical nature** : The proteins are divided into three categories –

(i) **Simple proteins** : These are formed of peptide chains and yield only amino acids on hydrolysis. On the basis of shape, these may be fibrous proteins e.g. collagen of white fibres, elastin of yellow fibres, keratin of exoskeletal structures like nails, horns, hoofs, hair, feather etc.; globular proteins e.g. albumins and globulin of blood plasma, protamines, histones, glutelins etc.

(ii) **Conjugated proteins** : These are formed of a proteinaceous and a non-proteinaceous prosthetic group. These include nucleoproteins (of chromosomes-DNA and proteins; and ribosomes-RNA and proteins), glycoproteins (of blood-antigens), phosphoproteins (casein of milk), lipoproteins (lipovitellin of egg-yolk), chromoproteins (haemoglobin of RBCs), haemocyanin, rhodopsin (visual purple), iodopsin (visual violet), cytochromes, metalloproteins (carbonic anhydrase enzyme with  $Zn^{2+}$ ) etc.

(iii) **Derived proteins** : These are formed by the partial hydrolysis of simple proteins and include peptones, proteoses etc.

**Specific features**

(1) **Source** : Chief source is pulses, egg, milk, meat, fish, leafy vegetables, soyabean, groundnut etc.

(2) **Daily requirement** : 70-100 gm.

(3) **Caloric value** : 5.6 k cal/gm.

(4) **Physiological caloric value** : 4 k cal/gm.

**Table : 5.1-9 Types and functions of protein**

Types of Protein	Functions
Structural	Form structural framework or various parts of the body.  Examples : Collagen in bone and other connective tissues, and keratin in skin, hair, and fingernails.
Regulatory	Functions as hormones that regulate various physiological processes; control growth and development; as neurotransmitters, mediate responses of the nervous system.  Examples : The hormone insulin, which regulates blood glucose level, and a neurotransmitter known as substance P, which mediates sensation of pain in the nervous system.
Contractile	Allow shortening of muscle cells, which produces movement.  Examples : Myosin and actin.
Immunological	Aid responses that protect body against foreign substances and invading pathogens.  Examples : Haemoglobin, which transports most oxygen and some carbon dioxide in the blood.
Catalytic	Act as enzymes that regulate biochemical reactions.  Examples : Salivary amylase, sucrase and ATPase.

**(iv) Vitamins**

**Historical review**

N. I. Lunin (1881) discovered vitamins. The term 'vitamin' was first used by Funk in 1912. Hopkins and Funk (1912) propounded a 'vitamin theory'.

**Definition** : Vitamin are complex organic compounds needed daily in minute quantities and act as growth and metabolic regulatory substances.

**Sources** : Vitamins can only be synthesized by green plants, hence animals depend for their vitamin requirement upon the plants. Human body manufactures vitamin D using ultraviolet rays of sunlight and can store A, D, E, K and  $B_{12}$ . The chemical compositions of vitamins are known and it is possible to synthesize them.

**Importance** : The vitamins are not a sources of energy. They regulate the various metabolic processes. They mostly act as the constituents of coenzymes in the cells.

**Types** : Vitamins are divided into two groups –

(a) **Fat soluble vitamin** : A, D, E and K.

(b) **Water soluble vitamin** : B complex and C.

Table : 5.1-10 Fat soluble vitamins

Name of vitamins and chemical formula	Discovery	Sources	Daily requirement per day	Functions	Name of Deficiency Disease	Symptoms	Other Features
Vitamin A or Retinol or anti xero-phthalmic or anti infection vitamin $C_{20}H_{29}O$	McCullum and Davis (1913)	Butter, liver oils, egg yolk, mango and orange, carrot, yellow, green vegetables.	2 mg	Part of visual pigment, maintenance of epithelia and prevention of keratinization of epithelium. Beta carotene act as Antioxidants.	Xerophthalmia Night blindness or nyctalopia Keratomalacia. Dermatosis	Drying of eyeball Unable to see in dim light Epithelium keratinised Dry scaly skin	Synthesized and stored in the liver. Destroyed by - strong light.
Vitamin D or Ergocalciferol or sunshine vitamin or anti ricket vitamin $C_{28}H_{44}O$	Steenbock and Hess (1924)	Cod liver oil, butter, fish, eggs, milk, brain, lung, and spleen.	0.01 mg	Facilitates absorption of calcium and phosphorus by intestine and their retention in body and deposition in bones.	Rickets in children Osteomalacia in adults.	Deformities of bones like bowlegs, pigeon chest Weak bones liable to easy fracture	Synthesized in the body on exposure of skin (7-hydroxy cholesterol) to light. Destroyed by - oral contraceptives
Vitamin E or $\alpha$ Tocopherol or anti sterility vitamin $C_{29}H_{46}O_2$	Evan and sore (1922)	Fresh green vegetables, meat, yolk, vegetable oils, butter and cheese, peanuts wheat germs.	20 mg	Antioxidant and some role in ETS, DNA / RNA/RBC formation promote wound healing.	Anaemia Sterility Muscular atrophy	Destruction of RBC. In male causes sterility and in female abortion may occur. Effect not proved in man. Degeneration of muscles	Destroyed by UV – rays. It is also used for curing tumour and cancer
Vitamin K or Phylloquinone or anti haemorrhagic vitamin $C_{31}H_{46}O_2$	Dam and Droisy (1935)	Fresh green vegetables. tomatoes, liver, soyabean, cheese, egg.	0.07 – 0.14 mg	Synthesis of prothrombin for normal clotting of blood.	Haemorrhage	Reduced ability of blood to clot and also leads to haemorrhages.	Vitamin K is synthesised by intestinal microbes present in the intestine. Destroyed by prolonged use of antibiotics.

Table : 5.1-11 Water soluble vitamins

Name of Vitamins and Chemical Formula	Discovery	Sources	D.R.	Function	Name of Deficiency Disease	Symptoms	Other Features
Vitamin $B_1$ or Thiamine or anti neuritic or antiberiberi $C_{12}H_{16}N_4SO$	C. Funk (1926)	Branrice, whole wheat flour, egg, meat, liver yeast etc.	1-1.5 mg	Act as an enzyme in cellular respiration, role in nutrition of nerve cells. Essential for carbohydrate metabolism, protein synthesis and control water balance in body. Major component of co-enzyme carboxylase.	Beri- beri or Dry beri - beri (man) Polyneuritis or wet beri – beri (animals) Cardiovascular atrophy	Loss of appetite and weight, retarded growth, muscular dystrophy. Nerves become extremely irritable. Heart enlargement	Beri-beri disease was discovered by Eijkman Destroyed by – cooking

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Vitamin $B_2$ or G or yellow enzyme or Riboflavin or Lactoflavin or ovalflavin or hepatoflavin $C_{17}H_{26}N_4O_6$	Warburg and Christain	Cheese, egg, yeast, meat, liver, cereals, green, vegetable.	1-2 mg	Required for cell growth. Form pair of coenzyme (FMN, FAD).	Cheilosis Glossitis Keratitis	Cracking of skin at corners of mouth Inflammation of tongue Inflammation of skin	Stored in liver, Excess of this is eliminated in urine. It is associated with the physiology of vision
Vitamin $B_3$ Yeast factor or pantothenic acid or anti greying factor on chick antidermatitis factor $C_9H_{17}O_5N$	Williams (1933)	All foods, more in yeast, kidney, liver, egg, meat, milk, ground nut	5-10 mg	Part of co-enzyme A. needed for cell respiration, necessary for normal skin and nerves.	Burning feet syndrome, Nervous disorder	Nerve degeneration	It occurs in all types of plants and animal tissues. Its deficiency cause greying of hair
Vitamin $B_5$ or Niacin or Nicotinic acid or pellagra preventing factor $C_6H_5NO_2$	Goldberger (1912)	Fresh meat, liver, fish, milk, cereals, pulses, yeast etc.	16-20 mg	It is an essential component of NAD and NADP thus form coenzymes, metabolism of carbohydrates, functioning of gastrointestinal tract and nervous system	Pellagra, Dermatitis, Diarrhoea Dementia Death (4-D syndrome)	Rough skin Inflammation of skin which becomes scaly and papillated Dehydration Neural deterioration which may lead to madness	It is characterised by 3D's i.e. dermatitis diarrhoea and dementia Destroyed by - cooking Pellagra preventing factor Goldberger also called Goldberger's p-p factor It is also synthesized by colon bacteria
Vitamin $B_6$ or pyrido-xine or anti dermatitis factor $C_8H_{11}O_3N$	Gyorgyi (1928)	Brewer's yeast, liver, egg, yolk, kidney, milk, and vegetables.	2 mg	It is essential component of coenzyme pyridoxal phosphate. It promotes growth in rats used for curing tuberculosis.	Anaemia Dermatitis, paralysis & death of rats. Mental disorder Dermatitis	Nausea, lack of RBC (blood) Disturbance of central nervous system Skin lesions	Term $B_6$ was coined by Gyorgy. Destroyed by - cooking and oral contraceptives
Vitamin H or $B_7$ or Biotin or coenzyme R $C_{10}H_{16}N_2O_3S$	Bateman and Allison (1916)	Yeast, vegetables and egg yolk	150-300 mg	It acts as coenzymes and essential for fat synthesis and energy production.	Dermatitis	Scaly and itchy skin	It is synthesized by intestinal bacteria Destroyed by - prolonged use of antibiotics
Folic Acid or Vitamin M or folacin or Anti anaemic factor	Day (1935)	Green vegetable (spinach) Banana, orange and Liver.	0.4 mg	It forms coenzymes and play essential role in cell metabolism, Necessary for erythropoiesis, required for DNA synthesis.	Megaloblastic anaemia. Sprue	Enlarged RBCs Ulceration of mouth	It is also synthesized by intestinal bacteria Destroyed by - cooking

Vitamin $B_{12}$ or Cyanocobalamin or Animal protein factor (APF) or Intrinsic factor of castle $C_6H_{66}O_{14}N_{14}PCo$	Rickets (1948)	Meat, egg, liver, fish, synthesized by intestinal bacteria.	0.003 mg	Required for chromosome duplication and formation of blood corpuscles.	Pernicious anaemia	Reduced formation of erythrocytes in bone marrow	It is also known as anti pernicious factor Also synthesized by intestinal bacteria in human colon Destroyed by - excessive heat
Vitamin C or Ascorbic Acid $C_6H_6O_6$	Szent Gyorgyi (1928)	Citrus fruits such as lemon, mango, amla, plumes, guava.	40-60 mg	Functions as part of oxidation-reduction system. Helps in secretion of collagen cement dentine. Helps body to develop resistance to diseases. Helps in absorption of Ca and Fe in the intestine. Wound healing.	Scurvy.	Spongy and bleeding gums, fragile blood vessels and bones.	Required by primates, all other vertebrates and some other invertebrates can synthesize vitamin C. It is the earliest known vitamin. It is wound healing vitamin. Destroyed by heating

Table : 5.1-12 Other Types of vitamins, functions and deficiency symptoms

Name of Vitamin	Function	Symptoms of deficiency
Inositol or mouse antialopecia factor	Stimulate growth of mice. Spectacle-eye condition in rat can be treated. Keep a limit on the cholesterol level in the blood of man.	Causes reduced growth and alopecia (loss of hair) in the mice. Also causes haemorrhagic degeneration of the adrenal gland.
Choline	It is an important lipotropic factor which prevent excessive development of fatty liver. It takes part in the formation of acetylcholine which is involved conduction of nerve impulse.	Chronic deficiency causes cirrhosis in the liver also causes haemorrhagic changes in kidney.
Vit.P or citrin	Control the permeability and fragility of the capillary wall to plasma protein works as the co-factor with vitamin C.	Its deficiency causes subcutaneous bleeding due to break down of capillary walls.

(vii) **Mineral elements :** They forms approximately 4% of body weight. They are essential to regulate the various metabolic activities of the animals. The various types of mineral are group

into two categories as minor element. Examples – Ca, S, P, Na etc. and trace element examples – Cu, Zn, Mn etc. Some of these minerals are described as follows –

Table : 5.1-13 Chart of important minerals required in animal bodies

Mineral elements	Sources	Significance	Effects of deficiency
<b>Minor elements</b>			
(1) Calcium-Ca	Milk, Cereals, Cheese, Green Vegetables, Pods.	Required for formation of teeth and bones, blood clotting, functions of nerves and muscles.	Weak teeth and bones; retarded body growth.
(2) Phosphorus-P	Milk, Meat, Cereals.	Required for formation of teeth and bones and acid-base balance; component of ATP, DNA, RNA.	Weak teeth and bones; retarded body growth and physiology.
(3) Sulphur-S	Many proteins of food.	Component of many amino acids.	Disturbed protein metabolism
(4) Potassium-K	Meat, Milk, Cereals, Fruits and Vegetables.	Required for acid-base balance; water regulation and function of nerves.	Low blood pressure, weak muscles; risk of paralysis.
(5) Chlorine-Cl	Table Salt.	Required for acid-base balance; component of gastric juice.	Loss of appetite; muscle cramps.
(6) Sodium-Na	Table Salt.	Required for acid-base and water balances and nervous functions.	Low blood pressure, loss of appetite; muscle cramps.
(7) Magnesium-Mg	Cereals, Green Vegetables.	Cofactor of many enzymes of glycolysis and a number of other metabolic reactions dependent upon ATP.	Irregularities of metabolism, principally affecting nervous functions.

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(8) Iron-Fe	Meat, Eggs, Pods, Cereals, Green Vegetables.	Component of haemoglobin and cytochromes.	Anaemia weakness and weak immunity.
(9) Iodine-I	Milk, Cheese, Seafood, Iodized salt.	Important component of thyroxin hormone and regulate metabolism of cell.	Goitre, cretinism.
<b>Trace Elements</b>			
(10) Fluorine-F	Drinking water, Tea, Seafood	Maintenance of bones and teeth.	Weak teeth, Larger amount causes mottling of teeth.
(11) Zinc-Zn	Cereals, Milk, Eggs, Meat, Seafood	Cofactor of digestive and many other enzymes.	Retarded growth, anaemia, rough skin, weak immunity and fertility.
(12) Copper-Cu	Meat, Dry fruits, Pods, Green Vegetables, Seafood.	Cofactor of cytochrome oxidase enzyme. Necessary for iron metabolism and development of blood vessels and connective tissues.	Anaemia, weak blood vessels and connective tissue and damage to central nervous system.
(13) Manganese-Mn	Dry fruits, cereals, Tea, Fruits and Green Vegetables.	Cofactor of some enzymes of urea synthesis and transfer of phosphate group.	Irregular growth of bones, cartilages and connective tissues.
(14) Cobalt-Co	Milk, Cheese, Meat.	Important component of vitamin $B_{12}$	Anaemia.
(15) Selenium-Se	Meat, Cereals, Sea food.	Cofactor of many enzymes; assists vitamin E.	Muscular pain; weakness of cardiac muscles.
(16) Chromium-Cr	Yeast, Seafood, Meat, Some vegetables.	Important for catabolic metabolism.	Irregularities of catabolic metabolism and ATP production.
(17) Molybdenum-Mo	Cereals, Pods, Some Vegetable	Cofactor of some enzymes.	Irregular excretion of nitrogenous waste products.

### Nutritional imbalances and disorders

**Balanced diet :** The diet which contain the various nutrients in such proportions as can satisfy all the various needs of our body, is called a "balanced diet".

**Table : 5.1-14 Balanced diet for moderately active adult Indian**

Name of food	Recommended amounts (gms. per day)	
	Adult man	Adult woman
(1) Cereals (Wheat/Rice)	520	440
(2) Pulses	50	45
(3) Milk	200	150
(4) Meat/Fish or Egg	30	30
(5) Fats (Oil, Butter, Ghee)	45	25
(6) Sugar/Molasses	35	20
(7) Root and Tubers (Raddish, Potato, etc.)	60	50
(8) Green leafy vegetables	40	100
(9) Other vegetables	70	40

The proportion of carbohydrates, proteins and fats into fulfill energy requirement is 4 : 1 : 1 i.e. 65% of energy is obtained from carbohydrates and 10–20% each from proteins and fats. This amount of energy is fulfilled by intake of 400–600 gm of carbohydrates, 80–100 gm of proteins and 50–60 gm of fats. The balanced diet must also contain sufficient amount of minerals and vitamins.

#### Metabolic rates

(1) **Basal metabolic rate :** Amount of energy required daily by a person to maintain its basal metabolism and is about 1600 k cal/day.

(2) **Routine metabolic rate :** Amount of energy required daily by a person to do his routine work. It is about 2800 k cal/day for males and 2300 k cal for female.

(3) **Active metabolic rate :** Amount of energy required daily by a person to maintain its high metabolic rate during heavy physical work and is about 4000 to 6000 k cal/day for males and 4500 k cal for females. It has been scientifically determined that a child of 4–6 years approximately requires 1500, a child of 13–15 years requires 2500 and a youth of 16–18 year requires 3000 k cal of energy per day.

**Table : 5.1-15 Daily Dietary Requirements of Nutrients (Recommended by Indian Council of Medical Research)**

Individual	Total kcal	Protein (gms.)	Calcium (gms.)	Iron (mgs.)	Vitamin A ( $\mu$ g.)	Thiamin (mgs)	Riboflavin (mgs.)	Niacin (mgs.)	Folacin ( $\mu$ g.)	Vitamin $B_{12}$ ( $\mu$ g.)	Vitamin C (mgs.)	Vitamin D (IU)
(1) Man Moderately active	2800	55	0.4-0.5	24	750	1.4	1.7	19	100	1	40	
(2) Woman	2200	45	0.4-0.5	32	750	1.1	1.3	15	100	1	40	
(i) Moderately active	2700	59	1.0	40	750	1.3	1.5	17	300	1.5	40	
(ii) Pregnant	2750	70	1.0	32	1150	1.4	1.6	19	150	1.5	80	

(3) Boy (16-18 years)	2820	53	0.5-0.6	25	750	1.4	1.7	19	100	1	40	200
(4) Girl (16-18 years)	2200	44	0.5-0.6	35	750	1.1	1.3	15	100	1	40	200

**Nutritional disorders :** Every organism requires an adequate supply of nutrients in proper proportion in their diet for proper growth and development. There are two types of nutritional disorders

#### (1) Diseases due to over nutrition

(i) **Fluorosis :** Caused due to excess of fluorides. It results in tooth and bone decay.

(ii) **Obesity :** This is over-nutritional disorder. It is caused when "energy inputs exceeds energy output". It results in deposition of excess fat in the body.

(iii) **Constipation :** Slow movement of faeces down the large intestine causes accumulation of dry and hard stool in colon. It is generally caused by irregular bowel habits.

(iv) **Diarrhoea :** Rapid movement of faecal matter down the large intestine causes loose stools called diarrhoea. It may be also caused by viral or bacterial infections of intestinal tract, particularly of large intestine and by nervous tension.

(v) **Piles or haemorrhoids :** Enlargement of the anal veins. It may be either hereditary or may be caused due to rapid changes in the diet.

(vi) **Hypercholesterolemia :** Caused due to excess of saturated fats like butter, ghee, hydrogenated vegetable oils and eggs etc. It results in increased level of cholesterol in blood, arteriosclerosis, coronary thrombosis, heart attack etc.

(vii) **Hypervitaminosis A :** It results in loss of appetite, body hairs, painful swelling etc.

(viii) **Hypervitaminosis D :** It results in deposition of calcium ion in the soft tissues of the body.

#### (2) Diseases due to deficiency of nutrition (malnutrition)

Name of the Deficiency	Deficient Nutrient	Symptoms
Anaemia (microcytic)	Fe	Haemoglobin and number of erythrocytes gets reduced.
Megaloblastic anaemia	Folic acid and $B_{12}$	Presence of immature erythrocytes in blood.
Pernicious anaemia	Vitamin $B_{12}$	Immature RBC without Hb. This may be fatal unless treated with vitamin $B_{12}$ injection.
Xerophthalmia	Vitamin A	Thickened, keratinised, opaque ulcerated cornea. Prime cause of blindness in India, especially among children.
Night Blindness	Vitamin A	Less rhodopsin in rod cells of retina. So no vision in dim light.
Rickets (in children)	Vitamin D	Weak, soft, thin bones due to poor deposition of Ca and P. Bent long bones and painful swelling on wrist, elbow and knee joints.
Osteomalacia (adults)	Vitamin D	Weak bones of vertebral column, pelvis gets bent and deformed by body weight.
Sprue	Folacin	Ulceration of mouth, inflammation of bowel, indigestion, diarrhoea, weakness.
Pigeons breast	Vit. -D	Incomplete ossification at the end of limb bone, deformed ribs leading to pigeons breast.
Beri – beri	Vitamin $B_1$ (Thiamine)	Reduces aerobic carbohydrate metabolism. So peripheral nerves are inflamed causing pain, numbness and weakness of limb muscles. Paralysis. Fluid accumulation in tissues or oedema of hands and legs. Cardiac oedema.
Scurvy	Vitamin C	Fragile blood vessels because of defective collagen fibres in their walls. Bleeding gums, teeth fall, bones fragile. Wound healing delayed, vitamin C is recommended in serious injury.
Bleeding disease (Hypoprothrombin anaemia)	Vitamin K	Delayed blood clotting (s) so profuse bleeding.
Marasmus	Protein / Malnutrition	Growth and replacement of tissue proteins impaired so emaciated body with thin limbs and prominent ribs, dry, thin and wrinkled skin, Diarrhoea. It affects infants under one year of age.
Kwashiorkor	Protein	Wasting muscles, thin limbs, Retarded growth of body and brain, Oedema, Diarrhoea. It commonly affects babies between 1-3 years of age.
Pellagra	Nicotinamide	Swollen lips, thick pigmented skin of hands and legs. Irritability.
Osteoporosis	Ca	Weakning of bones, tooth decay.
Goitre	$I_2$	Enlargement of thyroid gland.
Muscular cramps	NaCl	Pulling of muscles due to dehydration.
Dental cramps	Fluorine	Tooth decay.

### Regulation of food intake

**Hunger** : Hunger is defined as the intrinsic (involuntary) desire or craving for food. Hunger is associated with a number of objective sensations. For instance, food deprival for many hours causes intense rhythmic hunger contractions in stomach, which even causes intense pain (hunger pangs) send sensory impulses to a "hunger or feeding centre", located in the lateral regions of hypothalamus.

When glucose levels fall in blood, hunger centre is stimulated. Hunger centre transmits impulses to wall of stomach and wall of empty stomach start contraction or hunger pangs. After taking meal satiety centre which is located in hypothalamus stimulates and feeding is stopped. During high fever person does not feel like taking meal because high temperature shuts off the appetite centre.

**Thirst** : Subconscious desire for water is called thirst. It is also induced by a hypothalamic "thirst centre". When amount of water decreases in body fluids (blood, lymph, tissue fluid, cerebrospinal fluid etc.) due to fever, exercise and sweating, copious urination, diarrhoea, etc. This induces the feeling of thirst. Presumably, a fall in glucose level in the blood also induces thirst.

## T Tips & Tricks

- ☛ Upper canine form tusk in walrus for digging mollusc and for locomotion.
- ☛ In carnivores, last premolars in upper jaw and first molars in lower jaw may have very sharp cusps for cracking bones and shearing tendons. These are called carnassial teeth.
- ☛ **Tonsillectomy** – Surgical removal of tonsil.
- ☛ **Cheek pouches** – In some rodents (squirrel, rat) certain old world monkey, the vestibule extends to form cheek pouches for temporary storage of masticated food.
- ☛ Elephant tusk is the upper incisors.
- ☛ Teeth of fishes are modified placoid scales.
- ☛ Pyorrhoea infected gums and tooth sockets.
- ☛ Maximum number of teeth present in opossum is  $\frac{5134}{4134} \times 2 = 50$ .
- ☛ The number of teeth that grows once and twice in humans life is 12 and 20 respectively.
- ☛ **Lophodont** : Cusps of premolars and molars fuse and form transverse ridges e.g. in elephant.
- ☛ **Jacobson organ (Vomeronasal organs)** – This organ serve to smell food and recognize its chemical nature. They also help enemy recognition, locating members to opposite sex, courtship etc. It is found in reptiles such as lizards, snakes and sphenodon.

- ☛ Taste of chilli is not real taste but it is burning sensation of nerves.
- ☛ Fangs of poisonous snake attached to maxillary bones, they are replaceable. Solenoglyphous, Proteroglyphous and Opisthoglyphous types of fang occurs in poisonous snake.
- ☛ Greenish faecal matter passed by infant in first two days of birth due to sterilized intestine is called meconium.
- ☛ National institute of nutrition is located in Hyderabad.
- ☛ Gastritis – Inflammation of stomach.
- ☛ Amount of rennin decreases with age, then the curdling of milk is done by pepsin and chymotrypsin.
- ☛ Removal of stomach causes dumping syndrome.
- ☛ Oesophagus does not secrete any enzyme.
- ☛ Stomach absent in labeo, lamprey and hag fish.
- ☛ The study of alimentary canal is called Gastro-Enterology.
- ☛ Digestion of cellulose is also found in termites (white ants). In which symbiotic flagellate Triconympha found in their intestine that secretes enzyme  $\beta$ -glucosidase which hydrolyse the cellulose to sugars which are used by both symbionts.
- ☛ Bursa fabricius is also called cloacal thymus, is a lymphoid mass in the cloaca of birds. It is site of differentiation of B-lymphocytes. So a part of immune system.
- ☛ Carnivores, cattles and other cud-chewing mammals lack Ptyalin enzymes in their saliva.
- ☛ Pepsin hydrolyses the peptic bonds on c-terminus side of tyrosine, tryptophan and methionine amino acids.
- ☛ Trypsin is called universal enzyme as found from protozoans to mammals.
- ☛ Nucleases of pancreatic juice digest about 80% of nucleic acid.
- ☛ Pancreatic juice is called as "complete digestive juice" as it is protease enzymes can break all type of peptide bonds.
- ☛ Amylases act on glycoside linkages.
- ☛ Pepsin, trypsin and chymotrypsin are endopeptidases whereas carboxy peptidase is exopeptidase.
- ☛ Blood is digested by trypsin.
- ☛ Enterokinase is a non-digestive protease while bile is a non-enzymatic digestive juice.
- ☛ Galactosemia is a disease of children in which amount of galactose increases in blood. Such children are kept on milk free diet.
- ☛ Sphincter of boyden is absent in rabbit and frog.
- ☛ **Cholecystectomy** – Surgical removal of gall bladder.
- ☛ Liver produces bile, cholesterol and iron.
- ☛ Prussic acid formed during metabolism is rendered harmless by liver.
- ☛ Septicaemal anaemia causes destruction of liver.
- ☛ Bile is alkaline in man but acidic in cats and dogs.
- ☛ Choleretic are substance which increase bile secretion from liver e.g. bile salts.

- ☛ Cholagogues are substances which causes the contraction of the gall bladder.
  - ☛ Obstructive jaundice is the condition when hepatic or common bile duct may be obstructed and failing to be excreted bile by the bile capillaries.
  - ☛ World food day (W.F.D) is 16<sup>th</sup> october.
  - ☛ **White revolution** – Increased milk production.
  - ☛ **Blue revolution** – Increased fish production.
  - ☛ **Yellow revolution** – Increased oil production.
  - ☛ The foul & flatus odour of the faeces is due to presence of gases such as  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{S}$ ,  $\text{CO}_2$  etc. and presence of indole, skatole and mercaptones amines formed due to decarboxylation of tryptophan amino acid.
  - ☛ Villus is the unit of absorption of food.
  - ☛ The enzymes that converts glucose to glucose 6-phosphate is hexokinase.
  - ☛ Human insulin is known as Humulin.
  - ☛ Fructose is the sweetest sugar found in fruits but not in grapes.
  - ☛ Glycogen is also called as "animal starch".
  - ☛ Zinc is necessary to maintain plasma concentration of vitamin A.
  - ☛ Vertebrates cannot digest keratin protein of hair, nails, fibroin protein of silk fibers etc, but certain insects can digest these proteins so damages silken and woolen garments.
  - ☛ Vitamin C was the first vitamin to be produced during fermentation process using wild bacteria.
  - ☛ An alcoholic is always deficient of vitamin C.
  - ☛ Vitamin  $\text{B}_{17}$  is a recently discovered vitamin with anti-cancer property.
  - ☛ Most of the B-complex vitamins are coenzymes.
  - ☛ Presently vitamin  $\text{B}_{12}$  is produced directly during the course of fermentation by propioni bacteria and certain strains of Pseudomonas.
  - ☛ Vitamins, which are synthesized by the intestinal flora are vitamin K, Thiamine, Riboflavin, Pantothenic acid, Niacin, Pyridoxin, Biotin and Folic acid.
  - ☛ Gamma – linolenic acid and arachidonic acids are essential fatty acid in mammals.
  - ☛ Phenyl alanine amino acid is denoted by symbol F.
  - ☛ The overdosage of vitamin 'A' causes injury to lysosomes.
  - ☛ Vitamin  $\text{B}_6$  is essential for transmission.
  - ☛ Frog tadpole is delayed in metamorphosis due to less amount of iodine in water.
  - ☛ The most complex amino acid having double rings structure is tryptophan.
  - ☛ The intestinal bacteria are able to synthesize both essential amino acids and vitamins in ruminants.
  - ☛ Whiptail disease is caused due to the deficiency of molybdenum.

## O Ordinary Thinking

## **Objective Questions**

## Digestive System

1. In mammals the lower jaw is made up of [IMP PMT 1998; BVP 2001]

  - Dentary
  - Maxilla
  - Premaxilla
  - Palatine

2. Dental formula of rabbit is [CPMT 1994, 98, 2010; Bihar CECE 1995]

(a) $\frac{1023}{1023}$	(b) $\frac{3023}{3023}$
(c) $\frac{1023}{2023}$	(d) $\frac{2103}{2304}$
(e) $\frac{2033}{1023}$	

3. Which one has a developed canine [MP PMT 1995]

  - Polar bear
  - Walrus
  - Male elephant
  - Rhinoceros

4. The hardest substance of vertebrate body is [NCERT; MP PMT 1995; RPMT 2006]

**Or**

Crown of teeth is covered by [AFMC 2005; MP PMT 2013]

  - Keratin
  - Enamel
  - Dentine
  - Chondrin

5. On the tongue of rabbit which type of papillae are present but absent in human

  - Circumvallate
  - Circumvallate and foliate
  - Foliate
  - Fungiform

6. The layer lining the lumen of the human alimentary canal is [Kerala PMT 2012]

  - Serosa
  - Sub-mucosa
  - Muscularis
  - Pleura
  - Mucosa

7. The back flow of faecal matter in the large intestine is prevented by the presence of [NCERT; Kerala PMT 2011]

  - Epiglottis
  - Sphincter of Oddi
  - Ileo-Caecal valve
  - Gastro-oesophageal sphincter
  - Pyloric sphincter

8. In mammals the teeth are

  - Of different types
  - Embedded in the cup-like socket of the jaw bones
  - Only two sets, present throughout life

These conditions are referred as

[Kerala PMT 2007, 09; Odisha JEE 2009]

**Or**

Teeth of rabbits are [CPMT 2004]

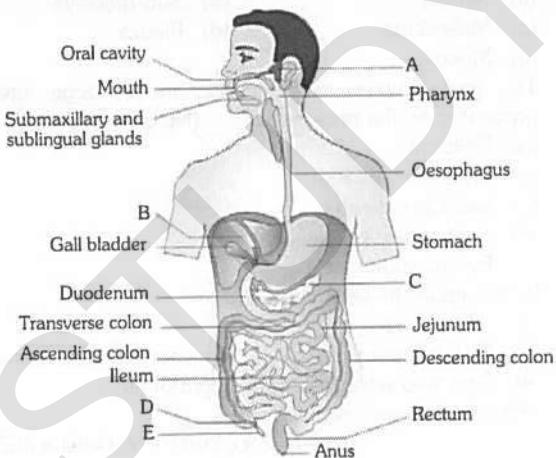
  - Heterodont, thecodont and diphyodont
  - Thecodont, heterodont and diphyodont
  - Diphyodont, thecodont and heterodont
  - Heterodont, diphyodont and thecodont
  - Thecodont, diphyodont and heterodont

9. It is a correct dental formula for the child falling under age group 5-6 yrs. [GUJCET 2007, 09]

  - $I2/2, C1/1, P\ M2/2, M0/0$
  - $I2/2, C1/1, P\ M2/2, M3/3$
  - $I1/1, C2/2, P\ M2/2, M3/3$
  - $I2/2, C2/2, P\ M1/1, M3/3$

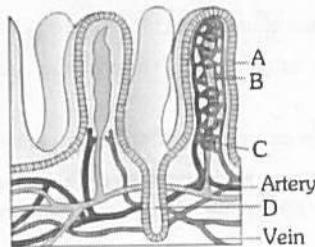
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10. The mucosal layer in the stomach form irregular folds known as [NCERT; Kerala PMT 2011]  
 (a) Villi (b) Lumen  
 (c) Rugae (d) Crypts of Lieberkühn  
 (e) Lacteals
11. A pair of small lymphatic tissue present at the sides of root tongue is called as [CBSE PMT 1993]  
 (a) Thyroid (b) Tonsils  
 (c) Epiglottis (d) Adenoids
12. Vomerine teeth are present in  
 (a) Man (b) Reptiles  
 (c) Frogs (d) Rabbits
13. The function of tongue is to [CBSE PMT 1993]  
 (a) Help in the act of swallowing  
 (b) Help in mixing saliva with the food  
 (c) Help in speaking  
 (d) All the above
14. The primary dentition in human differs from permanent dentition is not having one of the following type of teeth [AIPMT 2015]
- Or**
- A baby boy aged two years is admitted to play school and passes through a dental check-up. The dentist observed that boy had twenty teeth. Which teeth were absent [NEET 2017]  
 (a) Premolars (b) Molars  
 (c) Incisors (d) Canine
15. Taste buds for bitter taste are found on tongue at  
 (a) Tip (b) On basal surface  
 (c) Posterior part (d) Lateral sides
16. The given figure shows the human digestive system. Identify A, B, C, D and E respectively [NCERT]



- (a) A - Parotid gland, B - Liver, C - Caecum, D - Pancreas, E - Vermiform appendix  
 (b) A - Parotid gland, B - Caecum, C - Pancreas, D - Liver, E - Vermiform appendix  
 (c) A - Parotid gland, B - Pancreas, C - Liver, D - Caecum, E - Vermiform appendix  
 (d) A - Parotid gland, B - Liver, C - Pancreas, D - Caecum, E - Vermiform appendix

17. Two friends are eating together on a dining table. One of them suddenly starts coughing while swallowing some food. This coughing would have been due to improper movement of [NCERT; CBSE PMT (Pre.) 2011]  
 (a) Tongue (b) Epiglottis  
 (c) Diaphragm (d) Neck
18. If for some reason our goblet cells are non-functional, this will adversely affect [CBSE PMT (Pre.) 2010]  
 (a) Smooth movement of food down the intestine  
 (b) Production of somatostatin  
 (c) Secretion of sebum from the sebaceous glands  
 (d) Maturation of sperms
19. In mammals, the digestion of starch starts from [NCERT; CPMT 1995; BHU 2001; MH CET 2003; BCECE 2006]  
 (a) Mouth (b) Stomach  
 (c) Oesophagus (d) Duodenum
20. If the dental formula of Rabbit is 2033/1023. What does it show [CPMT 1993; Manipal 1995; RPMT 2001]  
 (a) Total number of teeth in Rabbit is 15  
 (b) Number of total incisors in Rabbit is 3  
 (c) Diastema is present between incisors & premolars  
 (d) In the formula 2033 is for adult and 1023 is for young ones
21. Which of the following teeth are lophodont [CPMT 1998; AIIMS 2002]  
 (a) Incisor and canine (b) Premolar and molar  
 (c) Canine and premolar (d) Premolar and incisor
22. The given figure shows a section of small intestinal mucosa showing villi. Identify A to D [NCERT]



- (a) A - Crypts, B - Lacteal, C - Capillaries, D - Villi  
 (b) A - Villi, B - Lacteal, C - Crypts, D - Capillaries  
 (c) A - Lacteal, B - Villi, C - Capillaries, D - Crypts  
 (d) A - Villi, B - Lacteal, C - Capillaries, D - Crypts
23. Tusk of an elephant is an enormously enlarged [AFMC 2000; HP PMT 2005; Odisha JEE 2010]  
 (a) Upper canine (b) Lower incisor  
 (c) Upper incisor (d) Lower canine
24. The type of muscle fibre present in the wall of alimentary canal is [Odisha JEE 2010]  
 (a) Smooth muscle fibre (b) Striped muscle fibre  
 (c) Cardiac muscle fibre (d) Both (a) and (b)
25. Which of the following is vestigial teeth found in human [Pb. PMT 2000]  
 (a) Incisors (b) Premolars  
 (c) Diphysodont (d) Wisdom tooth



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- 44.** Match column I with column II and choose the correct option

Column I		Column II	
A.	Goblet cells	1.	Antibacterial agent
B.	Lysozyme	2.	Mucus
C.	Saliva	3.	HCl
D.	Oxytic cells	4.	Sublingual gland

[NCERT; MP PMT 2000; Kerala PMT 2010]

- (a) A-3, B-1, C-4, D-2      (b) A-1, B-3, C-4, D-2  
 (c) A-2, B-3, C-1, D-4      (d) A-4, B-1, C-2, D-3  
 (e) A-2, B-1, C-4, D-3
- 45.** During chain elongation peptide bond is formed between carboxyl group of 1st amino acid and amino group of 2nd amino acid by

[Odisha JEE 2010]

- (a) Aminoacyl transferase      (b) Aminoacyl synthetase  
 (c) Peptidyl transferase      (d) Chloramphenicol
- 46.** Peyer's patches contain

[MP PMT 1996; Pb. PMT 2004]

- (a) Mucus      (b) Sebum  
 (c) Lymphocytes      (d) Red blood cells

- 47.** Narrower distal end of stomach is called

[NCERT; MP PMT 1994, 95]

- (a) Cardiac      (b) Duodenum  
 (c) Pharynx      (d) Pylorus

- 48.** Aggregates of lymphoid tissue present in the distal portion of the small intestine are known as

[DUMET 2010]

- (a) Villi      (b) Peyer's patches  
 (c) Rugae      (d) Choroid plexus

- 49.** Wisdom teeth are

[AFMC 2005]

- (a) Last molars      (b) Last premolars  
 (c) Incisors      (d) Canines

- 50.** Peyer's patches are found on the ileum in

[CBSE PMT 1993]

- (a) Fishes      (b) Reptiles  
 (c) Birds      (d) Mammals

- 51.** Water is largely absorbed in

[INCERT; CPMT 1999, 2005]

- (a) Stomach      (b) Oesophagus  
 (c) Small intestine      (d) Colon (Large Intestine)

- 52.** Crypts of Lieberkuhn are found in between the villi. They secrete

[MP PMT 2003, 06]

- (a) Glucagon      (b) Succus entericus  
 (c) Insulin      (d) None

- 53.** Both the crown and root of a tooth is covered by a layer of bony hard substance called

[J & K CET 2005]

- (a) Enamel      (b) Dentine  
 (c) Bony socket      (d) Cementum

- 54.** Which of the following nerves innervates alimentary canal

[Odisha JEE 2010]

- (a) Oculomotor      (b) Abducens  
 (c) Trigeminal      (d) Vagus

- 55.** Goblet cells are

[NCERT; MP PMT 2012]

- (a) Unicellular mucous gland  
 (b) Multicellular mucous gland of stomach  
 (c) Tubula-veolar gland  
 (d) All of the above

- 56.** Which of the following is correct regarding diastema

[Odisha JEE 2010]

- (a) Gap between bones  
 (b) Gap between the teeth/Absence of certain teeth  
 (c) Gap between nerves  
 (d) Gap between cells

- 57.** Brunner's gland are found in which of the following layers

[INCERT; CBSE PMT 1992, 99; CPMT 1993, 99;

MP PMT 1998, 2001, 03; AFMC 2003, 08, 10;

BHU 2012; WB JEE 2012, 16]

- (a) Submucosa of stomach

- (b) Mucosa of ileum

- (c) Submucosa of duodenum (intestine)

- (d) Mucosa of oesophagus

- 58.** Pepsinogen is secreted by

[INCERT; CPMT 1993; MP PMT 2003; DPMT 2007]

- (a) Chief cells      (b) Parietal cells  
 (c) Gastric glands      (d) Intestinal cells

- 59.** Intestinal villi are mainly concerned with

[MP PMT 1994; MH CET 2001]

**Or**

The process by which digested food of the alimentary canal passes through its mucous membrane into circulatory system is called as

[AIIMS 1992]

- (a) Assimilation      (b) Secretion  
 (c) Ultrafiltration      (d) Absorption

- 60.** Crypt of Lieberkuhn is example for

[Kerala CET 2003]

- (a) Simple tubular gland  
 (b) Coiled tubular gland  
 (c) Compound alveolar gland  
 (d) Compound tubular gland

- 61.** Brush bordered epithelium is found in

[CPMT 1999; JIPMER 2001]

- (a) Trachea      (b) Stomach  
 (c) Small intestine      (d) Fallopian tube

- 62.** Vermiform appendix is a part of

[MP PMT 1994, 95]

- (a) Alimentary canal      (b) Nervous system  
 (c) Vascular system      (d) Reproductive system

### Digestive glands

- 1.** How many kinds of cells are found in islet of Langerhans

[MP PMT 1997]

- (a) 1      (b) 2  
 (c) 3      (d) 4

- 2.** Which of the following statement is not correct

[AIPMT (Cancelled) 2015]

- (a) Goblet cells are present in the mucosa of intestine and secrete mucus

- (b) Oxytic cells are present in the mucosa of stomach and secrete HCl

- (c) Acini are present in the pancreas and secrete carboxypeptidase

- (d) Brunner's glands are present in the submucosa of stomach and secrete pepsinogen

3. Fat digestion is facilitated by [CPMT 1998]
- (a) Bile juice
  - (b) Pancreatic juice
  - (c) Gastric juice
  - (d) None of these
4. The predominant antibody in saliva is [DUMET 2010]
- (a) IgG
  - (b) IgA
  - (c) IgM
  - (d) IgD
5. In man, Glisson's capsule is associated with the [Kerala PMT 2012]
- (a) Digestive system
  - (b) Excretory system
  - (c) Nervous system
  - (d) Reproductive system
  - (e) Endocrine system
6. Parotid salivary gland are present [NCERT; MP PMT 1993]
- (a) Below the tongue
  - (b) Below the ear
  - (c) Below the eye orbit
  - (d) In the angle between two jaws
7. Pissiform cells loaded with zymogen granules can be seen in [MP PMT 1993]
- (a) Liver
  - (b) Pancreas
  - (c) Ovary
  - (d) Kidney
8. Pancreatic juice contains [NCERT]
- (a) Trypsin, lipase and maltase
  - (b) Pepsin, trypsin and maltase
  - (c) Trypsin, chymotrypsin, amylase and lipase
  - (d) Trypsin, pepsin and amylase
9. Gastric juice of infants contains [AIPMT (Cancelled) 2015]
- (a) Nuclease, pepsinogen, lipase
  - (b) Pepsinogen, lipase, rennin
  - (c) Amylase, rennin, pepsinogen
  - (d) Maltase, pepsinogen, rennin
10. Ptyalin is [AFMC 1996]
- (a) Strongly acidic
  - (b) Slightly acidic
  - (c) Slightly neutral
  - (d) Strongly alkaline
11. Liver in our body stores [AIIMS 1999]
- (a) Vitamin A
  - (b) Vitamin D
  - (c) Vitamin B<sub>12</sub>
  - (d) All of these
12. Argentaffin cells are found in [INCERT; BHU 1999; AMU (Med.) 2012]
- (a) Pancreas
  - (b) Internal ear
  - (c) Gastric glands
  - (d) Liver
13. pH of gastric juice is [Odisha JEE 2008; MP PMT 2010]
- (a) 2
  - (b) 4
  - (c) 6
  - (d) 8
14. Which of the following guards the opening of hepatopancreatic duct into the duodenum [NEET (Phase-I) 2016]
- (a) Semilunar valve
  - (b) Ileocaecal valve
  - (c) Pyloric sphincter
  - (d) Sphincter of Oddi
15. In pancreas, pancreatic juice and hormones are secreted by [CBSE PMT 1990]
- (a) Same cells
  - (b) Different cells
  - (c) Same cells at different times
  - (d) None of these
16. The pH of amylase present in saliva is [NCERT; CPMT 1996]
- (a) 6
  - (b) 6.8
  - (c) 7.2
  - (d) 8
17. Characteristic of mammalian liver is [AFMC 2006]
- (a) Kupffer's cells and leucocytes
  - (b) Leucocytes and canalicular
  - (c) Glisson's capsules and Kupffer cells
  - (d) Glisson's capsules and leucocytes
18. The pH of succus entericus is [MP PMT 1996]
- Or
- In intestine, pH value is
- (a) 7.6
  - (b) 6.6
  - (c) 5.6
  - (d) 2.0
19. Succus entericus is the name given to [NCERT]
- (a) Junction between ileum and large intestine
  - (b) Intestinal juice
  - (c) Swelling in the gut
  - (d) Appendix
20. Liver of rabbit is made up of
- (a) 4 lobes
  - (b) 6 lobes
  - (c) 5 lobes
  - (d) 7 lobes
21. Which of the following statements is correct [CPMT 2010]
- (a) Argentaffin cells produce serotonin
  - (b) Villikinin is secreted by large intestine
  - (c) In cheilosis, deficiency nutrient is nicotinamide
  - (d) Bleeding diseases occur due to deficiency of vitamin E
22. Which of the following is the symptom of Ulcerative colitis [GUJCET 2015]
- (a) Watery stools containing blood and mucus
  - (b) Difficulty in swallowing
  - (c) Loss of appetite
  - (d) Eyes turn yellow
23. Which one of the following is not the reason for very high load of bilirubin in a newborn [KCET 2010]
- (a) Excessive red blood corpuscles in the newborn burst, releasing the bilirubin
  - (b) The liver of the newborn is too young to cope up with the heavy load of bilirubin
  - (c) Mother's milk contain a high amount of bilirubin
  - (d) Insoluble bilirubin in the intestine is reabsorbed by the blood
24. Saliva is secreted from [NCERT; MP PMT 1998]
- (a) Submaxillary and sublingual glands
  - (b) Gastric gland
  - (c) Pancreas
  - (d) Gall bladder
25. The number of salivary glands in man is [NCERT]
- (a) Two pairs
  - (b) Three pairs
  - (c) Four pairs
  - (d) Five pairs

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- 26.** Ptyalin is an enzyme of  
 [CMC Vellore 1992; MP PMT 1994, 99;  
 CPMT 2003; MH CET 2004; Odisha JEE 2011]  
 (a) Salivary juice (b) Pancreatic juice  
 (c) Intestinal juice (d) None of these
- 27.** The enzymes responsible for the digestion of starch in food of man is present in  
 (a) The salivary and gastric secretions  
 (b) The salivary and pancreatic secretions  
 (c) The gastric and pancreatic secretions  
 (d) The gastric and duodenal secretions
- 28.** A lubricant, mucin in saliva is made up of [Pb. PMT 2004]  
 (a) Glycoprotein (b) Polysaccharides  
 (c) Phospholipids (d) Myosin
- 29.** The toxic substance are detoxicated in the human body by [AIIMS 2001]  
 (a) Lungs (b) Kidneys  
 (c) Liver (d) Stomach
- 30.** The trypsin enzyme is secreted by [AFMC 2003]  
 (a) Stomach (b) Duodenum  
 (c) Pancreas (d) Liver
- 31.** Bilirubin and biliverdin are found in [NCERT; MP PMT 2001]  
 (a) Blood (b) Bile  
 (c) Pancreatic juice (d) Saliva
- 32.** Match the names of glands listed under column-I with the location given under column-II, choose the answer which gives correct combination of the alphabets of the two columns
- | Column-I (glands)       | Column -II (location) |
|-------------------------|-----------------------|
| A. Crypts of Lieberkuhn | p. Loop of duodenum   |
| B. Pancreas             | q. Stomach            |
| C. Adrenal gland        | r. Intestine          |
| D. Gastric gland        | s. Kidney             |
- [KCET 2001; Kerala PMT 2008]
- (a) A = r, B = p, C = q, D = s  
 (b) A = r, B = p, C = s, D = q  
 (c) A = q, B = s, C = r, D = p  
 (d) A = p, B = r, C = s, D = q
- 33.** The bile secreted by the liver cells passes into the gall bladder through [NCERT; DPMT 1993]  
 (a) Hepato-pancreatic duct (b) Cystic duct  
 (c) Hepatic duct (d) Hepato-gall duct
- 34.** Which of the following is not a human salivary gland [NCERT; AIIMS 1993]  
 (a) Parotid (b) Submaxillary  
 (c) Sublingual (d) Infra-orbital
- 35.** Which is correct about the bile of rabbit [NCERT; RPMT 2002]  
 (a) It is synthesized by gall bladder & also stored there  
 (b) It is an enzyme which emulsify the fats  
 (c) It contain bile salts & bile pigments  
 (d) Bilirubin present in it decomposed fats
- 36.** Which of the following digestive juices have the minimum pH [AIIMS 2002]  
 (a) Bile (b) Saliva  
 (c) Gastric juice (d) Pancreatic juice
- 37.** In which of the following, putrefying bacteria is present [BHU 2006]  
 (a) Intestine (b) Colon  
 (c) Stomach (d) Liver
- 38.** The glucose is converted into glycogen in liver and stored in [MP PMT 1994, 95; CPMT 1995]  
 (a) Liver (b) Liver and muscles  
 (c) Liver and spleen (d) Spleen and muscles
- 39.** Gastric juice contains [NCERT; CPMT 1993; Kerala PMT 2010; MP PMT 2011]  
 (a) Pepsin, rennin, lipase (b) Pepsin, amylase, rennin  
 (c) Pepsin, amylase, trypsin (d) Lipase, rennin, trypsin
- 40.** Enzyme arginase is found in [CPMT 1994]  
 (a) Mouth cavity (b) Stomach  
 (c) Intestine (d) Liver
- 41.** A your infant may be feeding entirely on mother's milk which is white in colour but the stools which the infant passes out is quite yellowish. What is this yellow colour due to [CBSE PMT 2009]  
 (a) Intestinal juice  
 (b) Bile pigments passed through bile  
 (c) Undigested milk protein casein  
 (d) Pancreatic juice poured into duodenum
- 42.** Kupffer cells of liver are [JIPMER 2001; MP PMT 2001, 02; BVP 2002; CPMT 2003; BHU 2008; WB JEE 2011]  
 (a) Loose connective tissue (b) Phagocytic cell  
 (c) Mast cell (d) Fat cell
- 43.** Bile secretion is proportional to the concentration of [MP PMT 2007]  
 (a) Protein (b) Fat  
 (c) Carbohydrate (d) None of these
- 44.** The special feature of bile juice is that it [NCERT; Odisha JEE 2011]  
 (a) Has no enzyme (b) Has amylase  
 (c) Contains lipase (d) Contains  $H_2O$
- 45.** Cells of the liver manufacture [DPMT 1993]  
 (a) Diastase (b) Amylase  
 (c) Lipase (d) Insulin
- 46.** Succus entericus is secreted by [KCET 2007, 10]  
 (a) Islets of Langerhans  
 (b) Gastric gland  
 (c) Uterine crypt and endometrium  
 (d) Crypts of Leiberkuhn and Brunner's gland
- 47.** In which of the following proteins are absent [MP PMT 2000]  
 (a) Pancreatic juice (b) Saliva  
 (c) Bile (d) Intestinal juice



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- 6.** Which enzymes are likely to act on the baked potatoes eaten by a man, starting from the mouth and as it moves down the alimentary canal [NEET (Karnataka) 2013]
- Pancreatic amylase → salivary amylase → lipases
  - Disaccharidase like maltase → lipases → nucleases
  - Salivary amylase → pancreatic amylase → disaccharidases
  - Salivary maltase → carboxy peptidase → trypsinogen
- 7.** Trypsin is a digestive enzyme which occurs in mammals and digests [CPMT 1992, 93; MP PMT 1995]
- Starch in buccal cavity in an alkaline medium
  - Protein in stomach in an acidic medium
  - Protein in duodenum in an acidic medium
  - Protein in duodenum in an alkaline medium
- 8.** The major site of protein breakdown to form free amino acids, is in the [WB JEE 2009]
- Kidney
  - Spleen
  - Liver
  - Bone-marrow
- 9.** The first phase in the breakdown of glucose in animal cell is [CBSE PMT 1994]
- Glycolysis
  - Electron transport system
  - Fermentation
  - Kreb's cycle
- 10.** Digestion of both starch and protein is done by [NCERT; AFMC 1996]
- Gastric juice
  - Gastric lipase
  - Pancreatic juice
  - Ptyalin
- 11.** The end product of carbohydrate metabolism is [AFMC 1993]
- $CO_2$  and  $H_2O$
  - $NH_3$  and  $CO_2$
  - $NH_3$  and  $H_2O$
  - $CO_2$
- 12.** Which one of the following statements about glycogen is correct [CBSE PMT 1995]
- It is a disaccharide stored in liver which can react with ammonia to form proteins
  - It is synthesised in the liver and takes part in the formation of bile and lipase, besides being a source of energy
  - It is a polysaccharide which is synthesised and stored in liver cells
  - It is synthesised in blood and stored in liver and muscles to provide glucose in times of need
- 13.** Which one of the following statements is true regarding digestion and absorption of food in humans [CBSE PMT 2009]
- Oxytic cells in our stomach secrete the proenzyme pepsinogen
  - Fructose and amino acids are absorbed through intestinal mucosa with the help of carrier ions like  $Na^+$
  - Chylomicrons are small lipoprotein particles that are transported from intestine into blood capillaries
  - About 60% of starch is hydrolysed by salivary amylase in our mouth
- 14.** Fats and lipids are absorbed in [AFMC 2008]
- Lymph capillaries
  - Blood capillaries
  - Hepatic portal vein
  - None of these
- 15.** One of the following movements in our body is not completely involuntary. Identify it [KCET 2012]
- Deglutition
  - Peristalsis
  - Systole of the ventricles
  - Dilation of pupil of the eye
- 16.** In the gastrointestinal tract the Meissner's plexus and the Auerbach's plexus occur respectively in the [INCERT; AMU (Med.) 2012]
- Lamina propria and muscularis mucosa
  - Submucosa and muscularis externa
  - Submucosa and mucosa
  - Mucosa and muscularis externa
- 17.** Emulsified fat is digested by [AFMC 1996]
- Or**
- Bile salts act as activator of which enzyme [WB JEE 2010]
- Lipase
  - Lipase and hydrolase
  - Bile salts
  - Bile pigments
- 18.** Lacteals are found in [NCERT; MP PMT 1999; KCET 2004]
- Liver
  - Lungs
  - Kidney
  - Villus of intestine
- 19.** Which one of the following is the correct matching of the site of action on the given substrate, the enzyme acting upon it and the end product [NCERT; CBSE PMT 2008]
- Small intestine : → Proteins Pepsin Amino acids
  - Stomach : → Fats Lipase micelles
  - Duodenum : → Triglycerides Trypsin monoglycerides
  - Small intestine : → Starch  $\approx$  Amylase Disaccharide (Maltose)
- 20.** If for some reason the parietal cells of the gut epithelium become partially non-functional, what is likely to happen [NCERT; CBSE PMT (Mains) 2010]
- The pancreatic enzymes and specially the trypsin and lipase will not work efficiently
  - The pH of stomach will fall abruptly
  - Steapsin will be more effective
  - Proteins will not be adequately hydrolysed by pepsin into proteoses and peptones
- 21.** Which of the following is secreted by pancreas [Odisha JEE 2012]
- Dipeptidases
  - Amylase
  - $\alpha$ -Dextrins
  - Pepsin
- 22.** Most digestion and absorption of food takes place in [NCERT; Odisha JEE 2009]
- Stomach
  - Small intestine
  - Large intestine
  - Caecum
- 23.** Essentially the word 'digestion' means [NCERT; CPMT 2005]
- Burning of food
  - Oxidation of food
  - Hydrolysis of food
  - Breakdown of food

- 24.** Emulsification of fats is brought about by [NCERT; CBSE PMT 1990; Manipal 2005]

  - (a) Bile pigments (b) Bile salts
  - (c) Pancreatic juice (d) HCl

**25.** Sacculus rotundus is present in [CPMT 2010]

  - (a) Duodenum of rabbit (b) Ileum of frog
  - (c) Ileum of rabbit (d) Colon of rabbit

**26.** Which one of the following will not take place when glucose is taken as food [J & K CET 2002]

  - (a) Ingestion (b) Digestion
  - (c) Absorption (d) Assimilation

**27.** The diagram of large intestine of man is given below. Identify the parts labelled A, B, C, D, E and F [KCET 2010]

A	B	C	D	E	F
(a) Sigmoid	Vermiform	Ascending	Transve-	Descen-	Caecum
appendix		colon	rse	ding	
(b) Caecum	Vermiform	Sigmoid	Ascend-	Transv-	Descend-
		appendix	ing	erse	ing
(c) Caecum	Vermiform	Ascending	Transve-	Descen-	Sigmoid
		colon	rse	ding	
(d) Sigmoid	Vermiform	Descending	Transve-	Ascend-	Caecum
appendix		colon	rse	ing	

**28.** Some proteolytic enzymes are [NCERT; Odisha JEE 2010]

  - (a) Trypsin, Erepsin, pepsin
  - (b) Amylopsin, steapsin, Ptyalin
  - (c) Amylase, lipase, zymase
  - (d) Urease, zymase, dehydrogenase

**29.** Choose the wrong statement [Kerala PMT 2012]

  - (a) Lipases and nucleases are not present in pancreatic juice
  - (b) Goblet cells secrete mucus
  - (c) Brunner's glands are sub-mucosal glands
  - (d) Carboxypeptidase catalyses conversion of proteins, peptones and proteoses to dipeptides
  - (e) Bile contains no enzymes

**30.** Rennin acts on milk proteins and converts [JIPMER 2002]

  - (a) Caseinogen into casein
  - (b) Casein into paracasein
  - (c) Caseinogen into paracasein
  - (d) Paracasein into caseinogen

**31.** Lacteals are associated with [DPMT 1993; MP PMT 2013]

  - (a) Secretion of lactic acid
  - (b) Absorption of long chain fatty acids
  - (c) Absorption of short chain fatty acids
  - (d) Production of lymph

**32.** In gluconeogenesis [Pb. PMT 2000; DPMT 2003]

  - (a) Glucose is polymerized into glycogen
  - (b) Glycogen is broken into glucose
  - (c) Carbohydrates are synthesized from amino acids/lipids
  - (d) Glucose is broken into pyruvic acid

**33.** Carrier ions like  $Na^+$  facilitate the absorption of substances like [CBSE PMT (Pre.) 2010]

  - (a) Fructose and some amino acids
  - (b) Amino acids and glucose
  - (c) Glucose and fatty acids
  - (d) Fatty acids and glycerol

**34.** The pH of the digestive juices within the human small intestine is between 7.5 and 8.5. This environment is slightly [AIIMS 2009]

  - (a) Basic (b) Acidic
  - (c) Neutral (d) None of these

**35.** Trypsin differs from pepsin in that [NCERT]

  - (a) It digest protein in alkaline medium while pepsin does so in acidic medium
  - (b) It digest protein in acidic medium while pepsin does so in alkaline medium
  - (c) Both (a) and (b)
  - (d) None of these

**36.** Digestion of starch takes place in [NCERT; Kerala CET 2003]

  - (a) Stomach and duodenum
  - (b) Buccal cavity and duodenum
  - (c) Buccal cavity and oesophagus
  - (d) Duodenum only

**37.** Ptyalin is inactivated by a component of gastric juice known as [WB JEE 2011]

  - (a) Pepsin (b) Mucus
  - (c) Rennin (d) HCl

**38.** Function of HCl in stomach is to [MP PMT 1994; CPMT 1995; Odisha JEE 2012]

  - (a) Kill micro-organisms of food
  - (b) Facilitate absorption of food
  - (c) Dissolve enzymes
  - (d) Activate pepsinogen to pepsin

**39.** Lipids, which can be found in oil based salad dressings and ice cream, during digestion are splitted into [NCERT; AIIMS 2009]

**Or**

The main function of Lacteals in the human small intestine is the absorption of [KCET 2006]

  - (a) Fatty acids and glycerol (b) Glycerol and amino acids
  - (c) Glucose and fatty acids (d) Glucose and amino acids

**40.** In horses, rabbits, hares, the cellulose gets digested in the [CPMT 1994, 95, 2010; MP PMT 2000; AFMC 2005; RPMT 2006]

  - (a) Caecum (b) Stomach
  - (c) Appendix (d) Rumen

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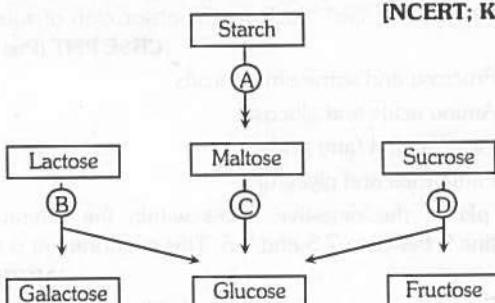
41. Part of the stomach which opens into the duodenum  
**[NCERT; BHU 2008; Odisha JEE 2010]**

(a) Cardiac (b) Pyloric  
(c) Fundus (d) Body

42. Energy released by carbohydrate, fats, protein is  
**[NCERT; DPMT 2006]**

(a) 4.1, 9.45, 5.65 (b) 4.1, 5.65, 9.40  
(c) 5.4, 6.5, 8.9 (d) 5.0, 7.8, 10.5

43. The following is a scheme showing the fate of carbohydrates during digestion in the human alimentary canal. Identify the enzymes acting at stages indicated as A, B, C and D. Choose the correct option from those given  
**[NCERT; KCET 2006]**



(a) A= amylase, B=maltase, C= lactase, D= invertase  
(b) A= amylase, B= maltase, C= invertase, D= lactase  
(c) A= amylase, B= invertase, C= maltase, D= lactase  
(d) A= amylase, B= lactase, C= maltase, D= invertase

44. The food that enters intestine from stomach is called  
**[NCERT; AFMC 2008, 09]**

(a) Chyle (b) Chyme  
(c) Fundus (d) None of these

45. End products of protein hydrolysis are  
**[RPMT 2002; HPMT 2005]**

(a) Mixture of amino acids (b) Sugars  
(c) Peptides (d) 25 amino acids

46. The amount of bile released in proportion to the amount of  
**[CPMT 2004]**

(a) Fat in meal (b) Protein in meal  
(c) Carbohydrate in meal (d) All of the above

47. Which one of the following is the matching pair of digestive enzyme and substrate  
**[MP PMT 1992]**

(a) Rennin-Protein (b) Amylase-Lactose  
(c) Trypsin-Starch (d) Invertase-Maltose

48. Digestion of which component of the food is likely to be most adversely affected if the pH of stomach is made neutral  
**[MP PMT 1992]**

(a) Sucrose (b) Starch  
(c) Protein (d) Fat

49. In man cellulose is digested in  
**[CBSE PMT 1992; CPMT 1995]**

(a) The caecum (b) The colon  
(c) The appendix (d) Not digested at all

50. Milk protein is acted upon by a gastric enzyme  
**[INCERT; CBSE PMT 2000; AIIMS 2002; BCECE 2005]**

Or

Which one of the following enzyme carries on the initial step in the digestion of milk in humans

**[CBSE PMT (Pre.) 2011; CBSE PMT 2014]**

(a) Casein (b) Rennin  
(c) Pepsin (d) Caseinogen

51. Bile salt  
**[AMU (Med.) 2005]**

(a) Acts as emulsifying agent  
(b) Helps in absorption of fatty acids, cholesterol etc.  
(c) Stimulates the bile production in liver  
(d) All of the above

52. Maltase converts  
**[Odisha JEE 2005]**

(a) Maltose to glucose at pH greater than 7  
(b) Maltose to glucose at pH less than 7  
(c) Maltose to alcohol  
(d) Starch to maltose at higher pH than 7

53. Duodenum has characteristic Brunner's glands which secrete two hormones called  
**[CBSE PMT 2004, 05; KCET 2012]**

(a) Prolactin, parathormone (b) Estradiol, progesterone  
(c) Kinase, estrogen (d) Secretin, cholecystokinin

54. The function of erepsin in the process of digestion is to convert  
**[IMP PMT 2004]**

(a) Fats into amino acids  
(b) Proteins in amino acids  
(c) Polysaccharides into disaccharides  
(d) Disaccharides into monosaccharides

55. Just as hydrochloric acid is to pepsinogen, so is

**[IMP PMT 2004]**

(a) Enterokinase to trypsinogen  
(b) Haemoglobin to oxygen  
(c) Bile juice to fat  
(d) Glucagon to glycogen

56. In ileum which of the following is absorbed  
**[CPMT 2009]**

(a) Vitamin K (b) Bile salt  
(c) Glucose (d) Fat

57. Bile salts are poured into the alimentary canal where they are necessary for the absorption of

(a)  $\text{Na}^+$  and  $\text{Ca}^{++}$   
(b) Fat soluble vitamins  
(c) Amino acids and monosaccharides  
(d) All the nutrients contained in chyme

58. Fatty substances are emulsified by  
**[WB JEE 2016]**

(a) Lipase enzyme  
(b) Bilirubin and biliverdin  
(c) HCl  
(d) Sodium salts of glycocholic and taurocholic acids

59. Which of the following option best represents the enzyme composition of pancreatic juice  
**[NEET 2017]**

(a) Amylase, peptidase, trypsinogen, rennin  
(b) Amylase, pepsin, trypsinogen, maltase  
(c) Peptidase, amylase, pepsin, rennin  
(d) Lipase, amylase, trypsinogen, procarboxypeptidase

### Gastro intestinal hormones/Digestive enzymes

1. What will happen if the secretion of parietal cells of gastric glands is blocked with an inhibitor  
**[CBSE PMT 2008]**

(a) In the absence of HCl secretion, inactive pepsinogen is not converted into the active enzyme pepsin  
(b) Enterokinase will not be released from the duodenal mucosa and so trypsinogen is not converted to trypsin  
(c) Gastric juice will be deficient in chymosin  
(d) Gastric juice will be deficient in pepsinogen

2. Pancreatic secretion and gall bladder contraction are stimulated by [AFMC 1993, 2005; CBSE PMT 1998; BHU 1999; AIIMS 2000; CPMT 2003; DPMT 2006; MP PMT 2010]  
 (a) Gastrin  
 (b) Enterocrin  
 (c) Enterogastrone  
 (d) Cholecystokinin pancreaticozymin
3. Digestion is brought about by [Odisha JEE 2009]  
 (a) Hormones (b) Neurotransmitters  
 (c) Growth factors (d) Enzymes
4. Salivary amylase, a digestive enzyme begins digestion of [Odisha JEE 2009; MP PMT 2010]  
 (a) Proteins (b) Fats  
 (c) Carbohydrates (d) All of these
5. One of the constituents of the pancreatic juice while poured into the duodenum in humans, is [CBSE PMT (Mains) 2011]  
 Or  
 Which is same as propepsin [CPMT 1994]  
 (a) Trypsin (b) Enterokinase  
 (c) Trypsinogen (d) Chymotrypsin
6. Match list I with list II and choose the correct option
- | List I               | List II                    |
|----------------------|----------------------------|
| (A) Salivary amylase | (1) Proteins               |
| (B) Bile salts       | (2) Milk proteins          |
| (C) Rennin           | (3) Starch                 |
| (D) Pepsin           | (4) Lipids                 |
| (E) Steapsin         | (5) Emulsification of fats |
- [INCERT; Kerala PMT 2009]  
 (a) (A) — (5), (B) — (4), (C) — (1), (D) — (2), (E) — (3)  
 (b) (A) — (2), (B) — (3), (C) — (4), (D) — (5), (E) — (1)  
 (c) (A) — (2), (B) — (4), (C) — (3), (D) — (1), (E) — (5)  
 (d) (A) — (3), (B) — (5), (C) — (2), (D) — (1), (E) — (4)  
 (e) (A) — (3), (B) — (5), (C) — (1), (D) — (2), (E) — (4)
7. Which of the following statement is correct [AIIMS 1993]  
 (a) Though secretin is an enzyme, it is not involved in digestion  
 (b) Secretin is an enzyme and so it helps digestion  
 (c) Secretin is a hormone but it plays a role in digestion  
 (d) Secretin is a hormone and hence it does not play any role in digestion
8. The enzyme added to the starch solution may have been [CPMT 1992, 93]  
 (a) Maltase (b) Invertase  
 (c) Lipase (d) Amylase
9. Enzymes which acts similarly are called as [CPMT 1995]  
 (a) Isoenzymes (b) Cofactor  
 (c) Coenzymes (d) All the above
10. Zymogen cells and chief cells secrete [CBSE PMT 1990; CPMT 1994]  
 (a) Hydrochloric acid (b) Mucus  
 (c) Pepsin (d) Trypsin
11. If this enzyme were to be absent in our small intestine, digestion of proteins in our body would be severely affected [GUJCET 2007; KCET 2009, 12]  
 (a) Pancreatic amylase (b) Maltase  
 (c) Lipase (d) Enterokinase
12. Prorennin is secreted by [DPMT 2007]  
 (a) Zymogen cells (b) Islet of Langerhans  
 (c) Sertoli cells (d) Hepatocytes
13. Enzyme Rennin is secreted by [MP PMT 2001]  
 (a) Cells of stomach  
 (b) Cells of intestine  
 (c) The cortical cells of kidney  
 (d) The cells of juxtaglomerular apparatus of kidney
14. The digestive enzyme that is not found in human pancreatic juice is [Kerala PMT 2006]  
 (a) Nucleotidase (b) Nuclease  
 (c) Trypsin (d) Lipase  
 (e) Amylase
15. Deoxyribonuclease, ribonuclease and Carboxypeptidase are secreted by [BHU 2003; Kerala PMT 2004]  
 (a) Liver (b) Stomach  
 (c) Pancreas (d) Kidney
16. Bile synthesis occurs in [NCERT; MP PMT 1994; J & K CET 2002; Bihar CECE 2006]  
 (a) Liver (b) Duodenum  
 (c) Pancreas (d) Stomach
17. Which one of the following four secretions is correctly matched with its source, target and nature of action [AIIMS 2005]
- |     | Secretion                       | Source                                   | Target                          | Action  |
|-----|---------------------------------|--|---------------------------------|---|
| (a) | Gastrin                         | Stomach lining                           | Oxytic cells                    | Production of HCl   |
| (b) | Inhibin                         | Sertoli cells                            | Hypothalamus                    | Inhibition of secretion of gonadotropin releasing hormone |
| (c) | Enterokinase                    | Duodenum                                 | Gall bladder                    | Release of bile juice                                     |
| (d) | Atrial Natriuretic Factor (ANF) | Sinus atrial node (SAN) M-cells of Atria | Juxtaglomerular apparatus (JGA) | Inhibition of release of renin                            |
18. Which one of the following enzymes initiates protein digestion [MP PMT 1997; Bihar CECE 2006; GUJCET 2014]  
 Or  
 Which of the following digest proteins and peptides [HP PMT 2005]  
 (a) Aminopeptidase (b) Carboxypeptidase  
 (c) Trypsin (d) Pepsin
19. Pepsin is produced by [MP PMT 1995, 98, 2006]  
 (a) Salivary glands (b) Stomach  
 (c) Duodenum (d) Small intestine
20. Which one of the following is the correct match of digestive enzyme and substrate [CBSE PMT 1996]  
 (a) Lactose-Renin (b) Starch-Maltose  
 (c) Fat-Steapsin (d) Casein-Trypsin
21. Glucagon secreted by the alpha-cells of the islets of Langerhans does this function [CPMT 1993; KCET 1994; MP PMT 2000; GUJCET 2014]  
 (a) Glucagon converts glucose into glycogen and increases the concentration of blood sugar  
 (b) Glucagon converts glycogen into glucose and increases the concentration of blood sugar  
 (c) Glucagon converts glucose into glycogen  
 (d) None of these

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- 22.** Match the following and choose the correct combination from the options given

Column I		Column II	
A.	Ptyalin	1.	Lipids
B.	Pepsin	2.	Starch
C.	Steapsin	3.	DNA
D.	Nuclease	4.	Proteins

**[MP PMT 1994; Kerala PMT 2004]**

- (a) A-1, B-3, C-2, D-4
- (b) A-1, B-4, C-3, D-2
- (c) A-2, B-4, C-1, D-3
- (d) A-2, B-3, C-1, D-4
- (e) A-4, B-3, C-1, D-2

- 23.** Cells of the pancreas is not digested by their own enzymes because

**[MP PMT 2003]**

- (a) Enzymes are secreted in inactive form
- (b) Cells are not lined by mucous membrane
- (c) Enzymes are released only when needed
- (d) None of the above

- 24.** When fat is in the stomach the secretion of gastrin is inhibited. This inhibition is due to

**[CPMT 1992]**

- (a) Presence of fat
- (b) Non-stimulation of vagus
- (c) Slow digestion of fat
- (d) Release of enterogastron

- 25.** Which of the following hormone stimulates the secretion of gastric juice

**[CMC Vellore 1993; CPMT 2002; BHU 2003; WB JEE 2010]**

**Or**

Which of the following hormone helps in secretion of HCl from stomach

**[WB JEE 2008, 11]**

- (a) Secretin
- (b) Gastrin
- (c) Cholecystokinin
- (d) Gastrin

- 26.** Cholecystokinin is a secretion of

**[IMP PMT 1992; WB JEE 2012]**

- (a) Stomach which stimulates pancreas to release the pancreatic juice
- (b) Liver synthesised from cholesterol and controls secondary sexual characters
- (c) Duodenum and makes the gall bladder to contract and release bile
- (d) Goblet cells of ileum and stimulates the secretion of succus entericus

- 27.** In rabbit proteins are digested by

**[CPMT 1995]**

- (a) Pepsin and trypsin
- (b) Trypsin and steapsin
- (c) Steapsin and pepsin
- (d) All the above

- 28.** Which of the following is not a proteolytic enzyme

**[Bihar MDAT 1995]**

**Or**

Which of the following belongs to the class of pepsin and trypsin

**Or**

Enzyme released from kidney is

**[AFMC 2008]**

- (a) Pepsin
- (b) Trypsin
- (c) Erepsein
- (d) Renin

- 29.** Identify the correct set which shows the name of the enzymes from where it is secreted and substrate upon which it acts

**[Odisha PMT 2002]**

- (a) Pepsin-stomach wall- casein
- (b) Ptyalin- intestine-maltose
- (c) Chymotrypsin- salivary gland-lactose
- (d) Ptyalin – pancreas-lipid CoA

- 30.** Trypsin converts

**[MP PMT 1995]**

- (a) Fats into fatty acids
- (b) Starch and glycogen into maltose
- (c) Proteins into peptones
- (d) Sucrose into glucose and fructose

- 31.** Islets of Langerhans produce

**[MP PMT 1995]**

- (a) Insulin
- (b) Rennin
- (c) Ptyalin
- (d) HCl

- 32.** Which of the following is a gastro-intestinal enzyme

**[AFMC 1997; WB JEE 2011]**

- (a) Cholinesterase
- (b) Enterokinase
- (c) Secretin
- (d) Prolactin

- 33.** Secretin

**[AMU (Med.) 2009]**

- (a) Stimulates enzyme secretion by pancreas, inhibits acid secretion in stomach, stimulates gall bladder
- (b) Stimulates bicarbonate secretion by pancreas, inhibits acid secretion in stomach, stimulates bicarbonate secretion by liver
- (c) Stimulates acid secretion in stomach, potentiates action of CCK, inhibits intestinal movement
- (d) Stimulates gall bladder, inhibits acid secretion in stomach, stimulates bicarbonate secretion by pancreas

- 34.** The gastrointestinal hormone which stimulates insulin secretion is

**[AMU (Med.) 2012]**

- (a) Gastrin
- (b) CCK
- (c) Secretin
- (d) GIP

- 35.** Gastric enzymes are

**[CPMT 2009]**

- (a) Pepsinogen
- (b) Prorennin
- (c) Gastric lipase
- (d) All of these

- 36.** Enzymes, vitamins and hormones can be classified into a single category of biological chemicals, because all of them

**[AIIMS 1992; CBSE PMT 2005]**

- (a) Are proteins
- (b) Enhance the oxidative metabolism
- (c) Aid the regulating mechanism
- (d) Are synthesised within the body of an organism

- 37.** The hormone 'secretin' stimulates secretion of

**[CBSE PMT 1990; MP PMT 1996, 2002, 07, 12;**

**Pb. PMT 1999, 2000; BHU 2000]**

- (a) Pancreatic juice
- (b) Bile juice
- (c) Salivary juice
- (d) Gastric juice

38. What is common among amylase, rennin and trypsin  
**[CBSE PMT 1997; Pb. PMT 1999, 2000; BHU 2001]**  
 (a) These all are proteins  
 (b) These all are proteolytic enzymes  
 (c) These are produced in stomach  
 (d) These act at a pH lower than 7
39. Cholecystokinin and duocrinin are secreted by  
**[CBSE PMT 1999; AIEEE Pharmacy 2003]**  
 (a) Intestine (b) Pancreas  
 (c) Adrenal cortex (d) Thyroid gland
40. Which part of body secretes the hormone secretin  
**[MP PMT 1994, 95; CBSE PMT 1999; AIEEE Pharmacy 2003]**  
 (a) Ileum (b) Stomach  
 (c) Duodenum (d) Oesophagus
41. What is the substrate for lipase enzyme  
**[WB JEE 2012]**  
 (a) Protein (b) Carbohydrate  
 (c) Lipid (d) Nucleic acid
42. Which of the following hormones induce secretion of succus entericus  
**[RPMT 2000]**  
 Or  
 Which hormones do stimulate the production of pancreatic juice and bicarbonate  
**[NEET (Phase-II) 2016; WB JEE 2016]**  
 (a) Insulin  
 (b) Secretin and cholecystokinin  
 (c) Glucagon  
 (d) Secretin
43. What is cholecystokinin  
**[Odisha PMT 2002]**  
 (a) Enzyme (b) Bile-pigment  
 (c) Gastro-intestinal hormone (d) Lipid
- Nutrition and Nutritional requirement**
1. When breast feeding is replaced by less nutritive food low in proteins and calories; the infants below the age of one year are likely to suffer from  
**[MP PMT 2001; CBSE PMT 2009; J & K CET 2010]**  
 (a) Marasmus (b) Rickets  
 (c) Kwashiorkor (d) Pellagra
2. Statements  
 A. The element which is very important for the production of thyroxine is iodine  
 B. Vitamin  $B_6$  is otherwise known as niacin or nicotinic acid  
 C. Fructose is a monosaccharide and is a hexose sugar  
 D. Globulin is an example for a conjugated protein  
 Of the above statements  
**[Kerala PMT 2008]**  
 (a) A, B and C are correct but D is wrong  
 (b) A and C are correct but B and D are wrong  
 (c) A and B are correct but C and D are wrong  
 (d) A is correct while B, C and D are wrong  
 (e) A, C and D are correct but B is wrong
3. The number of essential amino acids in adult human is  
**[Odisha JEE 2009]**  
 (a) Nine (b) Eight  
 (c) Four (d) Seven
4. Which one of the following statements is not correct  
**[CBSE PMT 2014]**  
 (a) Retinal is a derivative of vitamin C  
 (b) Rhodopsin is the purplish red protein present in rods only  
 (c) Retinal is the light absorbing portion of visual photopigments  
 (d) In retina the rods have the photopigment rhodopsin while cones have three different photopigments
5. Inadequate protein intake leads to kwashiorkor. The subsequent edema is most closely related to inadequate synthesis of which protein  
**[DUMET 2009]**  
 (a) Gamma globulin (b) Glucagon  
 (c) Insulin (d) Albumin
6. Hypochromic microcytic anaemia and leucopenia are caused by the deficiency of .... respectively  
**[EAMCET 2009]**  
 (a) Pyridoxine and riboflavin (b) Pyridoxine and folacin  
 (c) Biotin and folacin (d) Biotin and cyanocobalamin
7. Liver necrosis and muscular dystrophy are caused by the lack of this trace element  
**[AMU (Med.) 2009]**  
 (a) Arsenic (b) Molybdenum  
 (c) Zinc (d) Selenium
8. This trace element is needed for insulin to exert its maximal effect in glucose uptake  
**[AMU (Med.) 2010]**  
 (a) Vanadium (b) Chromium  
 (c) Molybdenum (d) Selenium
9. Which of the following is a reducing sugar  
**[CBSE PMT 2002; AFMC 2012]**  
 (a) Sucrose (b) Galactose  
 (c) Gluconic acid (d)  $\beta$ -methyl galactoside
10. What is the common between amino acids, fatty acids and glycerol  
 (a) These are all rich source of calories  
 (b) These are the builders of protoplasm  
 (c) These are the end products of digestion of two categories of food constituents  
 (d) These can be stored in the form of fat
11. The smallest structural units of proteins are called  
**[CPMT 1993; RPMT 1999]**  
 (a) Amino acids (b) Peptides  
 (c) Proteoses (d) Peptones
12. In human per cent of body weight of carbohydrates, lipids and proteins respectively is  
**[AMU (Med.) 2009]**  
 (a) 1, 15, 17 (b) 15, 17, 7  
 (c) 7, 17, 15 (d) 17, 15, 7

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- 13.** During prolonged fasting [AFMC 1994; CBSE PMT 2003; CPMT 2005]
- The first to be used up are carbohydrates, next fat is withdrawn and proteins are metabolised at the last
  - The first to be used up are the fats, next carbohydrates are withdrawn from stored glycogen in the liver and muscles and proteins are withdrawn at the last
  - First lipids are used up, then proteins and finally carbohydrate
  - None of these
- 14.** To get sufficient carbohydrates one should take [CBSE PMT 2002]
- Meat
  - Rice
  - Carrots
  - Ground nuts
- 15.** Glucose and amino acids are absorbed in the intestine by [INCERT; JIPMER 2002]
- Active transport
  - Passive transport
  - Selective absorption
  - Osmosis
- 16.** Milk protein is [Manipal 1995]
- Rennin
  - Casein
  - Galactose
  - Glycine
- 17.** Unsaturated fatty acids have [Kerala CET 2002]
- Palmitic acid
  - Stearic acid
  - Oleic acid
  - One or more double bonds
- 18.** Which one of the following set is a polysaccharide group [CBSE PMT 1996; BHU 1999]
- Glucose, fructose, lactose
  - Starch, glycogen, cellulose
  - Sucrose, maltose, glucose
  - Galactose, starch, sucrose
- 19.** Lactose is composed of [CBSE PMT 1998; BHU 2000; DPMT 2006; WB JEE 2011]
- Glucose + fructose
  - Glucose + glucose
  - Glucose + galactose
  - Fructose + galactose
- 20.** The anhydro bond of proteins are called [Pb. PMT 2000]
- Glycosidic
  - Peptide
  - Ester
  - Diester
- 21.** Role of carbohydrates is to function as [INCERT; RPMT 1999]
- Catalyst
  - Source of energy
  - Enzyme
  - Building material
- 22.** Digestion of protein takes place in [INCERT; MP PMT 1996]
- Duodenum and stomach
  - Stomach and oesophagus
  - Small and large intestine
  - Intestine and rectum
- 23.** Amino acids not synthesized in the body are called [MP PMT 1996]
- Non-essential
  - Active
  - Essential
  - Inactive
- 24.** Essential : non-essential amino acid is [AMU (Med.) 2010]
- Lysine : leucine
  - Methionine : threonine
  - Valine : tyrosine
  - Alanine : cystine
- 25.** Most abundant mineral of animal body is [WB JEE 2010]
- Iron
  - Sodium
  - Potassium
  - Calcium
- 26.** Which element is the cause of etai etai disease [WB JEE 2009]
- Hg
  - Pb
  - Cd
  - As
- 27.** Which of the following is not a vitamin deficiency disease [CPMT 2010]
- Addision's disease
  - Goitre
  - Keratomalacia
  - Xerophthalmia
- 28.** Choose the correct non-protein amino acid [WB JEE 2009]
- Hydroxyproline
  - Hydroxylsine
  - Cystine
  - $\gamma$  amino butyric acid
- 29.** Thiamine ( $B_1$ ) deficiency results in [AIIMS 2009, 13]
- Wernickes' syndromes
  - Korsakoffs' syndromes
  - Osteonecrosis
  - Tunnel vision
- 30.** Vitamin D is synthesised by one of the following with the help of sunlight [AIIMS 1992; RPMT 1999; WB JEE 2010]
- Skin
  - Gall bladder
  - Liver
  - Pancreas
- 31.** Water soluble vitamins are [AFMC 2001; Kerala PMT 2007]
- Vitamin A, B and C
  - Vitamin B and C
  - Vitamins C and D
  - None of these
- 32.** Which of the following elements is a constituent of biotin [NEET (Karnataka) 2013]
- Magnesium
  - Calcium
  - Phosphorus
  - Sulphur
- 33.** Which of the following are required in minimum amount by human [DPMT 2006; AIIMS 2011]
- Iron, iodine, carbon, manganese, copper,  $O_2$
  - Iron, iodine, manganese, copper, zinc, fluorine
  - Iron, iodine, manganese, zinc, hydrogen
  - Nitrogen, oxygen, zinc, fluorine
- 34.** Which is not used up in human body [DPMT 2006]
- Calcium
  - Phosphorus
  - Zinc
  - Barium
- 35.** Simple storage protein that coagulates upon heating but remains soluble in dilute salt solution is correctly exemplified by [Kerala PMT 2004; WB JEE 2012]
- Globulin
  - Albumin
  - Histone
  - Collagen
- 36.** Fat soluble vitamins are
- Vitamin A, B and C
  - Vitamin A, B and D
  - Vitamin A, D, E and K
  - Vitamin C and D
- 37.** Vitamin C is [AFMC 2012]
- Ascorbic acid
  - Nicotinic acid
  - Lipoic acid
  - Aspartic acid

38. A pregnant female delivers a baby who suffers from stunted growth, mental retardation, low intelligence quotient and abnormal skin. This is the result of [NEET 2013]  
 (a) Over secretion of pars distalis  
 (b) Deficiency of iodine in diet  
 (c) Low secretion of growth hormone  
 (d) Cancer of the thyroid gland
39. Main difference between brown fat and white fat is that the cells of brown fat  
 (a) Are multicoloured      (b) Have more mitochondria  
 (c) Are polygonal in shape      (d) All the above
40. Collagen is a [WB JEE 2009]  
 (a) Phosphoprotein      (b) Globulin  
 (c) Derived protein      (d) Scleroprotein
41. Higher animals cannot synthesize few fatty acids which are very essential for their growth and development. These fatty acids are typically [WB JEE 2012]  
 (a) Saturated      (b) Cycle  
 (c) Unsaturated      (d) Branched
42. Which vitamin gets destroyed by heating  
 (a) Vitamin A      (b) Vitamin E  
 (c) Vitamin C      (d) Vitamin K
43. Continued consumption of a diet rich in butter, red meat and eggs for a long period may lead to [AIIMS 2007]  
 (a) Vitamin A toxicity  
 (b) Kidney stones  
 (c) Hypercholesterolemia  
 (d) Urine laden with ketone bodies
44. Term "vitamin" was given by [CBSE PMT 1992]  
 (a) James Lind      (b) Sterling  
 (c) Funk      (d) J.C. Drummond
45. In vertebrate's body mainly the food is stored in the form of [BHU 2002]  
 (a) Fat      (b) Fat and glycogen  
 (c) Glycogen      (d) Proteins
46. Which of the following vitamins is water soluble as well as an anti-oxidant [BHU 2005; Bihar CECE 2006]  
 (a) Vitamin  $B_1$       (b) Vitamin A  
 (c) Vitamin D      (d) Vitamin C
47. Zinc is associated with [RPMT 2000]  
 (a) Glycosylation      (b) Immunization  
 (c) Sulfation      (d) Transcription
48. Vitamin K is required for [CPMT 2009; MP PMT 2013]  
 (a) Converting prothrombin to thrombin  
 (b) Synthesis of prothrombin  
 (c) Calcium combination with prothrombin  
 (d) All of the above
49. Iron is present in which one of the following [RPMT 2000]  
 (a) Glycophorin      (b) Nuclein  
 (c) Lectin      (d) Catalase
50. A balanced diet does not include [KCET 2011]  
 (a) Carbohydrates and fats  
 (b) Nucleic acids and enzymes  
 (c) Proteins and vitamins  
 (d) Minerals and salts
51. Vitamin D is synthesized in skin, by the action of sunlight on [CPMT 2000; BHU 2006]  
 (a) Cholesterol      (b) 7-hydroxy cholesterol  
 (c) Cephalo-cholesterol      (d) Ortho-phenoxy cholesterol
52. Which one is an amino acid [WB JEE 2011]  
 (a) Pepsin      (b) Proline  
 (c) Cysteine      (d) Renin
53. Cyanocobalamin is essential for the formation of [JIPMER 2002; AFMC 2012]  
 (a) RBC      (b) WBC  
 (c) Lymph      (d) Platelets
54. Salivary amylase is also known as [Manipal 2005]  
 (a) Ptyalin      (b) Gastrin  
 (c) Glyoxylase      (d) Pepsin
55. Beri-beri was discovered by  
 (a) Funk      (b) G.E. Foxan  
 (c) Eijkman      (d) Admiral Takaki
56. In a normal adult, ascending order of concentration of following molecules is [AIIMS 2012]  
 (a)  $K > Na > Fe > Cu$       (b)  $Na > K > Cu > Fe$   
 (c)  $Fe > Na > K > Cu$       (d)  $Na > Fe > K > Cu$
57. Megaloblastic anaemia of pregnancy is caused by the deficiency of  
 (a) Vitamin  $B_{12}$       (b) Vitamin  $B_{12}$  and folic acid  
 (c) Folic acid      (d) Vitamin D
58. A non-essential amino acid is [AFMC 2002]  
 (a) Lysine      (b) Methionine  
 (c) Alanine      (d) Isoleucine
59. Which of the following is not an unsaturated fatty acid (essential) [CPMT 2009]  
 (a) Oleic acid      (b) Linoleic acid  
 (c) Linolenic acid      (d) Stearic acid
60. Fluorine helps in maintaining the  
 (a) Dentine to deposit normally in teeth  
 (b) Enamel deposition and prevents the dental carries  
 (c) Erythropoiesis  
 (d) Absorption of certain substances by the cell
61. Which one of the following is a fat-soluble vitamin and its related deficiency disease [CBSE PMT 2007]  
 (a) Ascorbic acid      – Scurvy  
 (b) Retinol      – Xerophthalmia  
 (c) Cobalamine      – Beri-beri  
 (d) Calciferol      – Pellagra
62. Cod and shark liver oil is a source of [Kerala PMT 2007]  
 (a) Energetic nutrients  
 (b) Constructive nutrients  
 (c) Energetic and constructive nutrients  
 (d) Protective nutrients  
 (e) Protective and constructive nutrients
63. Certain vitamin B acts as [MP PMT 2002]  
 (a) Enzymes      (b) Coenzymes  
 (c) Digestive enzymes      (d) Hormones

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- 64.** Which one of the following vitamins is manufactured in human liver [BHU 2012]  
 (a) Vitamin A (b) Vitamin D  
 (c) Vitamin C (d) Vitamin K

**65.** Deficiency of it, causes loss of appetite, mental confusion, fatigue and muscle depreciation [GUJCET 2007]  
 (a) Vitamin - K (b) Vitamin - C  
 (c) Thiamine (d) Riboflavin

**66.** The following are needed for blood-clotting in mammals [MP PMT 1994, 97, 2001, 02; HPMT 2005; BHU 2006; VITEEE 2006; DPMT 2007; Kerala PMT 2009]  
 (a)  $\text{Ca}^{++}$  and Vitamin E (b)  $\text{Ca}^{++}$  and Vitamin K  
 (c)  $\text{Ca}^{++}$  and Vitamin A (d)  $\text{K}^{+}$  and Vitamin K

**67.** Which of the following is mismatched [CBSE PMT 1998, 99]  
 (a) Vitamin K – Beri-beri (b) Vitamin C – Scurvy  
 (c) Vitamin A-Xerophthalmia (d) Vitamin D – Rickets

**68.** In beri-beri [CBSE PMT 1993]  
 (a) The coagulation time increases  
 (b) Dermatitis in organs exposed to sun rays  
 (c) The depigmentation of skin and hair starts  
 (d) The affect over peripheral nervous system, gastrointestinal tract and cardiovascular is pronounced

**69.** Examination of blood of a person suspected of having anaemia, shows large, immature, nucleated erythrocytes without haemoglobin. Supplementing his diet with which of the following is likely to alleviate his symptoms [AIEEE Pharmacy 2003; CBSE PMT 2006]  
 (a) Riboflavin (b) Iron compounds  
 (c) Thiamine (d) Folic acid and cobalamine

**70.** In mammals vitamin synthesised by the intestinal bacteria is [MP PMT 2006]  
 (a) Pantothenic acid (b)  $B_{12}$  (Cyanocobalamin)  
 (c) Biotin (d) Choline

**71.** Which of the following helps in synthesis of DNA and cell division [MP PMT 2001, 02; BHU 2002]  
 (a) Nicotinamide (b) Biotin  
 (c) Folic acid (d) Pantothenic acid

**72.** Which one is the most abundant protein in the animal world [CBSE PMT (Pre.) 2012]  
 (a) Trypsin (b) Haemoglobin  
 (c) Collagen (d) Insulin

**73.** Defective red blood corpuscles can be seen when there is a deficiency of [MP PMT 1993]  
 (a) Retinol (b) Vitamin K  
 (c) Vitamin  $B_2$  (Riboflavin) (d) Vitamin  $B_6$  (Pyridoxine)

**74.** General metabolism of the body will be affected due to the deficiency of [MP PMT 1993]  
**Or**  
 One of the following minerals is responsible to regulate your heart beats  
 (a) Sodium (b) Calcium  
 (c) Iodine (d) Cobalt

**75.** Infertility is believed to be due to the lack of vitamin [AIIMS 1993; DPMT 1993; MP PMT 2012]  
 (a) A (b) B  
 (c) C (d) E

**76.** Animals consuming only plant materials are referred as [J & K CET 2005]  
 (a) Herbivores (b) Carnivores  
 (c) Omnivores (d) Insectivores

**77.** A person suffers from beri-beri, rickets and scurvy if he is not taking adequate amounts of [JIPMER 1993; MP PMT 1994, 95; Bihar MDAT 1995; CPMT 1995; BHU 1998, 99; Odisha JEE 2010; PET (Pharmacy) 2013]  
 (a) Vitamin  $B_{12}$ , A and C (b) Vitamin  $B_1$ , D and C  
 (c) Vitamin A, B and E (d) Vitamin  $B_6$ , and K

**78.** Riboflavin ( $B_2$  or G) is concerned with [CMC Vellore 1993; MP PMT 2012]  
 (a) Maintenance of epithelial cells of skin  
 (b) Iron porphyrin proteins  
 (c) Metal containing pigments  
 (d) Oxidation process and intermediate metabolism

**79.** A nutrient not required / has no function in plants except in Fabaceae, but essential nutrient of animals whose deficiency makes a person anemic as it is an integral part of vitamin B-12, and this nutrient is [Kerala CET 2003; MP PMT 2013]  
 (a) Iron (b) Calcium  
 (c) Cobalt (d) Cadmium

**80.** Rickets in children and osteomalacia in adults is caused by the deficiency of [NCERT; MP PMT 1996, 99, 2000, 03, 10; BHU 1999; CPMT 2001; CBSE PMT 2001; Kerala CET 2002; DUMET 2009; WB JEE 2009, 11]  
**Or**  
 Weakening of limb bones may be due to deficiency of [MP PMT 1993]  
 (a) Vitamin A (b) Vitamin B  
 (c) Vitamin C (d) Vitamin D (calciferol)

**81.** Which one of the following is the best source for vitamin A (Antixerophthalmic) [AFMC 1996, 99; AIEEE Pharmacy 2003]  
 (a) Apples (b) Carrots  
 (c) Honey (d) Peanuts

**82.** Angiotensinogen is a protein produced and secreted by [CBSE PMT 2006]  
 (a) Liver cells  
 (b) Juxtaglomerular (JG) cells  
 (c) Macula densa cells  
 (d) Endothelial cells (cells lining the blood vessels)

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- 83.** Which one of the following is dominant intracellular cation [RPMT 2000]  
 (a) Potassium      (b) Chloride  
 (c) Phosphate      (d) Calcium
- 84.** Vitamin  $B_{12}$  is available to ruminants by [DPMT 2006]  
 (a) Plants  
 (b) Micro-organisms in caecum  
 (c) Animals  
 (d) All of the above
- 85.** A vitamin which is generally excreted in human urine is  
**Or**
- Earliest known vitamin is  
 (a) C                (b) K  
 (c) A                (d) D
- 86.** The richest sources of vitamin  $B_{12}$  are [CBSE PMT 2004]  
 (a) Rice and hen's egg  
 (b) Carrot and chicken's breast  
 (c) Goat's liver and Spirulina  
 (d) Chocolate and green gram
- 87.** To which of the following family do folic acid and pentothenic acid belong [CBSE PMT 1998, 99]  
 (a) Vitamin K      (b) Vitamin A  
 (c) Vitamin C      (d) Vitamin B complex
- 88.** Which of the following is the correct match [KCET 1994; CBSE PMT 2001]  
 (a) Vitamin A-calciferol      (b) Vitamin E-tocopherol  
 (c) Vitamin D-thiamine      (d) Vitamin K-ascorbic acid
- 89.** Pellagra is caused due to the deficiency of [CBSE PMT 1994, 96; MP PMT 1998, 2011;  
 BHU 2000, 01, 03; DPMT 2003; AMU (Med.) 2006;  
 WB JEE 2009; DUMET 2009]  
 (a) Thiamine  
 (b) Ascorbic acid  
 (c) Niacin (Nicotinic Acid) ( $B_3$ )  
 (d) Calciferol
- 90.** One of the factors required for the maturation of erythrocytes is [CBSE PMT 1998; AFMC 2000]  
 (a) Vitamin D      (b) Vitamin A  
 (c) Vitamin  $B_{12}$       (d) Vitamin C
- 91.** Which is the best source for vitamin  $B_1$   
 (a) Cod liver oil      (b) Egg  
 (c) Whole wheat bread      (d) Curd
- 92.** Xerophthalmia in children and nyctalopia (Night blindness) in adults is caused by the deficiency of vitamin [CBSE PMT 1992; MP PMT 1999, 2002;  
 MH CET 2001; J & K CET 2002]  
 (a) A                (b) D  
 (c) E                (d) K
- 93.** Which one of the following is very rich in magnesium [JIPMER 2002]  
 (a) Meat              (b) Egg  
 (c) Soybean          (d) Milk
- 94.** Which one of the following pairs is *not* correctly matched [CBSE PMT 2004]  
 (a) Vitamin  $B_1$  – Beri-beri  
 (b) Vitamin  $B_5$  – Pellagra  
 (c) Vitamin  $B_{12}$  – Pernicious anaemia  
 (d) Vitamin  $B_6$  – Loss of appetite
- 95.** Which one is correctly matched [Kerala PMT 2006]  
 (a) Vitamin E – Thiamine      (b) Vitamin D – Riboflavin  
 (c) Vitamin  $B_1$  – Tocopherol      (d) Vitamin A – Calciferol  
 (e) Vitamin  $B_{12}$  – Cyanocobalamin
- 96.** Which of the following is a fat soluble vitamin [MP PMT 2003]  
 (a) Thiamine                (b) Folic acid  
 (c) Ascorbic acid          (d) Tocopherol
- 97.** Excessive intake of vitamin D leads to bone reabsorption and  
 (a) Beri-beri                (b) Hypercalcemia  
 (c) Hyperkeratosis          (d) Keratomalacia
- 98.** Vitamin  $B_{12}$  is helpful  
 (a) In the absorption of fats  
 (b) To stimulate the liver  
 (c) To stimulate the bone marrow  
 (d) To increase life span of RBC
- 99.** Starch is converted to maltose by the action of [CPMT 1999; JIPMER 2001]  
 (a) Invertase                (b) Amylase  
 (c) Sucrase                 (d) Maltase
- 100.** Recently discovered vitamin having anti-cancer properties is  
 (a) Vitamin  $B_5$                 (b) Vitamin  $B_{15}$   
 (c) Vitamin  $B_{17}$                 (d) Vitamin Q
- 101.** How many of the twenty amino acids are essential amino acids for children [HP PMT 2005; Kerala PMT 2006]  
 (a) 6                        (b) 8  
 (c) 10                      (d) 7  
 (e) 11
- 102.** The vitamin nicotinamide can be synthesized in our body from [AIIMS 2002]  
 (a) Tyrosine                (b) Valine  
 (c) Tryptophan              (d) Phenyl alanine
- 103.** Rhodopsin is synthesised with the help of [MP PMT 2000]  
 (a) Vitamin A                (b) Vitamin  $B_{12}$   
 (c) Vitamin D                (d) Vitamin  $B_6$
- 104.** For normal absorption and deposition of calcium and phosphate the vitamin that is very necessary [MP PMT 1998; AIEEE Pharmacy 2003]  
**Or**
- Calcium deficiency in the body occurs in the absence of [CBSE PMT 1994]  
 (a)  $B_1$                       (b)  $B_2$   
 (c) A                        (d) D
- 105.** Nutrition involving engulfment of the whole or part of a plant or an animal in solid or in liquid state is known [J & K CET 2005; Kerala PMT 2009]  
 (a) Holozoic                (b) Saprozoic  
 (c) Parasitic                (d) Symbiotic

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- 106.** Match the following nutrition/vitamin deficiencies in column I with causes/deficiencies in column II and choose the correct option from the answer key

<b>Column I</b>	<b>Column II</b>
(a) Kwashiorkor	(p) Iron
(b) General Anaemia	(q) Menadione
(c) Dermatitis	(r) Protein
(d) Marasmus	(s) Pyridoxin
(e) Bleeding	(t) Biotin

[Kerala CET 2005]

- (a) (a) – (p), (b) – (t), (c) – (q), (d) – (r), (e) – (s)
- (b) (a) – (t), (b) – (q), (c) – (r), (d) – (s), (e) – (p)
- (c) (a) – (q), (b) – (r), (c) – (s), (d) – (p), (e) – (t)
- (d) (a) – (r), (b) – (p), (c) – (t), (d) – (s), (e) – (q)
- (e) (a) – (r), (b) – (s), (c) – (p), (d) – (t), (e) – (q)

- 107.** Iodine test used to detect [DPMT 2003]

- (a) Protein (b) Fat
- (c) Carbohydrate (d) Chitin

- 108.** Which one of the following is antioxidant vitamin [DPMT 2003; BHU 2003]

- (a) Vitamin C, E, A (b) Vitamin B<sub>1</sub>, B<sub>4</sub>
- (c) Vitamin A, D, E (d) Vitamin B<sub>3</sub>, B<sub>5</sub>

- 109.** Vitamin-C is mainly helpful in [MP PMT 2006]

- (a) Growth of bones
- (b) Formation of connective tissue
- (c) Treatment of anaemia
- (d) Formation of visual pigment

- 110.** Continuous bleeding from an injured part of body is due to deficiency of [CBSE PMT 2002; MP PMT 2003]

- (a) Vitamin A (b) Vitamin B
- (c) Vitamin K (d) Vitamin E

- 111.** Which group of three of the following five statement (1-5) contain all three correct statements regarding beri-beri

1. A crippling disease prevalent among the native population of sub-Saharan Africa
  2. A deficiency disease caused by lack of thiamine (vitamin B<sub>1</sub>)
  3. A nutritional disorder in infants and young children when the diet is persistently deficient in essential protein
  4. Occurs in those countries where the staple diet is polished rice
  5. The symptoms are pain from neuritis, paralysis, muscle wasting, progressive oedema mental deterioration and finally heart failure.
- [CBSE PMT 2005]

- (a) 2, 4 and 5 (b) 1, 2 and 4
- (c) 1, 3 and 5 (d) 2, 3 and 5

- 112.** 'Burning feet syndrome' is due to deficiency of

- (a) Vitamin D (b) Vitamin A
- (c) Vitamin B<sub>3</sub> (d) Vitamin B<sub>5</sub>

- 113.** A patient of diabetes mellitus excretes glucose in urine even when he is kept in a carbohydrate free diet. It is because

[Odisha JEE 2005]

- (a) Fats are catabolised to form glucose
- (b) Amino acids are catabolised in liver
- (c) Amino acids are discharged in blood stream from liver
- (d) Glycogen from muscles is released in blood stream.

- 114.** The disease due to inflammation of veriform appendix of digestive system is known as [CBSE PMT 1993]

- (a) Amoebic dysentery (b) Intestinal cancer
- (c) Appendicitis (d) None of the above

- 115.** Which of the following is related with vitamin B<sub>2</sub> [AFMC 1997]

**Or**

Riboflavin is essential in our diet, as it is required for the synthesis of

- (a) FMN / FAD (b) NAD
- (c) NADH (d) NADH<sub>2</sub>

- 116.** The method of intake of food in case of ciliate *Paramecium*

- (a) Holozoic (b) Saprozoic
- (c) Saprophytic (d) Parasitic

- 117.** Which one of the following is a matching pair of a certain body feature and its value/count in a normal human adult [AIIMS 2003]

- (a) Urea 5-10 mg/100 ml of blood
- (b) Blood sugar 80-100 mg/100 ml
- (c) Total blood volume 3-4 litres
- (d) ESR in Wintrobe method 9-15 mm per hour in males and 20-34 mm per hour in females

- 118.** Average kilocalorie of energy needed by woman is

[NCERT; Odisha JEE 2005]

- (a) Less than man (b) More than man
- (c) Equal to man (d) Cannot be predicted

- 119.** An average man needs approximately

[NCERT; CBSE PMT 1999; MP PMT 2004]

- (a) 2900 K cal. energy/day (b) 500 K cal. energy/day
- (c) 1000 K cal. energy/day (d) 2000 K cal. energy/day

- 120.** The people dependent exclusively on maize diet, are more likely to suffer from [AIEEE Pharmacy 2003]

- (a) Rickets (b) Pellagra
- (c) Beri-beri (d) Dysentery

- 121.** Vasco de Gama (1498) sailed to explore India with 180 companions but most of them died due to

- (a) Rickets (b) Pellagra
- (c) Scurvy (d) Xerophthalmia

- 122.** Anti-infection vitamin is

- (a) B<sub>12</sub> (b) A
- (c) D (d) K

- 123.** Chemical formula of 'Retinol-1' is

- (a) C<sub>6</sub>H<sub>5</sub>NO<sub>2</sub> (b) C<sub>3</sub>H<sub>10</sub>O<sub>3</sub>N
- (c) C<sub>20</sub>H<sub>30</sub>O (d) C<sub>28</sub>H<sub>44</sub>O

- 124.** Vitamin essential for formation of collagen is

- (a) A (b) E
- (c) B<sub>12</sub> (d) C

- 125.** Which one of the following is the correct matching of a vitamin, its nature and its deficiency disease

[CBSE PMT 2004; BCECE 2005]

- (a) Vitamin A – Fat-soluble – Beri-beri
- (b) Vitamin K – water-soluble – Pellagra
- (c) Vitamin A – Fat-soluble – Night blindness
- (d) Vitamin K – Fat-soluble – Beri-beri

## Digestion and Absorption 801

- 126.** Vitamin E is also known as  
 [MP PMT 2002; Kerala CET 2003]  
 (a) Decalciyng vitamin  
 (b) Antisterility vitamin  
 (c) Prothrombin vitamin  
 (d) Antihaemophilic vitamin
- 127.** Vitamin A was discovered by  
 (a) McCollum and Davis      (b) Funk  
 (c) Hopkin      (d) Eijkmann
- 128.** Organisms, which obtain energy by oxidation of reduced inorganic compounds, are  
 [CBSE PMT 2002]  
 (a) Phototrophs      (b) Saprozoic  
 (c) Copro-heterotrophs      (d) Chemo-autotrophs
- 129.** Which vitamin is destroyed by ultraviolet rays  
 (a) A      (b) D  
 (c) E      (d) K
- 130.** *E. coli* in human colon behave as  
 [AFMC 2002]  
 (a) Parasite      (b) Commensal  
 (c) Saprophyte      (d) Mutualism
- 131.** Vitamin M is  
 (a) Nicotinic acid      (b) Pantothenic acid  
 (c) Folic acid      (d) Ascorbic acid
- 132.** The vitamin isolated from egg yolk by Kogl and Tonnis in 1943 was  
 (a) Vitamin K      (b) Vitamin M  
 (c) Vitamin H      (d) Vitamin  $B_9$
- 133.** The vitamin which helps in carbohydrate metabolism during glycolysis and TCA cycle is  
 (a) Riboflavin      (b) Thiamine  
 (c) Folic acid      (d) Pantothenic acid
- 134.** Which one of the following pairs is not correctly matched  
 [CBSE PMT 2003]  
 (a) Vitamin  $B_6$  – Beri-beri  
 (b) Vitamin C – Scurvy  
 (c) Vitamin  $B_5$  – Pellagra  
 (d) Vitamin  $B_{12}$  – Pernicious anaemia
- 135.** Which set includes neurotic vitamins  
 (a) Vitamin  $B_{12}$ ,  $B_5$ ,  $B_2$       (b) Vitamin  $B_2$ ,  $B_6$ ,  $B_{12}$   
 (c) Vitamin A, D, E      (d) Vitamin  $B_6$ ,  $B_{12}$ , K
- 136.** Which one of the following vitamins can be synthesized by bacteria inside the gut  
 [CBSE PMT 1997]  
 (a)  $B_1$       (b) A  
 (c) D      (d) K
- 137.** Cow's milk is slightly yellowish in colour due to the presence of  
 (a) Carotene      (b) Riboflavin  
 (c) Xanthophyll      (d) Xanthophyll and carotene
- 138.** The water soluble materials pass through the proteins called  
 [Kerala CET 2003]  
 (a) Glycoprotein      (b) Glycocalyx  
 (c) Extrinsic proteins      (d) Channel proteins
- 139.** Which combination is incorrect  
 [CPMT 1994]  
 (a) Niacine – Pellagra  
 (b) Thiamine – Beri – beri  
 (c) Vitamin K – Sterility  
 (d) Vitamin D – Rickets
- 140.** Vitamins, we must consume daily are  
 [AFMC 1995; CBSE PMT 2000]  
 (a) Fat soluble      (b) Water soluble  
 (c) Both (a) and (b)      (d) None of these
- 141.** Besides having C, H, O which of the following also contains N, S, P etc.  
 [AFMC 1995]  
 (a) Protein      (b) Fat  
 (c) Carbohydrate      (d) Vitamin
- 142.** Which of the following does not belong to vitamin B group  
 [MP PMT 2002]  
 (a) Riboflavin      (b) Nicotin  
 (c) Cyanocobalamine      (d) Tocopherol
- 143.** Milk sugar is  
 [Bihar MDAT 1995; KCET 2010]  
 (a) Sucrose      (b) Galactose  
 (c) Lactose      (d) Glucose
- 144.** Which of the following is not a source of vitamin A  
 [CPMT 2002; RPMT 2005, 06]  
 (a) Carrot      (b) Mango  
 (c) Apple      (d) Yeast
- 145.** What does the doctor advise to the patients suffering from high blood cholesterol  
 [CBSE PMT 1996]  
 (a) Red mutton with fat layer  
 (b) Vegetable and margerin  
 (c) Vegetable oil such as ground-nut oil  
 (d) Pure desi ghee or butter
- 146.** Deficiency of copper causes  
 [MP PMT 1996]  
 (a) Pellagra  
 (b) Anaemia and damage to CNS  
 (c) Influenza  
 (d) Xerophthalmia
- 147.** The main cause of anaemia (Hypochromic or macrocytic) is  
 [MP PMT 1996, 99, 2006; AFMC 2006]  
 (a) Deficiency of Ca  
 (b) Deficiency of Fe  
 (c) Deficiency of Na  
 (d) Deficiency of Mg
- 148.** Mode of nutrition in Amoeba is  
 [HPMT 1993; MP PMT 2001]  
 (a) Saprozoic      (b) Holophytic  
 (c) Coprozic      (d) Holozoic
- 149.** Balanced diet should have approximately  
 [INCERT; AFMC 1994; CBSE PMT 2000]  
 (a) 1/5 protein, 3/5 fat and 1/5 carbohydrate  
 (b) 3/5 protein, 1/5 fat and 1/5 carbohydrate  
 (c) 1/5 protein, 1/5 fat and 3/5 carbohydrate  
 (d) 1/2 protein, 1/4 fat and 3/5 carbohydrate
- 150.** Holophytic nutrition is found in  
 [MP PMT 2000]  
 (a) Amoeba      (b) Giardia  
 (c) Entamoeba      (d) Euglena
- 151.** Fish-liver oils contain large amounts of  
 (a) Vitamin K  
 (b) Vitamin E  
 (c) Vitamins A and D  
 (d) Vitamins  $B_2$  and C

**N Q NCERT**  
**Exemplar Questions**

- Select what is not true of intestinal villi among followings [NCERT]
  - (a) They possess microvilli
  - (b) They increase the surface area
  - (c) They are supplied with capillaries and the lacteal vessels
  - (d) They only participate in digestion of fats
- Hepato-pancreatic duct opens into the duodenum and carries [INCERT]
  - (a) Bile
  - (b) Pancreatic juice
  - (c) Both bile and pancreatic juice
  - (d) Saliva
- One of the following is not a common disorder associated with digestive system [INCERT]
  - (a) Tetanus
  - (b) Diarrhoea
  - (c) Jaundice
  - (d) Dysentery
- A gland not associated with the alimentary canal is [INCERT]
  - (a) Pancreas
  - (b) Adrenal
  - (c) Liver
  - (d) Salivary glands

- Match the two columns and select the correct among options given

Column I	Column II	[INCERT]
A. Biomacromolecules of food	i. Alimentary canal and associated gland	
B. Human digestive system	ii. Embedded in jawbones	
C. Stomach	iii. Outer wall of visceral organs	
D. Thcodont	iv. Converted into simple substances	
E. Serosa	v. J-shaped bag like structure	
Options		
(a) A-ii, B-i, C-v, D-iii, E-iv		
(b) A-iv, B-i, C-v, D-ii, E-iii		
(c) A-i, B-ii, C-iii, D-iv, E-v		
(d) A-i, B-iii, C-ii, D-iv, E-v		

- Match the two columns and select the right one among options given

Column I	Column II	[INCERT]
A. Duodenum	i. A cartilaginous flap	
B. Epiglottis	ii. Small blind sac	
C. Glottis	iii. 'U' shaped structure emerging from the stomach	
D. Caecum	iv. Opening of wind pipe	
Options		
(a) A-i, B-ii, C-iii, D-iv		
(b) A-iv, B-iii, C-ii, D-i		
(c) A-iii, B-i, C-iv, D-ii		
(d) A-ii, B-iv, C-i, D-iii		

- Match the enzyme with their respective substrate and choose the right one among options given

A. Lipase	i. Dipeptides
B. Nuclease	ii. Fats
C. Carboxypeptidase	iii. Nucleic acids
D. Dipeptidases	iv. Proteins, peptones and proteoses

Options [INCERT]

- (a) A-ii, B-iii, C-i, D-iv
- (b) A-iii, B-iv, C-ii, D-i
- (c) A-iii, B-i, C-iv, D-ii
- (d) A-ii, B-iii, C-iv, D-i

- Liver is the largest gland and is associated with various functions, choose one which is not correct [INCERT]

- (a) Metabolism of carbohydrate
- (b) Digestion of fat
- (c) Formation of bile
- (d) Secretion of hormone called gastric

- Mark the right statement among the following [INCERT]

- (a) Trypsinogen is an inactive enzyme
- (b) Trypsinogen is secreted by intestinal mucosa
- (c) Enterokinase is secreted by pancreas
- (d) Bile contains trypsin

## Critical Thinking

### Objective Questions

- This is the common passage for bile and pancreatic juices [INCERT; AMU (Med.) 2010, 12]

- (a) Ampulla of Vater
- (b) Ductus Choledochus
- (c) Duct of Wirsung
- (d) Duct of Santorini

- Digestion in *Hydra* takes place within [Odisha JEE 2009]

- (a) Pelvic cavity
- (b) Abdominal cavity
- (c) Pericardial cavity
- (d) Gastrovascular cavity

- Which is the characteristic lining of stomach of mammals [MP PMT 1993]

- (a) Paneth cells
- (b) Deiter cells
- (c) Oxytic cells
- (d) Kupffer cells

- Fatty acid and glycerol are first taken up from alimentary canal by [AFMC 1994]

- (a) Villi
- (b) Blood capillaries
- (c) Hepatic portal vein
- (d) Lymph vessels

- Erythropoiesis starts in [DUMET 2009; AIPMT (Cancelled) 2015]

- (a) Kidney
- (b) Liver
- (c) Spleen
- (d) Red bone marrow

- In rabbit the colour of bile juice is

- (a) Colourless due to the presence of sodium and potassium taurocholate
- (b) Green due to the accumulation of biliverdin
- (c) Red due to the accumulation of haemoglobin
- (d) Yellow due to the presence of bilirubin

- During absorption of carbohydrates in the blood the most rapidly transported monosaccharide is [BHU 2012]

- (a) Glucose
- (b) Galactose
- (c) Fructose
- (d) Sucrose

8. The wall of the stomach is protected against the action of **HCl** by  
 (a) Epidermal layer (b) Mesodermal layer  
 (c) Mucous layer (d) Muscular layer [J & K CET 2010]

9. Column I contains names of the sphincter muscles of the alimentary canal and column II contains their locations. Match them properly and choose the correct answer

Column I	Column II
A. Sphincter of ani internus	1. Opening of hepatopancreatic duct into duodenum
B. Cardiac sphincter	2. Between duodenum and posterior stomach
C. Sphincter of Oddi	3. Guarding the terminal part of alimentary canal
D. Ileocaecal sphincter	4. Between oesophagus and anterior stomach
E. Pyloric sphincter	5. Between small intestine and bowel

[INCERT; KCET 2011]

- (a) A - 3, B - 2, C - 4, D - 1, E - 5  
 (b) A - 2, B - 5, C - 1, D - 4, E - 3  
 (c) A - 3, B - 4, C - 1, D - 5, E - 2  
 (d) A - 4, B - 3, C - 1, D - 2, E - 5

10. The pungent odour of faeces is due to presence of [MP PMT 1997]  
 (a) Indole (b) Skatole  
 (c) Various gases (d) All the above
11. Maximum percentage of lipoprotein is present in [DPMT 2007]  
 (a) Chylomicron (b) HDL  
 (c) VDL (d) VLDL

12. Where do certain symbiotic microorganisms normally occur in human body [INCERT; CBSE PMT (Mains) 2012]  
 (a) Caecum  
 (b) Oral lining and tongue surface  
 (c) Vermiform appendix and rectum  
 (d) Duodenum

13. For the enzyme action [BHU 1995]  
 (a) Value of  $K_m$  is unchange (b) Value of  $K_m$  is low  
 (c) Value of  $K_m$  is constant (d) Value of  $K_m$  is high
14. Inhibition of gastric secretion is brought about by [CMC Vellore 1993; CBSE PMT 1994; MP PMT 2003; CPMT 2005]

Or

- Which of these is not an enzyme of digestive system  
 (a) Cholecystokinin (b) Pancreozymin  
 (c) Gastrin (d) Enterogastron

15. A principal gastrointestinal hormone is  
 (a) Prolactin (b) Choline esterase  
 (c) Secretin (d) Acetyl
16. The activator of intestinal juice is [JIPMER 1993]

Or

- Mechanical stimulation of villi by the food produces a hormone which is known as [RPMT 2005]  
 (a) Succus entericus (b) Secretin  
 (c) Enterocrinin (d) Enterozymase

17. Anxiety and eating spicy food together in an otherwise normal human, may lead to

[NCERT; CBSE PMT (Pre.) 2012]  
 (a) Indigestion (b) Jaundice  
 (c) Diarrhoea (d) Vomiting

18. Wisdom teeth in human is [CPMT 2002; RPMT 2005]  
 (a) 3<sup>rd</sup> molar & 4 in number (b) 3<sup>rd</sup> molar & 2 in number  
 (c) 2<sup>nd</sup> molar & 4 in number (d) 2<sup>nd</sup> molar & 2 in number

19. In the stomach, gastric acid is secreted by the [NEET (Phase-I) 2016]  
 (a) Gastrin secreting cells (b) Parietal cells  
 (c) Peptic cells (d) Acidic cells

20. Which of the following can be called 'animal starch' [AIIMS 1993]  
 (a) Hemicellulose (b) Glucose  
 (c) Glycogen (d) Chitin

21. One of the following is needed for the conversion of trypsinogen into trypsin [INCERT; CBSE PMT 1995, 99; AFMC 1996; BHU 2000; Kerala PMT 2008]  
 Or

Trypsinogen is an inactive enzyme secreted by the pancreas. It is activated by

[WB JEE 2016]

- (a) HCl (b) Enterokinase  
 (c) Lipase (d) Zymase

22. Leison in ventromedial hypothalamus [MP PMT 2004]  
 (a) Increases hunger (b) Decreases hunger  
 (c) Do not change hunger (d) Stop eating

23. Antihaemorrhagic vitamin is [BHU 2008]  
 (a) Vitamin A (b) Vitamin B  
 (c) Vitamin C (d) Vitamin K

24. The mine workers are most likely to suffer from  
 (a) Beri-beri (b) Osteomalacia  
 (c) Scurvy (d) Xerophthalmia

25. Write proper option by matching column I, II and III

Column I (Name)	Column II (Enzyme)	Column III (Function)
(i) Gastric Juice	(P) Chymotrypsinogen	(A) Dipeptide convert into amino acid
(ii) Intestinal Juice	(Q) Ptyalin	(B) Proteoses convert into small polypeptides
(iii) Saliva	(R) Renin	(C) Casein convert into paracasein
(iv) Pancreatic juice	(S) Erepsin	(D) Conversion of starch into maltose

[GUJCET 2015]

- (a) (i - R - C) (ii - S - A) (iii - Q - B) (iv - P - D)  
 (b) (i - R - C) (ii - S - A) (iii - Q - D) (iv - P - B)  
 (c) (i - S - D) (ii - R - C) (iii - P - B) (iv - Q - A)  
 (d) (i - Q - A) (ii - P - C) (iii - R - B) (iv - S - D)

26. Wound healing is enhanced by a vitamin [MP PMT 2002]  
 (a) A (b) C  
 (c) D (d) E

27. Which of the following pair is characterised by swollen lips, thick pigmented skin of hands and legs and irritability

[CPMT 2004]

- |                  |               |
|------------------|---------------|
| (a) Iodine       | - Goitre      |
| (b) Protein      | - Kwashiorkor |
| (c) Thiamine     | - Beri-Beri   |
| (d) Nicotinamide | - Pellagra    |

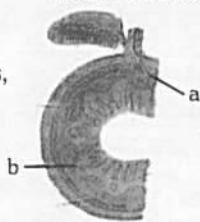
## 804 Digestion and Absorption

- 28.** Select the mismatch between a vitamin and its deficiency disease, among the following [AIEEE Pharmacy 2004]
- Riboflavin-slow clotting of blood
  - Niacin-damage to skin and lining of intestine
  - Ascorbic acid-scurvy
  - Thiamine-damage to nerves and heart.
- 29.** The delicious food generally makes mouth watery. It is due to [J & K CET 2002]
- Hormonal response
  - Neural response
  - Olfactory response
  - Optic response
- 30.** A triglyceride molecule has or A typical fat molecule is made up of [Kerala CET 2003; NEET (Phase-I) 2016]
- Three fattyacids with one glycerol molecule
  - Three fattyacids with two glycerol molecule
  - Two fattyacids with two glycerol molecules
  - One fattyacid with one glycerol molecule
- 31.** Excessive stimulation of vagus nerve in humans may lead to [AIIMS 2003]
- Hoarse voice
  - Peptic ulcers
  - Efficient digestion of proteins
  - Irregular contractions of diaphragm
- 32.** Protein deficiency in children is called [KCET 1994; CBSE PMT 1998; BHU 2003; DPMT 2007; AFMC 2008; CPMT 2008]
- Or**
- In Africa and South-east Asia, people like to have much bread and butter than pulses. They suffer
- Obesity
  - Marasmus
  - Diabetes
  - Kwashiorkor
- 33.** The intestine is different from the stomach by the presence of [NCERT; AIIMS 1993]
- Digestive gland
  - Villi
  - Sub-mucosa
  - Serosa
- 34.** In the empty stomach, mucosal folds appear. They are called [MP PMT 2002]
- Fiveoles
  - Ancinura angularis
  - Rugae
  - None
- 35.** Which of the following controls the peristaltic movement of the intestine [BHU 2002]
- Sacral plexus
  - Brachial plexus
  - Discoidal plexus
  - Auerbach's plexus
- 36.** Secretin hormone is secreted by [CBSE PMT 2002]
- Liver
  - Pancreas
  - Intestine
  - Brunner's glands
- 37.** Consider the following statements
- The anti pellagra vitamin is nicotinamide present in milk, yeast, meat and leafy vegetables
  - Crypts of Leiberkuhn are present in the liver
  - Steapsin is the pancreatic amylase [Kerala PMT 2007]
  - A and B correct
  - B and C correct
  - A and C incorrect
  - A and C correct
  - B and C incorrect
- 38.** Digestion process in humans is [BHU 2002]
- Extracellular
  - Intracellular
  - Intercellular
  - Both (a) and (c)
- 39.** Mumps are caused due to
- Excessive cold
  - Viral infection in tonsils
  - Viral infection of parotid salivary glands
  - Viral infection of zygomatic glands
- 40.** The folds of Kerkring are developed in
- Duodenum
  - Jejunum
  - Ileum
  - Large intestine
- 41.** Meckel's diverticulum is found in [JIPMER 2002]
- Ileum
  - Appendix
  - Pylorus
  - Rectum
- 42.** Which of the following carries glucose from digestive tract to liver [CBSE PMT 1999; Pb. PMT 2000; BHU 2001]
- Hepatic artery
  - Pulmonary vein
  - Hepatic portal vein
  - Renal portal system
- 43.** Which of the following sugars is absorbed from the small intestine by facilitated diffusion [CBSE PMT 2001]
- Fructose
  - Glucose
  - Sucrose
  - Lactose
- 44.** Mammals drink water and also obtain it from [MP PMT 2013]
- Break down of glycogen into glucose
  - Secretion of saliva
  - Conversion of oxyhaemoglobin to haemoglobin
  - Oxidation of glucose
- 45.** Select the correct match of the digested products in humans given in Column I with their absorption site and mechanism in Column II [NEET 2013]
- | Column I                      | Column II                           |
|-------------------------------|-------------------------------------|
| (a) Cholesterol, maltose      | Large intestine, active absorption  |
| (b) Glycine, glucose          | Small intestine, active absorption  |
| (c) Fructose, Na <sup>+</sup> | Small intestine, passive absorption |
| (d) Glycerol, fatty acids     | Duodenum, move as chilomicrons      |
- 46.** A healthy person eats the following diet-5gm raw sugar, 4 gm albumin, 10 gm pure buffalo ghee adulterated with 2gm vegetable ghee (hydrogenated vegetable oil) and 5 gm lignin. How many calories he is likely to get [NEET (Karnataka) 2013]
- 126
  - 164
  - 112
  - 144
- 47.** The given figure is a duct system of liver, gall bladder and pancreas. Identify the names of ducts from A to D [NCERT]
- 
- Gall bladder  
A  
B  
Pancreas  
C  
Duodenum  
D
- A - Cystic duct, B - Pancreatic duct, C - Bile duct, D - Hepato - pancreatic duct
  - A - Cystic duct, B - Bile duct, C - Hepato - pancreatic duct, D - Pancreatic duct
  - A - Bile duct, B - Cystic duct, C - Pancreatic duct, D - Hepato - pancreatic duct
  - A - Cystic duct, B - Bile duct, C - Pancreatic duct, D - Hepato - pancreatic duct

48. Which option is correct for the region labelled as 'a' and 'b' in the given diagram of transverse section of gut

- (a) a = Nerve,  
b = Circular muscle
- (b) a = Sub mucosal plexus of vessels,  
b = Mucosal gland
- (c) a = Villi,  
b = Mucosal gland
- (d) a = Longitudinal muscle,  
b = Muscularis mucosa

[GUJCET 2014]



49. Pituitary gland is located in 'a', which is a 'b' and 'c' bone

[GUJCET 2014]

- (a) a = Sella turcica, b = Raised surface, c = Ethmoid
- (b) a = Reketh's pauch, b = Depression, c = Nasal
- (c) a = Sella turcica, b = Depression, c = Sphenoid
- (d) a = Reketh's pauch, b = Depression, c = Sphenoid

50. The enzyme that is not present in succus entericus is

[AIPMT 2015]

- |               |                  |
|---------------|------------------|
| (a) Nucleases | (b) Nucleosidase |
| (c) Lipase    | (d) Maltase      |

51. Good vision depends on adequate intake of carotene rich food

Select the best option from the following statements

- (A) Vitamin A derivatives are formed from carotene
- (B) The photopigments are embedded in the membrane discs of the inner segment
- (C) Retinal is a derivative of Vitamin A
- (D) Retinal is a light absorbing part of all the visual photopigments

Options

- |                 |                      |
|-----------------|----------------------|
| (a) (A) and (B) | (b) (A), (C) and (D) |
| (c) (A) and (C) | (d) (B), (C) and (D) |

[NEET 2017]

## A Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

- (a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion
- (b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion
- (c) If the assertion is true but the reason is false
- (d) If both the assertion and reason are false
- (e) If the assertion is false but reason is true

1. Assertion : Blood sugar level falls rapidly after hepatectomy.

Reason : The glycogen of the liver is the principal source of blood sugar.

2. Assertion : Arachidic acid is an unsaturated fatty acid

Reason : There are present one or more double bonds between carbon atoms in unsaturated fatty acids

3. Assertion : Rumen of alimentary canal of ruminant animals harbour numerous bacteria and protozoa.

Reason : Bacteria and protozoa help in the secretion of gastric juice in the rumen.

4. Assertion : Many tube like glands are present in the wall of small intestine.

Reason : These glands secrete enzymes DNAse and RNase into the intestinal juice.

5. Assertion : Minerals are not biologically active substances.

Reason : Some individuals suffer anaemia due to deficiency of copper.

[AIIMS 2009]

6. Assertion : Thick layers of muscles are present in the wall of alimentary canal.

Reason : These muscles help in the mixing of food materials with the enzymes coming from different glands in the alimentary canal.

[AIIMS 2007, 10]

7. Assertion : In alcoholic fermentation, the hexose molecule is converted into glucose and fructose.

Reason : Alcoholic fermentation is anaerobic respiration brought about by enzyme zymase.

[AIIMS 1996]

8. Assertion : Insulin is secreted by  $\alpha$ -cells of islets of Langerhans of pancreas.

Reason : Insulin promotes conversion of glucose to glycogen.

[AIIMS 1996]

9. Assertion : Carbohydrates are more suitable for the production of energy in the body than proteins and fats.

Reason : Carbohydrates can be stored in the tissues as glycogen for use in the production of energy, whenever necessary.

10. Assertion : The amino acid glycine comes under the category of nonessential amino acids.

Reason : This is due to the fact that it can not be synthesised in the body.

[AIIMS 2010]

11. Assertion : Scurvy is caused by deficiency of vitamin C.

Reason : Deficiency of ascorbic acid causes scurvy.

[AIIMS 2001]

12. Assertion : The main part of carbohydrate digestion takes place in small intestine.

Reason : Here pancreatic amylase converts carbohydrates into lactose.

[AIIMS 1995]

13. Assertion : In alcoholic drink, the alcohol is converted into glucose in the liver.

Reason : Liver cells are able to produce glucose from alcohol by back fermentation.

[AIIMS 1996]

14. Assertion : Adult human being is not perfect in digestion of milk.

Reason : With age, man produces little or no lactase in the intestinal juice.

[AIIMS 1996]

15. Assertion : Trypsin helps in blood digestion of predator animals.

Reason : Trypsin hydrolyses fibrinogen.

[AIIMS 1996]

16. Assertion : Volume and fluidity of intestinal contents have increased in a person.

Reason : The person drank sea water.

[AIIMS 2001]

17. Assertion : Sea-faring fishermen sometimes eat raw fish.

Reason : They can be deficient of Vitamin B<sub>1</sub>.

[AIIMS 2001]

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18. Assertion : Starch is hydrolysed by ptyalin to maltose.  
 Reason : Sucrase hydrolyses sucrose to lactose.  
 [AIIMS 2001]
19. Assertion : Cold blooded animals have no fat layer.  
 Reason : Cold blooded animals use their fat for metabolic process during hibernation.  
 [AIIMS 1997]
20. Assertion : Absorption of digested food mainly occurs in the stomach.  
 Reason : Stomach produces the hormone gastrin and the intrinsic factor and it liquifies ingested food.  
 [AIIMS 1996]

# Answers

### Digestive system

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

### Digestive glands

1	d	2	d	3	a	4	b	5	a
6	b	7	b	8	c	9	b	10	b
11	d	12	c	13	a	14	d	15	b
16	b	17	c	18	a	19	b	20	c
21	a	22	a	23	c	24	a	25	b
26	a	27	b	28	a	29	c	30	c
31	b	32	b	33	b	34	d	35	c
36	c	37	b	38	b	39	a	40	d
41	b	42	b	43	b	44	a	45	a
46	d	47	c	48	c	49	b	50	b
51	a	52	d	53	b	54	a	55	c
56	d	57	a	58	d	59	c	60	b
61	d	62	c	63	b	64	b		

### Physiology of digestion

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

### Gastro intestinal hormones/Digestive enzymes

1	a	2	d	3	d	4	c	5	c
6	d	7	c	8	d	9	a	10	c
11	d	12	a	13	a	14	a	15	c
16	a	17	d	18	d	19	b	20	c
21	b	22	c	23	a	24	c	25	d
26	c	27	a	28	d	29	a	30	c
31	a	32	b	33	d	34	d	35	d
36	c	37	a	38	a	39	a	40	c
41	c	42	b	43	c				

### Nutrition and Nutritional requirement

1	a	2	b	3	b	4	a	5	d
6	b	7	d	8	b	9	b	10	c
11	a	12	a	13	a	14	b	15	a
16	b	17	d	18	b	19	c	20	b
21	b	22	a	23	c	24	c	25	d
26	c	27	b	28	d	29	a	30	a
31	b	32	d	33	b	34	d	35	b
36	c	37	a	38	b	39	b	40	d
41	c	42	c	43	c	44	c	45	b
46	d	47	b	48	b	49	d	50	b
51	b	52	b	53	a	54	a	55	c
56	a	57	b	58	c	59	d	60	b
61	b	62	d	63	b	64	a	65	c
66	b	67	a	68	d	69	d	70	b
71	c	72	c	73	d	74	a	75	d
76	a	77	b	78	a	79	c	80	d
81	b	82	a	83	a	84	b	85	a

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86	c	87	d	88	b	89	c	90	c
91	c	92	a	93	c	94	d	95	e
96	d	97	b	98	c	99	b	100	c
101	c	102	c	103	a	104	d	105	a
106	d	107	c	108	a	109	b	110	c
111	a	112	c	113	a	114	c	115	a
116	a	117	b	118	a	119	a	120	b
121	c	122	b	123	c	124	d	125	c
126	b	127	a	128	d	129	c	130	d
131	c	132	c	133	b	134	a	135	b
136	a	137	b	138	d	139	c	140	b
141	a	142	d	143	c	144	d	145	c
146	b	147	b	148	d	149	c	150	d
151	c								

### NCERT Exemplar Questions

1	d	2	c	3	a	4	b	5	b
6	c	7	d	8	d	9	a		

### Critical Thinking Questions

1	a	2	d	3	c	4	d	5	b
6	b	7	b	8	c	9	c	10	d
11	a	12	a	13	b	14	d	15	c
16	c	17	a	18	a	19	b	20	c
21	b	22	b	23	d	24	b	25	b
26	b	27	d	28	a	29	b	30	a
31	b	32	d	33	b	34	c	35	d
36	d	37	e	38	d	39	c	40	b
41	a	42	c	43	a	44	d	45	b
46	d	47	d	48	b	49	c	50	a
51	b								

### Assertion and Reason

1	a	2	d	3	c	4	c	5	d
6	a	7	e	8	e	9	b	10	c
11	a	12	c	13	d	14	a	15	a
16	a	17	a	18	d	19	b	20	e

## Answers and Solutions

### Digestive system

- (a) The lower Jaw of man is formed by the fusion of dentary bone only.
- (e) Dental formula of Rabbit is  $\frac{2,0,3,3}{1,0,2,3} \times 2 = \frac{16}{12} = 28$
- (b) Upper canines are most developed in Walrus.

- (b) Crown of the teeth is covered by the hardest substance of the body called enamel.
- (c) Foliate papillae are present only on tongue of rabbit.
- (c) In frog teeth are pre maxillary, maxillary and vomerine.
- (d) Tongue forms the floor of the oral cavity and it helps in the act of swallowing, help in mixing saliva with the food, help in speaking etc.
- (a) Dental formula for milk teeth is  $\frac{2102}{2102}$  so premolars are absent.
- (c) Taste buds for bitter taste are found on tongue at posterior part while anterior tip for sweetness and lateral sides are responsible for sour.
- (b) If a person suddenly starts coughing while swallowing food, it is due to improper movement of epiglottis. If the glottis is not properly closed some food can enter respiratory tract.
- (a) In mammals, the digestion starts from mouth. Mouth contain 3-pair salivary gland which secretes saliva. Saliva contains a starch splitting enzyme ptyalin which acts on cooked starch changing them into a sugar maltose, isomaltose and limit dextrin.
- (c) The dental formula of Rabbit is  $\frac{2033}{1023} = \frac{8}{6} \times 2 = 28$ , so 28 teeth occur in rabbit, canines are absent and Diastema is present between incisor and premolar.
- (b) Premolar and molar teeth with transverse ridges called lophos, so, premolar and molar are lophodont occurs in rabbit and elephant.
- (c) Upper incisor of an elephant is an enormously enlarged, called tusk teeth.
- (d) The third molar appear very late and are called wisdom teeth. From evolutionary point of view it is vestigial structure.
- (d) Teeth of frog are homodont, acrodont and polyphyodont. They are small, sharp and backwardly directed which are not meant for mastication but for preventing escape of prey.
- (a) Dentine forming cells, the odontoblasts line the pulp cavity of teeth.
- (c) Lacteals are central lymph vessel found in villi of intestine. It is related to absorption of fats.
- (c) The wall of alimentary canal is made up of four basic layers. First of all there is serosa which is a thin membranous covering around oesophagus. Then there is muscle layer-outer layer of longitudinal muscles and inner layer of circular muscles. Last there is submucosa which contains a few oesophageal glands. Then comes mucosa which have several layers of flattened cells.
- (b) Dental formula of human is  $\frac{2,1,2,3}{2,1,2,3} = \frac{8}{8} \times 2 = 32$ . It shows the number of incisor 2, canine 1, premolar 2 molar 3 in each half upper and half lower jaw with 32 teeth in buccal cavity.
- (c) Animals which eat their own faeces are called pseudo ruminants or coprophagous and phenomenon is known as pseudo rumination or coprophagy. e.g., Rabbit, Guinea pig.
- (c) The muscular contraction in alimentary canal is known as peristalsis due to which the food passes from front to backward direction in the lumen of alimentary canal.

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35. (a) Its large broader anterior part is called cardiac stomach, while the short narrower posterior part the pyloric stomach. So fundic part is absent in Stomach of frog.
36. (b) The fundic part of stomach consist 2 type of cells, chief or zymogenic cell secrets pepsin and oxyntic or parietal cell secretes  $HCl$ .
38. (b) Inner lining of gut, stomach and liver is composed of simple columnar epithelium, single layer of non ciliated rectangular cells contains goblet cells, nuclei at basis of cell.
39. (b) The mucosal lining of the oesophagus of mammals is made of squamous epithelium, several layers of cell deep layers, deep layers are cuboidal to columnar surface layers flat and scale like.
41. (a) Casein is a phosphoprotein found in milk. It is digested by rennin enzyme.
42. (b) The site of protein digestion is stomach where pepsin enzyme occur which changes protein to peptones + proteases.
43. (b) Stomach of ruminants is divided in 4 chamber, Rumen, Reticulum, omasum and abomasum. Some ruminants like camel and deer do not have omasum.
46. (c) In the wall of intestine, lymphatic tissue are present called Peyer's patches. Peyer's patches are a group of lymph nodules that are most numerous in the ileum and produce lymphocyte.
50. (d) Peyer's patches are found in the ileum of mammals.
51. (d) Water is mostly absorbed in colon. Colon is a part of large intestine.
52. (b) The intestinal juice or succus entericus is secreted by crypts of lieberkuhn.
55. (a) Goblet cells are specialized unicellular cells that secrete mucus and form glands of the epithelium the stomach, intestine and part of the respiratory tract.
57. (c) Brunner's gland are found in submucosa of duodenum.
58. (a) Chief cells or pepsinogenic or zymogenic cells secretes pepsinogen and prorennin. These cells are situated in fundic part of stomach.
59. (d) Intestinal villi are mainly concerned with the absorption, the main function of intestinal villi is to provide large surface area for absorption.
60. (a) Crypt of lieberkuhn is a type of simple tubular glands in which secretory portion is straight and tubular.
62. (a) Vermiform appendix is vestigial organ of man which is found in alimentary canal.
8. (c) Pancreatic juice is also called as complete digestive juice. It contains trypsin, chymotrypsin, amylase, and lipase, which digest all types of food materials.
9. (b) Gastric juice of infants contains pepsinogen, lipase and rennin.
10. (b) Ptyalin is slightly acidic because its pH value is 6.8.
11. (d) Liver cell synthesize vitamin A from carotene and store vitamins A, D and  $B_{12}$ .
12. (c) Argentaffin cells are generally located at the base of gastric glands and secrete serotonin.
15. (b) Pancreas is a mixed gland its exocrine part release enzymes and endocrine part release hormones so, pancreatic juice and hormones are secreted by different cell.
16. (b) Amylase is present in saliva it is slightly acidic nature because its pH value is 6.8.
18. (a) Intestinal juice is a clear yellow fluid with slightly alkaline nature pH of 7.6, contains water, mucus and enzymes.
19. (b) Intestinal juice or succus entericus is mainly secreted by crypts of lieberkuhn.
20. (c) Liver of rabbit is partly divided into 5 lobes; three lobes on left side are a small spigelian, left lateral and left central, while two lobes on the right side are caudate and right central or cystic.
24. (a) Sub maxillary and sub lingual glands are salivary gland secretes saliva, which participates in digestion of starch.
25. (b) Human beings have 3 pairs of salivary glands parotid, submandibular and sublingual.
26. (a) Ptyalin is an enzyme of salivary juice.
27. (b) Ptyalin (salivary amylase) and pancreatic amylase are the starch splitting enzyme released by salivary gland and pancreas.
28. (a) A lubricant mucin in saliva is made up of glycoprotein.
29. (c) Liver detoxifies and neutralises harmful substances.
30. (c) The trypsin enzyme is present in pancreatic juice which is secreted by pancreas.
31. (b) Bilirubin and biliverdin are bile pigments and are present in the bile juice.
33. (b) By cystic duct bile juice passes into gall-bladder from liver.
34. (d) Infra orbital salivary gland is absent in man while in other mammals such as rabbit it is found.
35. (c) Bile juice contains bile salts and bile pigments.
36. (c) Gastric juices have pH 2-3.7.
37. (b) The bacteria are found in the colon which in fact are the main source of vitamin-B<sub>12</sub> as vitamin-B<sub>12</sub> is not found in plants. Few micro-organisms of the rumen of stomach of ruminant mammals also synthesize large quantity of vitamin-B<sub>12</sub>.
38. (b) In human body glycogen is stored in liver and muscles both total 400 gm. glycogen stored, 100 gm. in Liver and 300 gm. in muscles.
39. (a) Gastric juice is secreted by gastric glands. It consists pepsin, rennin, lipase.
40. (d) Arginase is found in liver. It is very important enzyme for ornithine cycle.
47. (c) Bile has no digestive enzymes and hence, no chemical action on food.

## Digestive glands

1. (d) The endocrine part of pancreas is known as islets of Langerhans which contains 4 type of cell  $\alpha$ -cell,  $\beta$ -cells,  $\gamma$ -cells and  $\Delta$ -cell.
2. (d) Brunner's glands are present in the submucosa of duodenum and secrete  $HCO_3^-$ .
3. (a) Bile salts emulsify the fats and later on digested by enzyme lipase.
6. (b) Parotid glands are one pair largest salivary gland which is situated below ear (pinna).

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48. (c) The chief function of bile is emulsification of fats and make easy digestion of fats.  
 49. (b) Pancreatic juice is secreted from pancreas its *pH* about 8.4.  
 50. (b) Glycogenesis and glycogenolysis both process found in liver.  
 52. (d) Bile juice synthesis in liver helps in digestion of fats but it does not contain any digestive juice so liver is a organ which does not produce any digestive enzyme.  
 56. (d) Intestinal juice contains many enzymes like maltase, sucrase, lactase etc.  
 57. (a) The largest gland in human body is liver.  
 60. (b) Caudate is the part of right lobe of liver.  
 61. (d) Daily secretion of saliva in man is about 1-1.5 lit.  
 62. (c) Lysozymes are found in saliva and tears both.

### Physiology of digestion

1. (d) Fructose is absorbed with the help of the carrier ions like  $\text{Na}^+$ . This mechanism is called facilitated transport.
3. (a) Lacteals are related with the absorption of fats are found in ileum.
4. (d) Pancreas is a digestive gland that secretes pancreatic juice. This juice acts on all type of food i.e., protein, starch, fat and nucleic acid. If pancreas is removed from the body, the digestion does not occur.
5. (c) Chylomicron's are fat droplets coated with glycerol and protein.
7. (d) Trypsin is a protein digesting enzyme occur in pancreatic juice.
9. (a) Glycolysis is the first phase in the breakdown of glucose change in pyruvic acid occur in animal cell.
10. (c) A good source of lipase is pancreatic juice which is converted to fat into fatty acid + Glycerol.
11. (a) The end product of carbohydrate metabolism is  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .
12. (c) Glycogen is a polysaccharide which is synthesized and stored in liver cell.
17. (a) Emulsified fat is digested by lipase enzyme which is secreted by pancreatic juice, and intestinal juice.
20. (d) Parietal or oxytic cells release HCl required for the activation of pepsin.
23. (d) Digestion is defined as the conversion of non-diffusible food particle in diffusible food particle.
24. (b) Breaking of large fat droplets into fine emulsion by bile salt (Bile juice contain bile pigment and bile salt) of the liver.
26. (b) Because glucose is directly absorbed by the blood.
28. (a) Those enzyme who digest protein called proteolytic enzyme, these are trypsin, peptidase, pepsin.
30. (b) Rennin hydrolyses the milk protein casein into paracasein.
32. (c) Gluconeogenesis is the process in which glucose is formed from substance other than the carbohydrates.
35. (a) Trypsin and pepsin both are endopeptidase enzyme. Trypsin digest proteins in alkaline medium while pepsin digest protein in acidic medium.
39. (a) All lipid digestion takes place in the small intestine. Fatty acids and glycerol are the digestion products of lipids.
40. (a) Caecum is a small, pouch-like structure which ends into a tubular structure called vermiform appendix.

42. (a) Carbohydrate and fats (lipids) are chief energy source although proteins can also give energy.

Macronutrient	Gross Caloric Value Kcal/g	Physiologic Value kcal/g
Carbohydrate	4.1	4
Protein	5.65	4
Fat	9.45	9

47. (a) Rennin enzyme is found in gastric juice. It is a milk coagulating proteinase. Rennin acts on casein (milk protein) and converts it into calcium paracaseinate. It is known as curdling of milk.  
 48. (c) Because protein is primarily digested in the acidic media.  
 49. (d) Because human alimentary canal lacks cellulase enzyme and symbiotic micro-organisms.  
 54. (b) Enzyme erepsin is found in intestinal juice. It converts peptones to amino-acids.  
 57. (b) Bile salts help in the absorption of fats and fat soluble vitamin such as A, D, E and K in intestine.  
 58. (d) Fatty substances are emulsified by bile salts secreted by liver.

### Gastro intestinal hormones/Digestive enzymes

2. (d) Cholecystokinin-pancreozymin hormone is secreted by the epithelium of entire small intestine. It stimulates the gall bladder to release bile and pancreas to secrete and release digestive enzymes in the pancreatic juice.
5. (c) Most of proteases are secreted in inactive forms called proenzyme. Propepsin and trypsinogen both are inactive forms of proteolytic enzymes.
7. (c) Secretin is secreted by the mucosa of duodenum and it stimulates the secretion of pancreatic juice and increases the duodenal movements. Thus it plays an important role in digestion.
8. (d) Amylase is a starch splitting enzyme similar to ptyalin, hydrolysing starch and glycogen to maltose, isomaltose and limit dextrin.
9. (a) Isoenzymes are those enzymes which are found in more than one form having similar functions.
10. (c) Gastric glands are lined with three kinds of secreting cells zymogen (main, peptic or chief) cells, parietal cells and mucous cells. The main peptic or zymogen cells secrete digestive proenzyme namely pepsinogen and prorennin. HCl converts pepsinogen and prorennin into pepsin and rennin.
11. (d) Enteropeptidase or enterokinase is an enzyme involved in human digestion. Trypsin has an important role in the digestion of proteins in the anterior portion of the small intestine. It also activates other proteases in the pancreatic juice. Therefore in the absence of enterokinase the process of conversion of dipeptides to amino acids will be affected.
13. (a) Rennin is secreted by the cells of stomach in inactive form as prorennin and then activated to rennin by HCl.
16. (a) Bile is secreted by liver and stored in gall bladder.
18. (d) Pepsin initiates the digestion of protein in stomach producing proteoses and peptones.
20. (c) Pancreatic lipase (formerly called steapsin) hydrolyses fats into glycerol and fatty acids.
21. (b) Stored glycogen is broken down to glucose under the effect of glucagon secreted by alpha cells of Islets of Langerhans.

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25. (d) Gastrin is a polypeptide hormone secreted by the pyloric mucosa which stimulates the stomach to release gastric juice.
26. (c) Cholecystokinin is a polypeptide hormone produced by the mucosa of the upper intestine which stimulates contraction of gall bladder.
28. (d) Renin is the hormone secreted by JGA in kidney. It is released due to hypotension (low BP).
30. (c) Trypsin an enzyme or enzyme complex is a part of pancreatic juice and is able to digest proteins in alkaline medium.
31. (a) Insulin is produced by  $\beta$ -cells of islets of Langerhans.
32. (b) Enterokinase is a gastro-intestinal enzyme secreted by small intestine of vertebrate, which converts trypsinogen to trypsin.
37. (a) Secretin hormone produced by duodenal mucosa which causes a copious secretion of pancreatic juice.
38. (a) Since amylase, rennin and trypsin are enzymes, therefore these all are proteins.
40. (c) The duodenal epithelium is stimulated to secrete secretin by the entry of acidic chyme into the duodenum.
42. (b) Succus entericus is the intestinal juice stimulated by secretin and cholecystokinin from the intestinal glands.
43. (c) It is a hormone secreted by the mucosa of small intestine.

## Nutrition and Nutritional requirement

1. (a) Marasmus occurs due to prolonged malnutrition and deficiency of proteins and calories.
4. (a) Retinal pigment is an aldehyde of vitamin A.
10. (c) Proteins are broken down into amino acids during the process of digestion and finally all fats are converted into fatty acid, glycerol and monoglycerides.
11. (a) Proteins are made up of amino acid molecules, hence on hydrolysis they form amino acids.
14. (b) Carbohydrates are chief source of energy in the food of most of the animals. Main source of carbohydrates are cereals, fruits, milk rice, and potato.
16. (b) Casein is protein which form the part of food for the young animal. Best source of casein is milk.
18. (b) Carbohydrate are classified as :  
Monosaccharides (e.g., glucose, fructose, galactose), disaccharides (e.g., sucrose, maltose, lactose) and polysaccharides (e.g., starches, glycogen, cellulose, dextrans).
19. (c) Lactose ( $C_{12}H_{22}O_{11}$ ) is milk sugar. It is a disaccharide composed of glucose and galactose unit.
20. (b) The anhydrobonds of protein are called peptide bonds. A peptide bond is formed between carboxyl group of one amino acid and amino group of adjacent.
21. (b) Carbohydrates are more suitable for the production of energy in the body than proteins and fats. Carbohydrate are also stored in the body cells as glycogen and are used for the production of energy whenever required.
23. (c) Essential amino acids are those which are taken from food, not synthesized in the body.
25. (d) Primary component of bones and also present in muscles and blood.
29. (a) Thiamine ( $B_1$ ) deficiency is common in alcoholics. It leads to decreased mental function, double vision and reduced muscular contraction and the resulting disorder is known as Wernicke's syndrome.
30. (a) Steen Hoeck described that vitamin D is synthesized in presence of UV rays of sunlight in the skin.
31. (b) The vitamins are generally divided into Two major groups : Fat soluble (A, D, E and K) and water soluble (B - complex and C)
32. (d) Biotin or nicotinic acid consists of sulphur. It acts as coenzyme needed for protein and fatty acid synthesis,  $CO_2$  fixation and transamination.
33. (b) On the basis of their requirement in body the inorganic elements are of two types :  
(i) **Macroelements** : C, H, N<sub>2</sub> and O<sub>2</sub> are called big four elements of living body because they are required in maximum amount in the body.  
(ii) **Microelements** : Iron, iodine, manganese, copper, zinc, fluorine etc, are required in minimum amount in the body.
34. (d) Barium is not used in human body.  
Calcium is useful in formation of bone teeth and helps in blood clotting. It keeps muscle and nerve activity normal. Phosphorus is important for formation of bone teeth and biomembranes. It keeps muscle and nerve activity normal. It is a part of energy carriers (ATP, ADP, AMT) nucleic acid (DNA and RNA) and coenzymes. Zinc is a component of atleast 70 enzymes. It is also essential for vitamin A metabolism, healing of wounds and protein synthesis.
37. (a) Vitamin C is also called anti scorbatic factor and Ascorbic acid.
42. (c) Vitamin C is heat labile.
44. (c) The term vitamin was given by Funk.
47. (b) Zinc takes part in immune reactions.
55. (c) Deficiency of vitamin  $B_1$  causes beri-beri disease. Beri-beri disease was discovered by Eijkman in 1897.
60. (b) Fluorine maintains normal dental enamel and prevents dental caries.
64. (a) Vitamin A is synthesized in liver from yellow and red carotenoid pigments.
65. (c) The given symptoms occur due to deficiency of thiamine (vit.  $B_1$ ). Thiamine is a precursor of the coenzyme thiamine pyrophosphate which functions in carbohydrate metabolism. Deficiency leads to beriberi in humans and to polyneuritis in birds. Good sources include brewer's yeast, wheat germ, beans, peas and green vegetables.

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66. (b) Because vitamin K helps in maintenance of normal prothrombin and factor VII in the blood and thus takes part in normal coagulation.
69. (d) As both vitamin  $B_{12}$  and folic acid are involved in maturation of erythrocytes in bone marrow.
75. (d) Vitamin E maintains normal functioning of reproductive organs hence it is called fertility vitamin. Sterility (impotence) and muscular atrophy is common deficiency disease of vitamin E.
79. (c) Vitamin  $B_{12}$  is a dark red compound containing cobalt.
80. (d) Vitamin D also known as calciferol. The deficiency of calciferol causes, the children suffer from rickets and adult from osteomalacia.
81. (b) Vitamin A occurs in yellow vegetables and fruits like carrots, tomatoes, papaya and mango, green leafy vegetables as spinach.
84. (b) Vitamin  $B_{12}$  is not found in plants. However it is considered that *spirulina* (an algae) contain  $B_{12}$ . Vitamin  $B_{12}$  is synthesized by intestinal bacteria which infact are main source of vitamin  $B_{12}$ . Many micro-organisms (bacteria) of the stomach of ruminant mammals also synthesize large quantities of vitamin  $B_{12}$ .
88. (b) Vitamin E is also called as tocopherol or antifertility vitamin.
89. (c) Nicotinic acid or vitamin  $B_5$  is a pellagra preventing factor or PP factor. Pellagra caused due to the deficiency of vitamin  $B_5$  is characterized by dermatitis (thick, pigmented skin), muscle atrophy and severe inflammation of mucous membrane of mouth.
90. (c) Vitamin  $B_{12}$  is also called cyanocobalamin. It is essential for the formation and maturation of erythrocytes.
98. (c) It increases the RBC count and the platelets through its action on the bone marrow. It promotes haemopoiesis.
100. (c) Vitamin  $B_{17}$  has been recently explained to be found in water melon. It is supposed to have anti cancer property.
109. (b) Vitamin-C (Ascorbic acid) play an important role in certain metabolic reactions. This vitamin activates an enzyme that is involved in synthesis of hydroxy proline which is an integral part of collagen. Obviously it is essential for formation and growth of connective tissues cartilage, bone, teeth etc.
110. (c) Since vitamin K helps in blood clotting, its deficiency will lead to excessive bleeding.
112. (c) Paralysis of muscle fatigue and burning feet syndrome is related with deficieny of pantothenic acid (vitamin  $B_5$ ).
114. (c) In man, attached to caecum is a twisted, coiled tube, measuring about 3 inches in length, called the vermiform appendix. Inflammation of the vermiform appendix is called appendicitis.
115. (a) It takes part in the formation of coenzyme FMN and FAD.
116. (a) *Nutrition or food intake in paramecium of nutrition in amoeba is holozoic that is, amoeba is heterotrophic.*
119. (a) A young man requires approximately 3000K. cal. per day while a child of about 15 years requires 2500 and infant of 4-6 years requires about 1500 Kcal per day.
122. (b) It also maintains the integrity of epithelial tissue and prevents the infection.
124. (d) Vitamin C is necessary for formation of collagen fiber, in this way vitamin C helps for healing to the wound.
127. (a) Vitamin A was discovered by Mc collum and Davis (1915) from butter and egg yolk.
129. (c) The activity of vitamin E is destroyed by U.V. rays and oxidation.
130. (d) *E.coli* lives in mutual association in human colon as it obtains food from the intestine and in turn help to produce vitamin  $B_{12}$ .
133. (b) It acts as the coenzyme of pyruvate carboxylase. Its active factor is thymine pyrophosphate. It causes decarboxylation of pyruvic acid.
134. (a) Beri-beri is caused by deficiency of vitamin  $B_1$  (thiamine)
136. (a) The chemical name of vitamin  $B_1$  is thiamine. It can be systhesized by bacteria inside the gut.
137. (b) Because riboflavin is an orange-yellow compound, so cow's milk appears slightly yellowish.
139. (c) Vitamin K (phylloquinone) is required for the formation of clotting factors by liver, thereby its deficiency leads to delay in coagulation i.e. haemorrhage.
141. (a) Proteins are large molecules of high molecular weight containing  $C, H, O$  and nitrogen ( $N$ ). The presence of  $N$  distinguishes them from carbohydrate and fat. Iron, copper, iodine, sulphur and phosphorus may also be present in a very low proportion. Proteins are found in fish, meat, egg, wheat, bean, ground-nut and pulses.
143. (c) Lactose or milk sugar is a disaccharide formed by the union of one molecule of galactose and one molecule of glucose. Besides milk it is found in flowers of some plants
145. (c) Vegetable oil contains low molecular weight lipids.
146. (b) Copper takes part in haemoglobin synthesis.
147. (b) Primary anaemia is due to deficiency of  $Fe$
148. (d) Amoeba takes solid food and digests it intracellularly.
150. (d) Euglena carries on both autotrophic and hetrotrophic modes of nutrition.

## Critical Thinking Questions

3. (c) The mucosa is highly folded and the single-layered mucous membrane of the infoldings forms tubular and often branched gastric gland in the lamina propria. Each gland has three types of secretory cells – neck cells, oxyntic cells, zymogen cells.

## 812 Digestion and Absorption

4. (d) Generally, fatty acids upto a chain length of 10 carbon atom are primarily absorbed through the blood capillaries, but those with higher chain length through lymphatic route (lymph vessels).
6. (b) The bile is a complex greenish and alkaline fluid. Containing bile salt and bile pigment. Most important bile pigment is bilirubin which is a breakdown product of hemoglobin, biliverdin is absent.
10. (d) Odour of faeces is due to presence of toxic amines indole and skatole derived from action of bacteria on amino acid. Gases also causes odour in faeces. They are produced by fermentation of carbohydrate.
11. (a) A lipoprotein is a biochemical assembly that contains both proteins and lipids. There are several types of lipoproteins, each having different functions, but all essentially are transport vehicles. Lipoproteins are categorized and named mainly accordingly to their density which varies with the ratio of lipids to proteins from largest and highest to smallest and heaviest, the four major classes of lipoproteins are chylomicrone, VLDL, LDL and HDLs.
12. (a) Caecum is small blind sac which host some symbiotic micro-organism.
14. (d) Enterogastrone is secreted by the duodenal epithelium. It inhibits gastric secretion and motility.
15. (c) Well established gastrointestinal hormones are – i. secretin, ii. CCK , iii. Gastrin, iv. GIP, v. Motilin.
16. (c) Enterocrinin is secreted by the epithelium of entire small intestine. It stimulates the crypts of lieberkuhn to release enzymes it to the intestinal juice.
18. (a) Third molars in human being are called wisdom teeth. Number of 3<sup>rd</sup> molar in both jaw is four.
20. (c) Glycogen is a branched polymer of glucose. It is stored mostly in muscles and liver of animal and it is also called animal starch.
21. (b) In the presence of enterokinase, inactive trypsinogen is converted into active trypsin.
23. (d) Vitamin K is also known as antihaemorrhagic vitamin.
26. (b) Vitamin C promote wound healing.
27. (d) Pellagra is a disease caused by the deficiency of nicotinamide or nicotinic acid or niacin or vitamin  $B_5$ . It is frequent among people eating food with low tryptophan content. The symptoms of pellagra are inflammation of skin, diarrhoea and dementia.
28. (a) Riboflavin (vitamin  $B_2$ ) causes cheilosis, which is characterized by inflammation and cracking at the angles of the mouth.
30. (a) Triglyceride molecule is completely hydrolyzed into three molecules of fatty acid + one molecule of glycerol.
32. (d) Kwashiorkor is caused by the deficiency of proteins in diet this disease occurs in children of age group 1 to 5 years.
33. (b) Intestinal villi are mainly concerned with absorption. Villi are absent in stomach.
34. (c) Empty stomach is lined with folds called rugae.
35. (d) Auerbach's plexus is a part of autonomic nervous system in vertebrates lying between the two main muscular layers of intestine and controlling its peristaltic movements.
38. (d) Digestion in human is extracellular (intercellular).
40. (b) The entire small intestine has circular folds of the mucous membrane, the 'valves' of kerkring. These folds are more prominent in the jejunum.
42. (c) The blood carries from digestive tract to liver through hepatic portal vein the blood which comes from the digestive tract contains absorbed food like glucose and amino acids.
43. (a) Glucose and galactose are absorbed by active transport. Fructose is absorbed by facilitated diffusion.
46. (d) Physiological value of carbohydrates is 4.0 kcal/g of proteins 4.0 kcal/g and of fats is 9.0 kcal/g  
Hence  
 $5 \text{ g raw sugar will yield } 5 \times 4.0 = 20.0 \text{ kcal}$   
 $4 \text{ g albumin (protein) will yield } 4 \times 4.0 = 16.0 \text{ kcal}$   
 $10 + 2 \text{ g of fat will yield } 12 \times 9.0 = 108.0 \text{ kcal}$   
Total yield = 144 kcal.
49. (c) Pituitary gland is located in bony depression called sella turcica in sphenoid bone of cranium.

### Assertion and Reason

1. (a) In liver, glycogen a reserve food material is changed into glucose (glycogenolysis) and released into blood. Under abnormal conditions, liver can convert proteins and fats into glucose by complex chemical reactions i.e., called gluconeogenesis. Thus, due to hepatectomy blood sugar level falls rapidly.
2. (d) Fatty acids which lack any double or triple bond in their hydrocarbon chain are known as saturated fatty acids. Example lauric acid, arachidic acid, myristic acid, palmitic acid, stearic acid etc in contrast to saturated fatty acids, unsaturated fatty acids have one or more double bonds between carbon atoms at fixed place along the hydrocarbon chain. Example palmitoleic acid, oleic acid, linoleic acid, linolenic acid, arachidonic acid etc.
3. (c) Ruminant animals such as cattle, buffalo, sheep, goat and camel have a compound stomach, which consists of four chamber, viz, rumen, reticulum, omasum and abomasum. Rumen is the first and the largest of the four chambers. Rumen and reticulum harbour numerous bacteria and protozoa, which carry out extensive fermentation of cellulose. So, these two chambers function as sites for cellulose digestion in ruminants. The gastric juice containing enzymes and HCl is secreted only by the fourth chamber i.e., Abomasum.

4. (c) Numerous tube like glands are present in the wall of small intestine which secrete intestinal juice into the intestinal lumen. This juice contains a number of enzymes like enterokinase, aminopeptidases, dipeptidases, maltase, lactase, lipase etc. for digesting various types of food. On the other hand, the enzymes RNAse and DNase are present in the pancreatic juice. These enzymes are secreted by the pancreas and are drained into the small intestine via Hepato pancreatic duct.
5. (d) Minerals take part in biological reactions and are thus biologically active. Anaemia is caused by deficiency of iron.
6. (a) Thick layer of muscles are present in the alimentary canal. These muscles facilitate the movement of food particles through alimentary canal. Large food particles are broken down into small, semi liquid particles by the action of these muscles. Later also help in the forward flow of food materials and mixing of enzymes coming from different glands related to alimentary canal.
7. (e) Alcoholic fermentation is the respiration in absence of  $O_2$ . In this process, hexose molecule is changed to ethyl alcohol and  $CO_2$ . In presence of zymase enzyme. In this less amount of energy is released as compared to aerobic respiration.
8. (e) Insulin is secreted by  $\beta$ -cells of islets of Langerhans. It helps in conversion of glucose into glycogen decreasing blood sugar level. This is called glycogenesis.
9. (b) Carbohydrates are more suitable for the production of energy in the body than proteins and fats, because carbohydrate molecules contain relatively more oxygen than the others, and consequently, requires less molecules of oxygen for their oxidation. In other words, for each litre of oxygen consumed, carbohydrates yield far more energy than proteins or fats. Carbohydrates are also stored in the tissue as glycogen for use in the production of energy, when necessary. Glycogen is the stored fuel particularly in such tissues as skeletal muscles which then have to work with a supply of oxygen far lower than their immediate need.
10. (c) Non essential amino acids are those amino acids which need not be supplied in the diet because they can be synthesised by the body, particularly from carbohydrate metabolites. Glycine is one such non essential amino acid. On the contrary, essential amino acids are those amino acids which can not be synthesised in the animal body and must be supplied with food in adequate amounts. Out of twenty amino acids, eight are considered essential in human diet.
11. (a) Ascorbic acid is called vitamin C. The deficiency of this vitamin causes scurvy.
12. (c) In small intestine Pancreatic amylase converts starch and dextrans into maltoses and small intestine is main site for digestion of carbohydrates.
13. (d) In liver, alcohol is oxidised into acetaldehyde which is further oxidised into acetate. The latter is converted to acetyl coenzyme A which is used in Krebs' cycle.  

$$\text{Ethyl alcohol} \rightarrow \text{Acetaldehyde} \rightarrow \text{Acetate} \rightarrow \text{Acetyl Co A} \rightarrow CO_2 + H_2O$$
14. (a) The human being is the only mammal who ingests significant amount of lactose in milk. Curiously, many human adults can not digest milk, because with age they produce little or no lactase in the intestinal juice. In such persons, the lactose of milk remains undigested and is fermented in the intestine producing gases and acids. This results in flatulence, intestinal cramps and diarrhoea.
- ```

    graph TD
      A[Adult human] --> B[Less or no lactase]
      B --> C[Lactose remains undigested]
      C --> D[Undigested substances fermented]
      D --> E[Produce gas, acids, intestinal cramps, diarrhoea]
  
```
15. (a) Trypsin is protein digesting enzyme present in the intestine of animals. Though it cannot digest casein (a milk protein), in predator animals drinking the blood of their prey, trypsin hydrolyses fibrinogen of blood into fibrin, leading to blood coagulation thus help in blood digestion. It also activates other pancreatic proteases.
16. (a) If sea water is drunk, its  $Mg^{2+}$  ions increase the solute concentration in the intestinal lumen because  $Mg^{2+}$  is absorbed very slowly. On the contrary,  $Mg^{2+}$  draws water from the blood to the intestinal lumen by osmosis. So, water is not gained, but is lost from the blood on drinking sea water. Thus, there occurs increase in the fluidity and volume of intestinal contents, in the same way this consequently stimulates intestinal peristalsis and evacuation of fluid faeces.
17. (a) Sea faring fisherman suffer from paralysis because raw fish muscles contain an enzyme which destroys Vitamin  $B_1$ .
18. (d) Starch is hydrolysed by pancreatic amylase to maltose, isomaltose and dextrans sucrose  $\xrightarrow{\text{sucrase}}$  glucose and fructose.
19. (b) The body temperature in cold blooded varies with that of the environment as there is no fat deposition. On the other hand, cold blooded animals use fat during hibernation to carry out their metabolic processes.
20. (e) Absorption takes place in small intestine as it offers large surface area for absorption. Stomach produces the hormone gastrin and intrinsic factor.

## Digestion and Absorption

## Self Evaluation Test

1. Find out the correctly matched pair [Kerala PMT 2007]

- |                      |                   |
|----------------------|-------------------|
| (a) Pepsinogen       | - Zymogenic cells |
| (b) HCl              | - Globlet cells   |
| (c) Mucus            | - Oxytic cells    |
| (d) Pancreatic juice | - Salivary glands |
| (e) Ptyalin          | - Acinar cells    |

2. A dental disease characterized by mottling of teeth is due to the excess of a certain chemical element in drinking water. Which of the following is that element [BHU 2000]

- |              |              |
|--------------|--------------|
| (a) Mercury  | (b) Chlorine |
| (c) Fluorine | (d) Boron    |

3. Spot the salivary gland among the following [KCET 1999]

- |                |              |
|----------------|--------------|
| (a) Sublingual | (b) Adrenal  |
| (c) Brunner    | (d) Lacrymal |

4. Excess carbohydrates and proteins are stored in the body as [DUMET 2010]

- |                 |                    |
|-----------------|--------------------|
| (a) Amino acids | (b) Fats           |
| (c) Starch      | (d) Monosaccharide |

5. The colour of the faeces is due to the

- |                |                 |
|----------------|-----------------|
| (a) Urochrome  | (b) Stercobilin |
| (c) Biliverdin | (d) Bacteria    |

6. Which one is detritus feeder [RPMT 2000]

- |            |                 |
|------------|-----------------|
| (a) Parrot | (b) Sheep       |
| (c) Unio   | (d) Dung beetle |

7. Lamina propria is related with

- |                       |                          |
|-----------------------|--------------------------|
| (a) Human intestine   | (b) Liver of human being |
| (c) Graafian follicle | (d) Acinus of pancreas   |

8. How many teeth in man grows twice in life [JIPMER 2001; AFMC 2002, 04]

- |        |        |
|--------|--------|
| (a) 32 | (b) 28 |
| (c) 20 | (d) 12 |

9. Find out the correct match

| Column - I              | Column - II               |
|-------------------------|---------------------------|
| A. Hepatic lobule       | 1. Sub mucosal glands     |
| B. Brunner's glands     | 2. Base of villi          |
| C. Crypts of Lieberkühn | 3. Glisson's capsule      |
| D. Sphincter of Oddi    | 4. Gallbladder            |
| E. Cystic duct          | 5. Hepato-pancreatic duct |
|                         | 6. Serous glands          |

[NCERT; Kerala PMT 2007; J & K CET 2008]

- |                             |
|-----------------------------|
| (a) A-3, B-6, C-2, D-5, E-4 |
| (b) A-5, B-2, C-3, D-6, E-1 |
| (c) A-3, B-1, C-2, D-5, E-4 |
| (d) A-4, B-6, C-5, D-2, E-1 |
| (e) A-4, B-2, C-6, D-5, E-3 |

10. By the mechanical stimulation on the wall of stomach, a hormone is released. This is

- |              |                  |
|--------------|------------------|
| (a) Gastrin  | (b) Progesterone |
| (c) Secretin | (d) Pancreozymin |

11. Insulin, epinephrine, glucagon collectively influence

- |                                     |
|-------------------------------------|
| (a) Glyconeogenesis                 |
| (b) Glycerophosphate shuttle        |
| (c) Glycolysis                      |
| (d) Glycogenolysis and glycogenesis |

12. Match the item in Column I (vitamins) with those in Column II (deficiency diseases)

| Column I<br>(Vitamins) | Column II<br>(Diseases)             |
|------------------------|-------------------------------------|
| I. K                   | A. Beri-beri                        |
| II. D                  | B. Haemorrhagic disease in new born |
| III. B <sub>1</sub>    | C. Night blindness                  |
| IV. A <sub>1</sub>     | D. Rickets                          |

Which one of the following is the correct matching of all the four vitamins

[CBSE PMT 1995; MP PMT 1999, 2002; DPMT 2006]

- |                            |                            |
|----------------------------|----------------------------|
| (a) I-C, II-B, III-D, IV-A | (b) I-A, II-B, III-D, IV-C |
| (c) I-C, II-A, III-D, IV-B | (d) I-B, II-D, III-A, IV-C |

13. Pernicious anaemia is caused due to the deficiency of [MP PMT 2009; WB JEE 2009]

Or

This vitamin is also known as "Castle's extrinsic factor"

- |                             |                            |
|-----------------------------|----------------------------|
| (a) Folic acid              | (b) Vitamin B <sub>6</sub> |
| (c) Vitamin B <sub>12</sub> | (d) Appendix               |

14. Exclusive holozoic nutrition is seen in [Odisha JEE 2011]

- |              |           |
|--------------|-----------|
| (a) Spider   | (b) Man   |
| (c) Housefly | (d) Shark |

15. Symbiotic bacteria present in intestine of most primates, which synthesize certain vitamins are

- |                           |
|---------------------------|
| (a) Entamoeba histolytica |
| (b) Entamoeba coli        |
| (c) Entamoeba gingivalis  |
| (d) None of these         |

## Answers and Solutions

|    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|
| 1  | a | 2  | c | 3  | a | 4  | b | 5  | b |
| 6  | c | 7  | a | 8  | c | 9  | c | 10 | a |
| 11 | d | 12 | d | 13 | c | 14 | b | 15 | b |

2. (c) Excess intake of fluorine causes fluorosis, which is manifested in its mild state by mottled teeth and in a more severe state by enlarged bones.

3. (a) In human, 3 pairs of salivary glands are present. They are sublingual, parotid and submaxillary.

5. (b) It is an oxidation product of bile pigment.

6. (c) Animal which feeds upon organic matter mixed with the soil e.g. earthworm and unio.

8. (c) In man, 20 teeth are diphodont, i.e., grow twice in life.

11. (d) Epinephrine and glucagon cause glycogenolysis while insulin causes glycogenesis.

13. (c) Pernicious anaemia marked by a decrease in the number of red blood cells which is caused by a reduced ability to absorb vitamin B<sub>12</sub>.

15. (b) *Escherichia coli* is common colon bacteria found in human beings and many vertebrates. This bacteria is normally not harmful but is mostly helpful in digestion through synthesis of vitamin.