Digestion and Absorption

Syllabus

Digestion and absorption; Alimentary canal and digestive glands; Role of digestive enzymes and gastrointestinal hormones; Peristalsis, digestion, absorption and assimilation of proteins, carbohydrates and fats; Caloric value of proteins, carbohydrates and fats; Egestion; Nutritional and digestive disorders – PEM, indigestion, constipation, vomiting, jaundice, diarrhea.

Chapter Index

TYPES OF NUTRIENTS OF ANIMALS

- Nutrients may be organic or inorganic in nature.
- The organic constituents of nutrients are carbohydrates, lipids, proteins and vitamins, and the inorganic constituents are minerals and water.
- Carbohydrates, lipids and proteins are **macronutrients or proximate principles of food** because these constitute the energy sources for the production of heat and different organic functions.
- Minerals, vitamins and water are **micronutrients** or **protective principles of food** because although these do not provide energy, yet their deficiencies are related to specific diseases and abnormalities in man.
- About 21 minerals *(e.g.* sodium, potassium, calcium, sulphur, phosphorus, magnesium and chlorine) or **macroelements** are known to be essential for human nutrition; they are required in larger amounts (more than 100 mg per day).
- Trace elements or microelements *(e.g.* iron, iodine, zinc, manganese, cobalt, copper, molybdenum etc.) are required in very small amounts. Altogether 20 vitamins are thought to be required in small amount for human nutrition.

MODE OF NUTRITION IN ANIMALS

1. **Holozoic:** When whole plants (or their parts) and whole animals (or their parts) or both are consumed either in solid or in liquid form through mouth, *e.g.,* most of the animals.

2. **Saprozoic:** When decaying organic materials of plant or animal origin are consumed. The digestive enzymes are secreted directly onto the food and therefore the food is digested outside the body. *e.g.,* fungi, bacteria, some protozoans.
3. **Parasitic:** When a living organism feeds on another living organism and causes harm to it *e.g.* tapeworm, malarial parasite etc.
4. **Holophytic:** Plant like nutrition *e.g. Euglena.*
5. **Insectivorous:** Feed upon insects *e.g.* wall lizard, frog.
6. **Larvivorous:** Feed upon larvae *e.g.* fish, dragon fly.
7. **Voracious:** Continuous feeder, taking huge amount of food in comparison to body size *e.g.* dragon fly, *Gambusia* fish.
8. **Cannibalism:** Feed upon their own species *e.g.* snakes, cockroach, scorpion, frog, fish.
9. **Sanguivorous feeder:** Feed upon blood *e.g.* leech, female mosquitoes, vampire bats.
10. **Filter feeder:** Feed upon micro food particle and reject macro food particle. *Unio* (Fresh water mussel), *Paramoecium, Amphioxus,* sponges, whale (mammal).
11. **Myxotrophic feeder:** Both holozoic as well as holophytic *e.g. Euglena.*
12. **Detritus feeder:** Feed upon organic food present in soil. *e.g.* Earthworm
13. **Coprophagus :** Feed upon their own faeces (excreta). Coprophagy, also known as Reingestion takes place for complete digestion of cellulose in rabbit.

- **Digestion :** The process of conversion of complex food substances to simple absorbable forms is called **digestion** and is carried out by our digestive system by mechanical and biochemical methods. It is of two types:
  (i) **Intracellular digestion:** Digestion within cells *e.g. Amoeba.*
  (ii) Extracellular digestion: Digestion outside the cells. *e.g.* frog, rabbit, man.

DIGESTIVE SYSTEM OF MAMMALS

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

(A) Fore gut / Stomodaeum : Ectodermal. It includes buccal cavity / oral cavity.

(B) Mid gut / Mesodaeum : Endodermal. It includes pharynx, oesophagus, stomach, small intestine, and large intestine.

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

- Digestive system of man consists of alimentary canal and some accessory digestive organs.

The Alimentary Canal:

- It is a coiled muscular tube about 6 -9 metres long extending from mouth to anus.

Mouth:

- The mouth is an opening bounded by upper and lower lip.
- Lips are attached on the inner side with the gums by thin transparent fold called **Labial frenulum**.
- The space between lips and teeth is called **vestibule**.

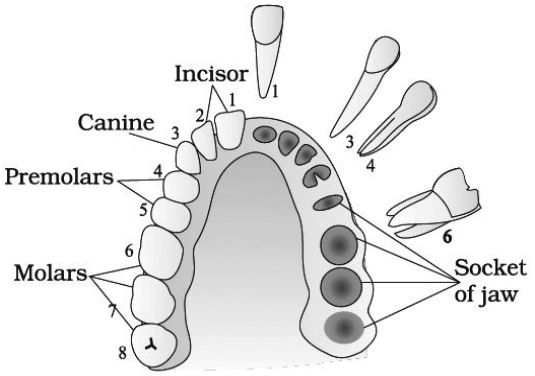
- The roof of buccal cavity is palate consisting of hard palate (maxilla, premaxilla and palatine bones) anteriorly and soft palate posteriorly.
- Mucus epithelium has thick transverse folds called **palatine rugae**.
- Terminal part of soft palate hangs in the throat called **uvula**. On sides of uvula tonsils are present which are made of lymphatic tissue.
- The floor of buccal cavity is occupied by a muscular tongue attached at base by a fold called **lingual frenulum**.
- Teeth present on upper and lower jaws are

  (i) Incisors: for cutting, have one root.

  (ii) Canines: for tearing, have one root.

  (iii) Premolars: for crushing, grinding and chewing, in upper premolar 2 roots and lower premolar 1 root.

  (iv) Molars: for chewing, in upper molar 3 roots and lower molar 2 roots.



Arrangement of different types of teeth in the jaws on one side and the sockets on the other side

Classification according to position

(i) Acrodont: Teeth are attached to the free surface or summit of the jaw bone. *e.g.,* fishes, amphibians and reptiles.

(ii) Pleurodont: Teeth fixed to lateral surface of jaw ridge *e.g.,* fangs of snakes.

(iii) Thecodont: Embedded in sockets and have well-developed roots (mammals and crocodiles).

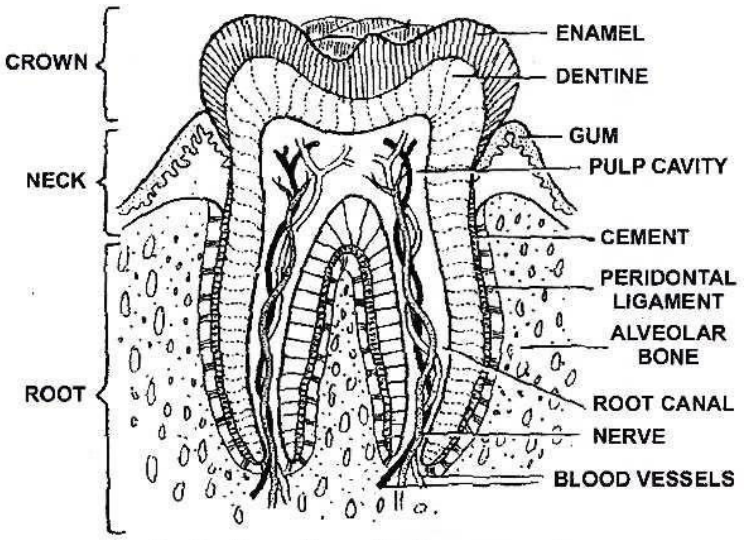
Classification according to arrangement of enamel and dentine :

(i) Bunodont - Small, blunt and rounded cusps *e.g.,* human

(ii) Lophodont - Intricate folding of enamel and dentine is present and cusps are connected by several transverse ridges (Iophos) *e.g.,* elephants.

(iii) Selenodont - Vertical crescent shaped cusps of hard enamel enclosing softer areas of dentine *e.g.,* sheep, cattle.

(iv) Secodont - Pointed cusps *e.g.,* carnivores.



Vertical section of a human molar

Dental formulae

In man, 20 teeth grow twice during life time *i.e.,* diphyodont $\left(\frac{2102}{2102}\right)$; (premolars and last molars absent In primary dentition) and 12 teeth appear only once *i.e.,* Monophyodont $\left(\frac{0021}{0021}\right)$.

Child = $i\frac{2}{2}; c\frac{1}{1}; pm\frac{0}{0}; m\frac{2}{2} = \frac{5}{5} \times 2 = \frac{10}{10} = 20$

17 yr. old = $i\frac{2}{2}; c\frac{1}{1}; pm\frac{2}{2}; m\frac{2}{2}; = \frac{7}{7} \times 2 = \frac{14}{14} = 28$

Adult = $i\frac{2}{2}; c\frac{1}{1}; pm\frac{2}{2}; m\frac{3}{3}; = \frac{8}{8} \times 2 = \frac{16}{16} = 32$

Rabbit: $i\frac{2}{1}; c\frac{0}{0}; pm\frac{3}{2}; m\frac{3}{3} \times 2 = 28$

Concept Builder

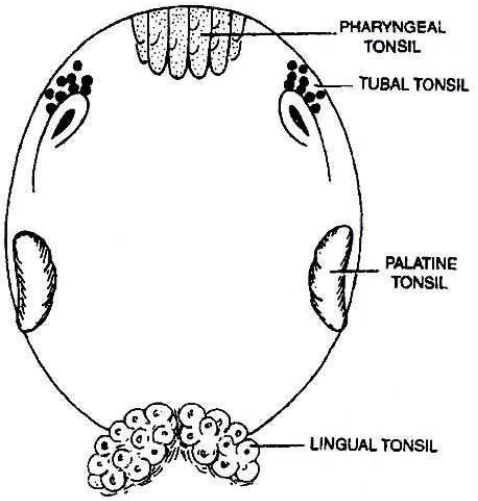
1. Canines are absent in rodents, this gap is called **diastema.**
2. In carnivores, one (last) premolar in upper jaw and one (first) molar in lower jaw are long and very sharp for cracking bones and called **carnassial** teeth.
3. In elephant, twe incisors of upper jaw keep on growing throughout life called **tusks.** (Teeth with persistent pulp)
4. Largest number of teeth in placental mammals are present in horse and pig (3143/3143).
5. **Enamel** (secreted by ameloblasts) -hardest substance of the body -Ectodermal in origin
6. **Dentine** (secreted by odontoblasts) main part of tooth-mesodermal in origin.
7. **Caries:** Decay of teeth due to degeneration of enamel and formation of cavities.
8. **Pyorrhoea:** Infected gums and tooth sockets.

9. Dental Formla :

Horse and pig	$\frac{3.1.4.3}{3.1.4.3} = 44$	Cat	$\frac{3.1.3.1}{3.1.2.1} = 30$
Dog	$\frac{3.1.4.2}{3.1.4.3} = 42$	Squirrel	$\frac{1.0.2.3}{1.0.1.3} = 22$
Lemur	$\frac{2.1.3.3}{2.1.3.3} = 36$	Rat	$\frac{1.0.0.3}{1.0.0.3} = 16$
Man	$\frac{2.1.2.3}{2.1.2.3} = 32$	Elephant	$\frac{1.0.0.3}{0.0.0.3} = 14$
Cow	$\frac{0.0.3.3}{3.1.3.3} = 32$	Permanent set milk set	$\frac{2.1.2.0}{2.1.2.0} = 20 / \frac{2.1.0.2}{2.1.0.2} = 20$

Tonsils

- Lymphoid tissue of pharynx is called tonsil. It includes:
  (i) Nasopharyngeal/pharyngeal tonsils/adenoids
  (ii) Palatine/faucial tonsils
  (iii) Lingual tonsils
  (iv) Tubal tonsils
  These are arranged in a ring like manner -**Waldeyer's ring.**



Waldeyer's ring

Self Assessment

When each tooth is embedded in a socket of jaw bone, then this type of attachment is called

(1) Thecodont (2) Lophodont (3) Secodont (4) Solenodont

Oral cavity leads into a short pharynx which serves as a common passage for

(1) Food only (2) Air only (3) Food and air (4) Digestive juices

Arrangement of teeth in each half of the upper and lower jaw in the order I, C, PM, M is represented by a dental formula which in humans is

(1) $\frac{2132}{2132}$ (2) $\frac{2123}{2123}$ (3) $\frac{2312}{2312}$ (4) $\frac{3212}{3212}$

Which of the following prevents the entry of food into the wind pipe?

(1) Glottis (2) Pharynx (3) Epiglottis (4) Both (1) & (2)

Frenulum is/are

(1) Adenoid present on pharyngeal wall

(2) Tonsils found on lateral walls of soft palate

(3) V-shaped sulcus dividing tongue into pharyngeal and oral parts

(4) Fold attaching tongue to the floor of oral cavity

Chewing is required for

(1) Solubilisation of food (2) Enjoying the taste of food

(3) Decreasing the surface area of food (4) Increasing the surface area of food

Hard chewing surface of teeth, made up of , helps in the mastication of food

(1) Dentine (2) Cementum (3) Enamel (4) Both (1) & (2)

Wharton's duct is associated with

(1) Brunner's gland (2) Sublingual salivary gland

(3) Submaxillary salivary gland (4) Parotid salivary gland

Thecodont, diphyodont and heterodont teeth are the characteristic of

(1) Reptiles (2) Aves (3) Amphibians (4) Mammals

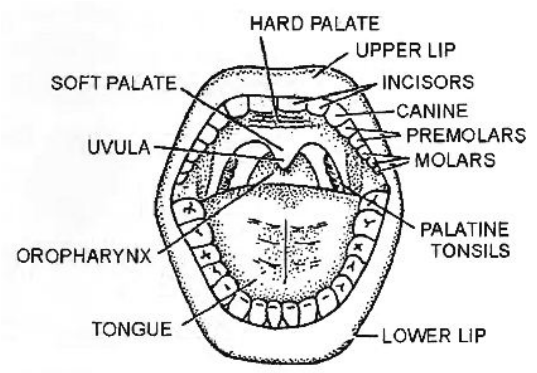
Adenoids are

(1) Tubal tonsils (2) Palatine tonsils (3) Lingual tonsils (4) Pharyngeal tonsils

Ans. Q.1 (1), Q.2 (3), Q.3 (2), Q.4 (3), Q.5 (4), Q.6 (4), Q.7 (3), Q.8 (3), Q.9 (4), Q.10 (4)

Tongue

- The tongue is a voluntary muscular and glandular structure which occupies the floor of the mouth.
- It is attached to the floor of the mouth by a fold called the **frenulum** of the tongue.
- An inverted V-shaped furrow called the **sulcus terminalis** divides the upper surface of the tongue into anterior oral part and posterior pharyngeal part.



Human oral cavity

- The apex of the sulcus terminalis projects backwards and is marked by a small median pit, named the foramen caecum.
- The foramen caecum is an embryological remnant and marks the site of the upper end of the thyroglossal duct. Oral part of the tongue has papillae on its surface.
- These are :

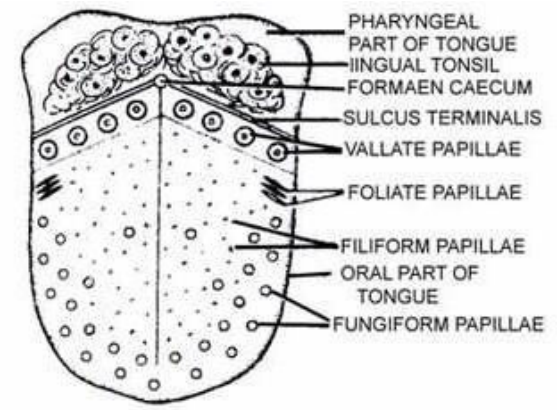
(i) **Filiform papillae :** smallest, most abundant and have no taste buds.

(ii) **Fungiform papillae :** appear as red dots on tongue and contain taste buds.

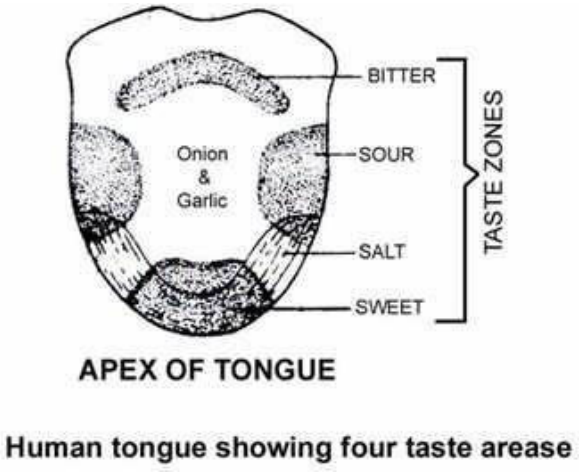
(iii) **Foliate papillae:** absent in man.

(iv) **Circumvallate papillae:** largest in size and knob like, also contain taste buds.

- The different areas of tongue are demarcated as follows:
  Tip – sweet
  Tip and sides – salt
  Sides – sour
  Base – bitter
  Sweat glands of dogs are present on tongue (panting of dog).



Upper surface of human tongua



Human tongue showing four taste arease

Salivary Glands

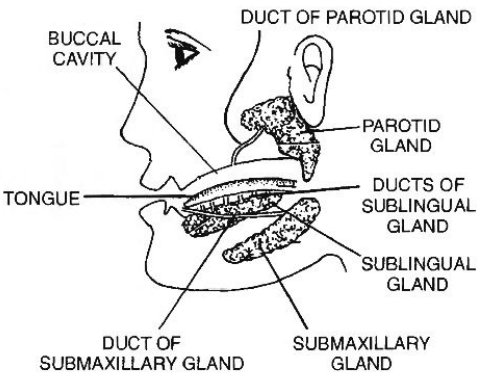
- Four pairs of salivary glands open in the mouth cavity:

(i) **Parotid:** Largest -present below and in front of ears -Stenson's duct.

(ii) **Submaxillary:** Medium sized -present at the angles of jaw lower -Wharton's duct

(iii) **Sublingual :** Smallest -located below the tongue - Rivinus duct.

(iv) **Infra orbital :** Absent in man, otherwise present below eyes *e.g.* , in rabbit.



Human salivary glands

- Daily Secretion of saliva is 1.5 litres, (pH of saliva is 6.7) and has salivary amylase (ptyalin), maltase and lysozyme.
- Salivary glands are stimulated to secrete saliva by parasympathetic innervation while sympathetic nerves causes reduced secretion leading to drying of mouth.
- Cl^- are required for activation of salivary amylase. Mumps is viral infection of salivary glands (mainly Parotid).
- Pharynx opens through gullet into the oesophagus and through glottis into the larynx.
- An elastic cartilage plate, epiglottis, covers the glottis at the time of swallowing. Food mixed with saliva in buccal' cavity-Bolus.

Oesophagus

- It is a long and thin tube, 25 cm long that pierces the diaphragm and enters the abdominal cavity.

- Oesophagus is characterised by :

(i) Absence of visceral peritoneum. Its outermost fibrous (non-coelomic) covering is called **tunica adventitia.**

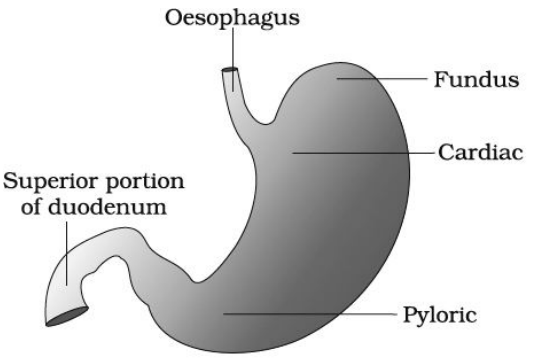
(ii) Absence of digestive glands. It has mucus-secreting goblet cells.

(iii) Presence of mucous membrane formed of non-keratinised stratified squamous epithelium some cells of which are ciliated.

(iv) Presence of voluntary (upper $1/3^{rd}$) and involuntary muscle fibres (lower $2/3^{rd}$).

Stomach

- Stomach is oval and pouch like organ, divisible into cardiac, fundic, main body and pyloric parts.
- Cardiac sphincter is present at the opening of oesophagus into stomach and prevents the regurgitation of food into oesophagus.
- The pyloric part opens into small intestine and opening is guarded by pyloric sphincter.

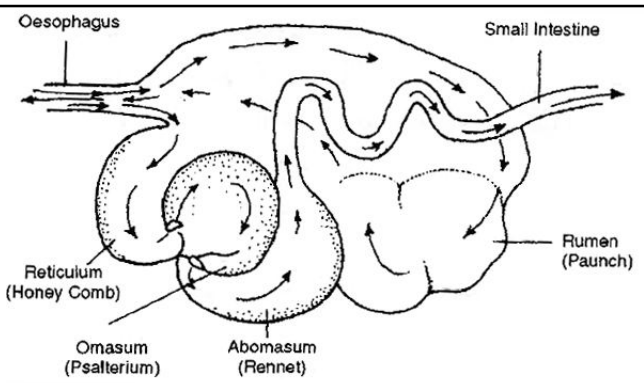


Anatomical regions of human stomach

- The wall of stomach has three layers of muscles, outermost longitudinal layer, middle circular layer and innermost of oblique layer.
- Mucosa has folds called **rugae** and **cardiac**, **fundic** and **pyloric glands**.
- Only fundic glands secrete gastric juice.
- These contain neck cells (secrete mucus and present in all three types of glands), oxyntic or parietal cells (secrete HCl and Castle's intrinsic factor for absorption of B_{12}).
- HCl of gastric juice converts Fe^{3+} into Fe^{2+} which makes the absorption of iron possible.
- Non-secretion of HCl (achlorhydria) or gastrectomy can lead to iron-deficiency anaemia.
- The peptic cells or chief cells or zymogenic cells release large quantity of pepsinogen and other enzymes.

Concept Builder

- The stomach of ruminants is known as **compound stomach**.
- It has 4 well defined chambers or compartments. viz., rumen, reticulum, omasum and abomasum.
- Rumen is the first and the largest chamber mainly meant for the storage of food.
- In camel and deer, omasum is absent and water cells project from rumen.
- Digestion of cellulose takes place by fermentation, with the help of symbiont bacteria and protozoans.
- Abomasum is the true stomach, which secretes gastric juices.
- Rumen and reticulum harbour large populations of anaerobic cellulolytic bacteria like *Rumenococcus* which secrete the cellulase enzyme for the fermentation of cellulose.
- Cellulose is simplified into small chain fatty acids.

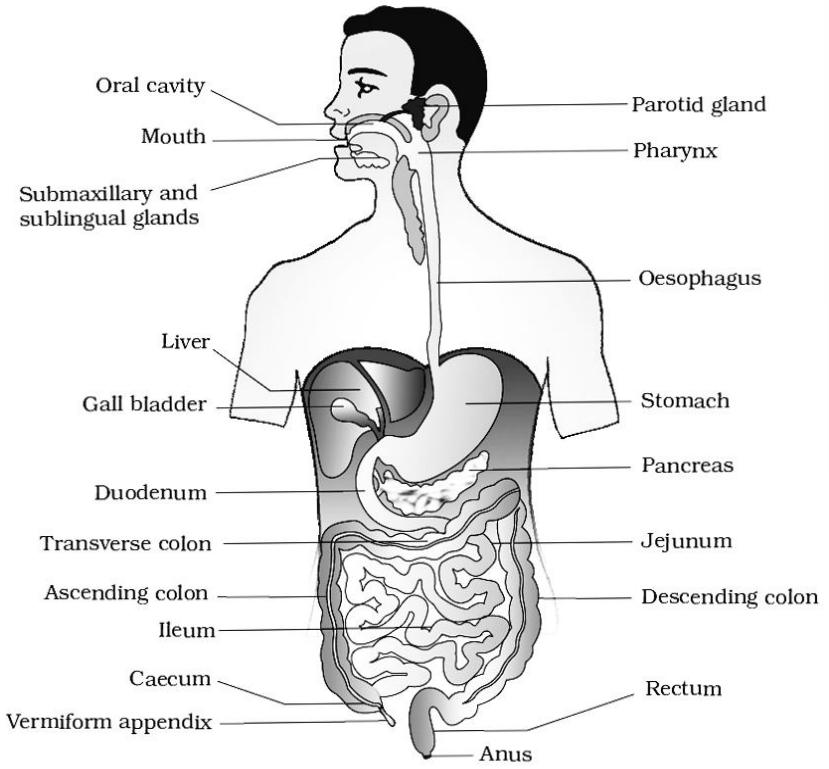


Stomach of a ruminate animal (Cow)

- Rabbits eat their own faeces (coprophagy) to complete the digestion of cellulose. It is taken as pseudorumination.
  Semisolid food mixed with gastric juices in stomach known as Chyme (it is highly acidic).

Small Intestine

- First part of small intestine is duodenum. It is 25 cm long, **U** or **C**-shaped in humans and receives the opening of hepatopancreatic duct (Bile duct + Pancreatic duct).
- A small swelling is present at the opening of hepatopancreatic duct and is called **'Ampulla of Vater'** or Hepatopancreatic ampulla and the opening is regulated by **sphincter of oddi**.
- Other parts of small intestine are **jejunum and ileum**.



Human Digestive System

- The wall of intestine has thin layers of longitudinal and circular muscles.
- Mucosa has folds called **plicae circulare** (folds of Kerkrings or Valvulae conniventes) and villi towards lumen of the intestine.

- Epithelial cells lining the villi have microvilli which further increase the absorptive area.
- Intestinal glands or **Crypts of Leiberkuhn** have epithelial cells (secrete mucus), **Paneth cells** (secrete digestive enzymes) and **argentaffin cells** (probably secrete hormones).
- In duodenum, **Brunner's glands** are also present (located in submucosa) which secrete mucus.
- Diffused patches of lymphoid tissues are present throughout the small intestine and are aggregated in ileum to form **Peyer's patches**.

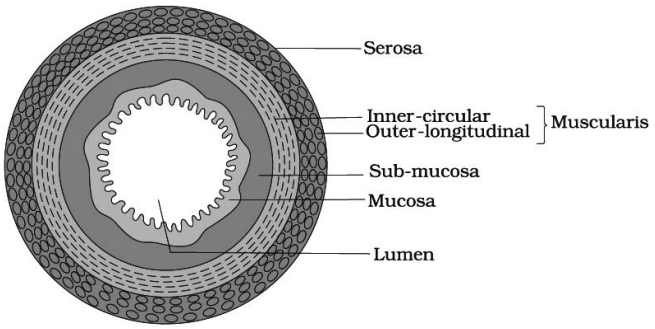
Large Intestine

- It is about 1.5 m long and consists of three parts -Caecum, Colon and Rectum.
- A blind pouch of caecum is **vermiform appendix**.
- These parts help in digestion of cellulose in herbivores.
- Wall of colon has sac like **haustra**.
- Histologically, wall of colon has three bands of longitudinal muscles called **taeniae coli**.
- Another characteristic of colon surface is the presence of small fat filled projections called **epiploic appendages**.
- The colon is divisible into ascending, transverse, descending and sigmoid colon.
- Ascending colon is the smallest part and lacks mesentry.
- Last part of rectum is anal canal having a strong sphincter. It opens outside by anus.

HISTOLOGY OF ALIMENTARY CANAL

- The alimentary canal consists of four basic layers. From the outer surface inward to the lumen (cavity), the layers are as follows :

1. **Visceral Peritoneum (= Serous membrane or Serosa) :** It is the outermost layer made up of squamous epithelium. It is continuous with the mesentery.



Diagrammatic representation of transverse section of gut

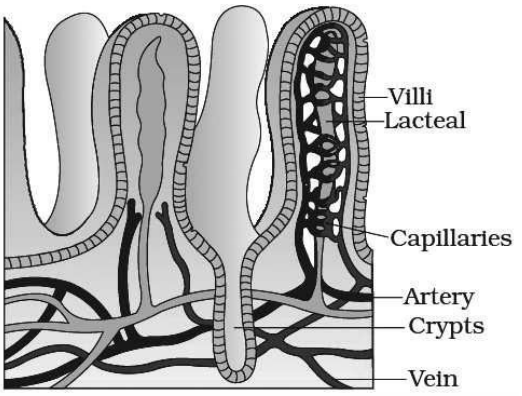
2. **Muscular Coat:** It is composed of outer longitudinal and inner circular muscle fibres. In the stomach, an additional layer of oblique muscle fibres is found inner to the circular muscle fibres. These muscle fibres are unstriped (smooth). The muscularis coat also contains the major nerve supply to the gastrointestinal tract -the myenteric plexus (plexus of Auerbach) which consists of fibres from both autonomic divisions and mostly controls the peristaltic movements in alimentary canal.
3. **Submucosa:** It consists of loose connective tissue richly supplied with blood and lymphatic vessels and in some areas with glands. Meissner's plexus (= submucosal plexus) is present

between the muscular coat and the mucosa which is part of the autonomic nerve supply to the smooth muscles and secretory cells of mucosal glands. This plexus controls various secretions of alimentary canal & movements of the mucosa.

4. **Mucosa (= Mucous membrane) :** It is so named because it secretes mucus to lubricate the inner lining of the gut. It is composed of three layers:

(i) The thin muscularis mucosa lies next to the submucosa. It consists of outer longitudinal and inner circular muscle fibres, both are unstriped.

(ii) The lamina propria, the middle layer of mucosa, consists of loose connective tissue, blood vessels, glands and some lymphoid tissue.



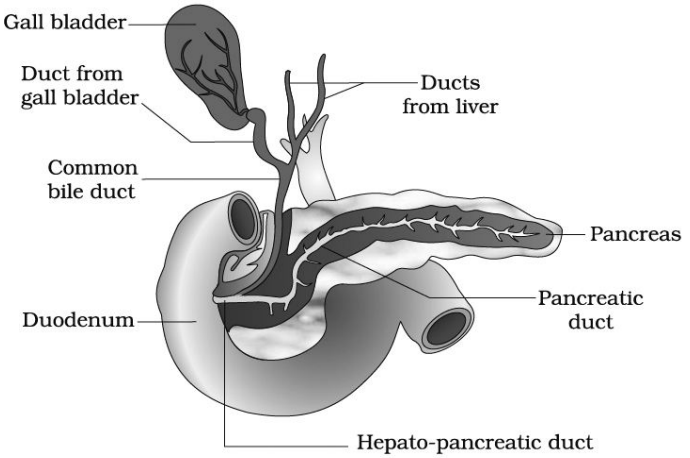
A section of small intestinal mucosa showing villi

(iii) The inner most layer is the epithelium, which forms gastric glands in stomach and villi and intestinal glands in small intestine.

DIGESTIVE GLANDS

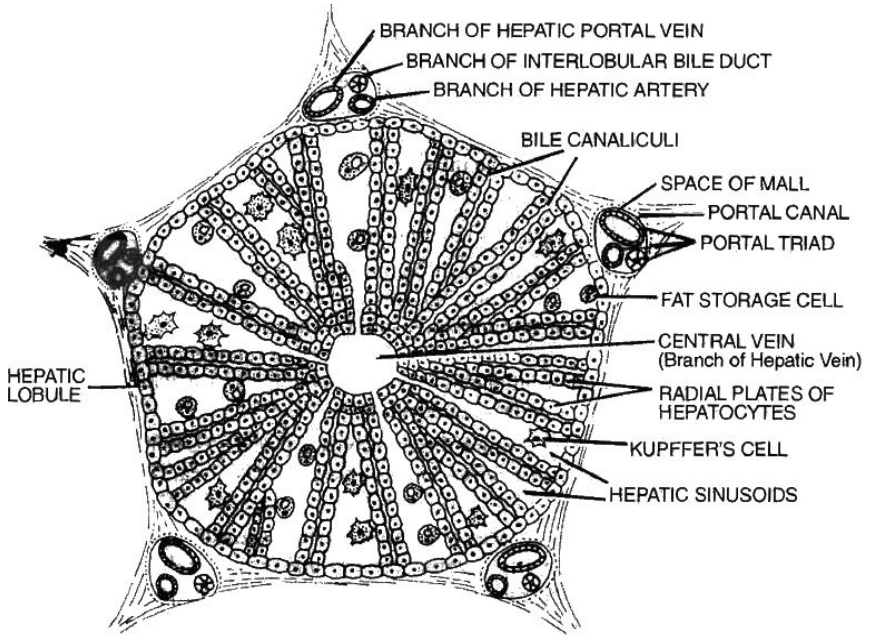
Liver

- Largest digestive gland. It lies in the upper right side of the abdominal cavity just below diaphragm.
- The liver is divided into two main lobes-right and left.
- Between the right and left lobes, falciform ligament is present.
- The right lobe is differentiated further into right lobe proper, a quadrate lobe and caudate lobe.



The duct systems of liver, gall bladder and pancreas

- Liver is surrounded by **Glisson's capsule,** its trabeculae divide liver lobes into hexagonal lobules.
- Polyhedral **hepatocytes** are arranged in cords around a central venule.
- **Portal triads** contain hepatic artery, portal venule, bile ductule and lymphatics.
- Blood sinusoids are present.
- **Kupffer cells** are present in sinusoids and are phagocytic.
- G**all bladder** is situated on the inferior surface of right lobe. It is 8 cm long and 2 cm wide.
- Bile is secreted by hepatocytes into the bile canaliculi, a series of narrow spaces between adjacent liver cells.
- The canaliculil drain via bile ductules into bile ducts, which run in portal tracts; the bile duct themselves discharge into the right and left hepatic ducts which unite to form the common hepatic duct at the hilum of the liver.



A part of transverse section of mammalian liver

- Gall bladder has a capacity of 30 to 50 ml. It consists of smooth muscles lined by columnar epithelium.
- It fills and empties via cystic duct which joins the common hepatic duct to form the bile duct; this in turn empties into the duodenum through **the ampulla of Vater** (hepatopancreatic ampulla).
- At the point of its entry into the duodenum, the bile duct and adjacent pancreatic duct join each other.
- The **sphincter of Boyden** surrounds the opening of bile duct.
- **Sphincter of oddi** surrounds the ampulla of Vater.

Concept Builder

1. During the Second World War (1939 -1945), many thousands of prisoners of war (POW) were disabled or killed by beriberi in German and Japanese POW camps.
   Sea faring fishermen sometimes eat raw fish from their catch. They may suffer from paralysis due to Vitamin B_1 deficiency, because raw fish muscle contains an enzyme which destroys thiamine. Cooked fish has no such no. effect because heat destroys that enzyme.
2. When sea water is drunk, its Mg^{2+} ions increase the solute concentration in the intestinal lumen because Mg^{2+} is absorbed very slowly. The osmotic effect of Mg^{2+} in the intestinal lumen prevents water absorption from the intestine. On the contrary, Mg^{2+}, draws water from the blood into the intestinal lumen by osmosis. So, water is not gained, but lost from the blood on drinking sea water. In acute constipation purgatives containing magnesium salts (magnesium sulphate) are generally used. They increase the fluidity and volume of intestinal contents in the same way. This consequently stimulates intestinal peristalsis and evacuation of fluid faeces.

Conceptual Questions

Which of the basic nutrients might a person need to restrict after an operation to remove the gallbladder? Why?

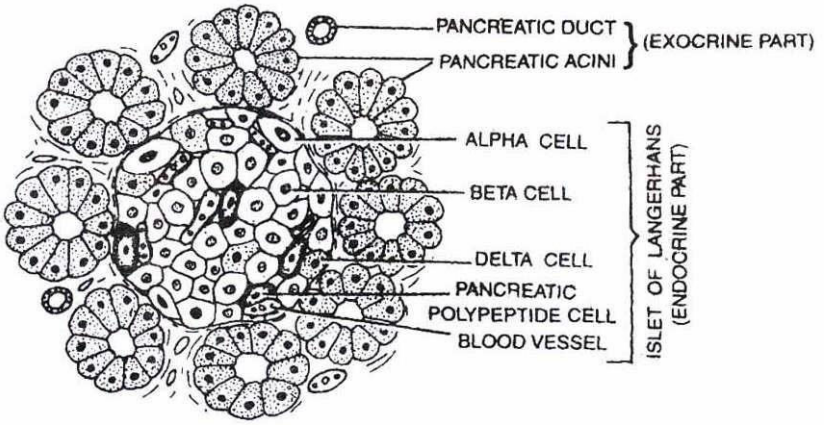
Why would large doses of vitamin B_2 be less harmful than large doses of Vitamin A?

Ans. 1. Fat; the gall bladder stores bile which is released for the emulsification of fats helping in fat digestion.

2. Vitamin B_2 is water soluble, which means excess amounts can be quickly excreted. Vitamin A is fat soluble, which means it cannot be quickly excreted and may be stored in body causing hypervitaminosis.

Pancreas

- It is a racemosely branched gland, situated between stomach and duodenum.
- Pancreas consists of acini (which secrete digestive enzymes) and islets of Langerhans (which secrete insulin and glucagon hormones).
- Pancreas has two ducts within it.
- The first is **duct of Santorini** which is accessory or nonfunctional, opening directly into duodenum and the other is **duct of Wirsung** which is functional and combines with bile duct to form common hepatopancreatic duct.



Section of pancreas

MOBILITY OF ALIMENTARY CANAL

- Alimentary canal undergoes regular contraction for proper digestion and absorption of food.
- Food enters into buccal cavity where it is mixed with saliva.
- Food is masticated with the help of teeth causing the mechanical breakdown of food.
- Salivary enzymes (Ptyalin-salivary amylase) cause chemical breakdown of food (Carbohydrates).
- Smaller food particles are held together by the mucin of saliva forming the food bolus which is then swallowed.
- The swallowing involves two phases :

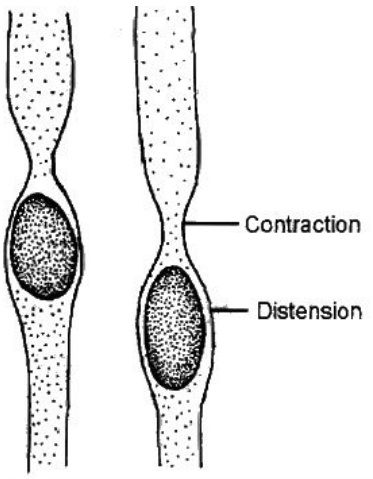
1. **Buccal Phase/Voluntary Phase:** Starts by pressing the tongue against hard palate giving a backward push to the food bolus.

2. **Pharyngeal Phase/Involuntary Phase:** Soft palate is raised up, straightening the uvula part; cutting off the nasopharynx. Larynx moves up to raise the epiglottis covering the glottis.

- As a result of this co-ordinated activity of tongue, soft palate, pharynx, the food bolus gets swallowed *i.e.* enters oesophagus.
- Waves of contraction or peristaltic waves in oesophagus push it downward.
- As the food reaches the end of oesophagus, the cardiac sphincter-regulating opening of oesophagus into stomach, relaxes to allow entry of food into stomach.
- If the sphincter fails to open up properly, it leads to accumulation of food in the lower part of oesophagus -**Cardia achalasia**.
- From stomach, acidic chyme enters the small intestine where digestion is completed followed by absorption of digested food.
- From small intestine, chyle enters large intestine and is finally egested.
- Movements in the alimentary canal are caused by myenteric plexus as well as hormones like motilin, serotonin, villikinin, gastrin etc.

Peristalsis:

- It involves contractions and relaxations resulting in wave like movements.
- Contraction is due to contraction of circular muscles and relaxation of longitudinal muscles. Relaxation is caused by simultaneous contraction of longitudinal muscles and relaxation of circular muscles.
- Peristaltic movements start from oesophagus.
- Churning movements of stomach are also peristaltic movements which become powerful as they proceed towards pylorus.
- In large intestine, peristaltic movements are moderately weak.



Peristaltic Movements

Self Assessment

Stomach has three major portions. In which portion of stomach does the oesophagus open?

(1) Fundic (2) Pyloric (3) Cardiac (4) Fundic and Pyloric

Which of the following statement is **incorrect** w.r.t. histology of alimentary canal?

(1) Serosa is the outermost layer made up of a thin mesothelium with some connective tissue

(2) Muscularis is formed by smooth muscles usually arranged into an inner longitudinal layer and outer circular layer

(3) Submucosal layer is formed of loose connective tissue

(4) An oblique muscle layer may be present in stomach

Brush border columnar epithelium is the lining of

(1) Stomach (2) Oesophagus

(3) Proximal convoluted tubules (4) Small intestine

Duct of the gall bladder is called

(1) Hepatic duct (2) Common bile duct (3) Cystic duct (4) Stenson's duct

Opening of hepatopancreatic duct into the duodenum is guarded by

(1) Pyloric sphincter (2) Sphincter of boyden

(3) Sphincter of oddi (4) Cardiac sphincter

Ileum is characterised by the presence of

(1) Brunner's glands and villi (2) Brunner's gland and Peyer's patches

(3) Peyer's patches and villi (4) Brunner's gland and Taeniae coli

In which layer of stomach are the gastric glands located?

(1) Serosa (2) Mucosa (3) Submucosa (4) Muscularis mucosa

The toxic substances in the diet are detoxified in human body by

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

Which of the following does not produce any digestive enzyme?

(1) Pancreas (2) Colon (3) Stomach (4) Duodenum

Which of the following structure controls the peristaltic movement of alimentary canal?

(1) Myenteric plexus (2) Auerbach plexus (3) Meissner's plexus (4) Both (1) & (2)

Ans. Q.11 (3), Q.12 (2), Q.13 (4), Q.14 (3), Q.15 (3), Q.16 (3), Q.17 (2), Q.18 (1), Q.19 (2), Q.20 (4)

DIGESTION AND GASTRO-INTESTINAL SECRETlo.NS

Digestion of Carbohydrates :

- The diet of most of the animals including man consists of carbohydrates.
- Depending upon the complexity, carbohydrates are of three types : **polysaccharides**, **disaccharides** and **monosaccharides**.
- During the process of digestion, both poly and disaccharides are broken down to monosaccharides and in this form they can be absorbed into the body.
- Some of these complex carbohydrates are starch and cellulose present in cereal grains, potato, fruits and tubers; sucrose present in cane sugar; lactose present in milk etc.
- Enzymes that act on carbohydrates are collectively known as **carbohydrases**.
- Pancreatic juice and intestinal juice also contain carbohydrate digesting enzymes.
- Pancreatic juice contains pancreatic amylase that acts on starch to digest it into maltose, isomaltose and dextrin.
- The secretions of the brush border cells constitute the intestinal juice or succus entericus.
- This juice contains a variety of enzymes like disaccharidases *(e.g.,* maltase), dipeptidases, lipases, nucleosidases etc.

$$\text{Starch} \xrightarrow{\text{Amylase}} \text{Maltose + Isomaltose + Dextrin}$$

$$\text{Maltose + Isomaltose + Dextrin} \xrightarrow[\text{Isomaltase}]{\text{Maltase}} \text{Glucose}$$

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

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

Digestion of Proteins:

- Proteins are complex organic compounds made up of smaller units called **amino acids**. So in the process of digestion, all proteins are broken down to amino acids.
- Enzymes that hydrolyse proteins are collectively known as **proteases** or **peptidases**.
- Many of these enzymes are secreted in their inactive form or proenzymes as their active form would hydrolyse cellular and extracellular proteins of the organism itself.
- Inactive enzymes are converted to their active form only at the site of action.
- Saliva as such does not contain any protein digesting enzyme, but it can denature the uncooked natural proteins like the ones present in raw egg, unboiled milk or uncooked germinating seeds.
- However, this is not a process of hydrolysis as in digestion.

Action of Gastric Juice:

- The gastric glands of stomach produce a light coloured, thin and transparent gastric juice.
- It contains water, hydrochloric acid (0.3%) and inactivated enzymes prorennin and pepsinogen.
- The presence of HCl makes the medium highly acidic (pH = 1 or 2) so that pepsin can act on proteins to convert them into peptones and proteoses.
- However, there is no pepsin in invertebrates.
- Both prorennin and pepsinogen are converted to their active forms in the presence of HCl.
- Pepsin and rennin can also do the same function once they are formed.
- HCl also helps to kill bacteria and other harmful organisms that may be present along with the food.
- Rennin acts on the casein protein of milk and converts it into paracasein which in the presence of calcium ions forms calcium paracaseinate (curdling of milk).
- The function of rennin is then taken over by pepsin and other milk-coagulating enzymes. Pepsin then acts on it.
- These reactions are summarized below :

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

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

$$\text{Milk Casein} \xrightarrow{\text{Rennin}} \text{Paracasein}$$

$$\text{Paracasein} + Ca^{++} \longrightarrow \underset{\text{(curdling of milk)}}{\text{Calciumparacaseinate}}$$

$$\text{Calcium paracaseinate} \xrightarrow{\text{Pepsin}} \text{Peptones and proteoses}$$

Action of Pancreatic and Intestinal Juice:

- Both pancreatic juice and intestinal juice (succus entericus) are poured into small intestine.
- Pancreatic juice contains trypsinogen, chymotrypsinogen, procarboxypeptidases, lipases, amylases or amylopsin, DNAases and RNAases.
- All these enzymes of pancreatic juice can act only in the alkaline medium.
- This change in the medium of food, from acidic to alkaline, is done by the bile juice.
- Therefore, bile juice acts on the food before the action of pancreatic juice.

- All these actions are given below :

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

  Peptones and proteoses $\xrightarrow{\text{Trypsin}}$ Peptides

- Chymotrypsinogen (inactive) is activated to chymotrypsin by trypsin itself.
- Chymotrypsin is another important milk coagulating enzyme and can hydrolyse casein into paracasein which then coagulates to form calcium paracaseinate.
- However unlike rennin, it acts in the alkaline medium.
- Chymotrypsin can act on other proteins also.

Concept Builder

- Carboxypeptidase hydrolyses the terminal carboxyl group from peptide bonds to release the last amino acid from the peptides thus making the peptide shorter.
- Intestinal juice or succus entericus contains two protein digesting enzymes aminopeptidases and dipeptidases. Aminopeptidase hydrolyses the terminal amino group from peptide bonds to release the last amino acid from the peptides thus making the peptide shorter. Dipeptidase acts on dipeptides to release the individual amino acids. Enterokinase activates trypsinogen to trypsin.

Digestion of Fats:

- Fat digestion starts only when the food reaches the stomach.
- Some amount of gastric lipase is present.
- Gastric lipase is of little importance except in pancreatic insufficiency.
- Most of the fat digestion begins in the duodenum, pancreatic lipase being one of the most important enzymes involved.
- Bile juice contains bile salts that break down the bigger molecules of fat globules into smaller droplets by reducing the surface tension of fat droplets.
- This process is known as **emulsification** of fats.
- Lipase is the chief enzyme that acts on emulsified fats.
- It is present both in the pancreatic juice and intestinal juice.
- Pancreatic lipase (steapsin) is the principal enzyme involved in fat digestion.
- Lipase converts emulsified fats into diglyceride and monoglycerides releaSing fatty acids at each step.
- At the end of digestion, all fats are converted into fatty acids, glycerol and monoglycerides.

Digestion of Nucleic Acid

- Nucleic acids are digested in the small intestine with the help of pancreatic and intestinal juice. Pancreatic juice contains two nucleases -DNAase and RNAase.
- Intestinal juice contains nucleotidase and nucleosidase.

  DNA $\xrightarrow{\text{DNase}}$ Deoxyribonucleotides

  RNA $\xrightarrow{\text{RNase}}$ Ribonucleotides

Nucleotides (Deoxyribonucleotides / ribonucleotides) —Nucleotidase→ Nucleosides (Deoxyribonucleosides / ribonucleosides) + Inorganic phosphate

Nucleosides (Deoxyribonucleosides / ribonucleosides) —Nucleosidases→ Nitrogenous base (Purine / pyrimidine) + Pentose sugar

Summary of chemical digestion of food

Chemical digestion of protein	Chemical digestion of carbohydrates	Chemical digestion of fats	Chemical digestion of nucleic acid
Protein Food ↓ Pepsin (gastric juice) **Proteoses and Peptones** ↓ Trypsin and Chymotrypsin (pancreatic juice) **Tri and Dipeptides** ↓ Peptidases (intestinal juice) **Amino acids** (monopeptides)	**Polysaccharides** (starches) ↓ Ptyalin (saliva), Amylase (pancreatic juice) **Disaccharides** (sugars) Maltase, Lactase Sucrase (intestinal juice) **Monosaccharides** (glucose, fructose, galactose)	**Fat** ↓ Bile salts (bile) **Emulsified Fats** ↓ Lipase (pancreatic and intestinal juice) **Fatty acids and glycerol**	**Nucleid acid** (DNA and RNA) ↓ Pancreatic nucleases (DNAase & RNAase) **Nucleotides** ↓ Intestinal Nucleotidases and Nucleosidases **Nitrogen bases** Pentose sugars and inorganic phosphate

Summary of Digestion

Part of alimentary tract	Name of glands	Enzyme	Optimum pH	Substrate (acted upon)	End products
Buccal Cavity	Salivary glands	Salivary amylase (Ptyalin)	6.8	Starch	Maltose
Oesophagus	—	No enzyme	–	–	–
Stomach	Fundic glands/main gastric glands	1. Pepsin 2. Rennin (only in calves of ruminants) and some amount in human infants 3. Gastric lipase	1.8 – 3.2	Proteins Casein (milk protein) Fats	Peptones Ca-paracaseinate Glycerol and fatty acids
Liver	Hepatocytes	Bile (no enzyme)	7.1 – 8.2	Fats	Emulsify fats
Pancreas	Acini	1. Trypsin	7.1 – 8.3	Proteins	Peptones and polypeptide

		2. Chymotrypsin 3. Carboxy-peptidase 4. Amylase (Amylopsin) 5. Lipase (Steapsin) 6. Nucleases		Blood Proteins Milk Proteins Peptides Starch Fats RNA, DNA	Coagulation Coagulation Dipeptides and amino acids Maltose Glycerol and fatty acids Nucleotides
Small Intestine	Crypts of Leiberkuhn	1. Enterokinase 2. Erepsin 3. Dipeptidas 4. Lipase 5. Maltase 6. Sucrase 7. Lactase 8. Nucleotidase 9. Nucleosidase	7.6	Trypsinogen Peptides Dipeptides Fats Maltose Sucrose Lactose Nucleotides Nucelosides	Trypsin Dipeptide and amino acids Amino acids Glycerol and fatty acids Glucose Glucose, fructose Glucose, galactose Nucleosides Free bases
Large Intesine		No digestive enzyme, only mucus	–	Lubricates faeces	–

Control of Enzyme Secretion

Part of alimentary canal	**Hormone**	**Stimulation**	**Inhibition**
Epithelium of stomach	Gastrin	HCl and pepsin	–
Epithelium of duodenum	Enterogastrone	–	HCl
	Secretin	Pancreatic juice (increase amount of bicarbonates and water)	–
	Duocrinin	Release of mucus in duodenum	–
	Cholecystokinin pancreozymin (CCK-PZ)	Digestive enzyme in pancreatic juice contraction of gall bladder	–
Epithelium of duodenum and ileum	Enterocrinin	Succus entericus	–
Intestinal villi	Villikinin	Movement of villi to increase absorption	–

Self Assessment

Which of the following sphincter controls the passage of food into the stomach?

(1) Upper oesophageal sphincter (2) Gastro-oesophageal sphincter

(3) Pyloric sphincter (4) Oesophageal sphincter

Which of the following is **not** a component of saliva?

(1) Electrolytes Na^+, K^+, Cl^- and HCO_3^- ions

(2) Ptyalin / α-salivary amylase

(3) Mucin, lysozyme and thiocyanate ions

(4) Antibody (lgG)

Tick mark the **false** statement.

(1) About 60% starch is hydrolysed in buccal cavity by the enzyme salivary amylase

(2) Salivary amylase acts on starch and is converted into maltose

(3) Salivary amylase acts at optimum pH 6.8

(4) Stomach stores the food for 4-5 hours

Which of the following is mismatched regarding the cells of gastric glands and their functions?

(1) Mucus neck cells : Secrete mucus

(2) Chief cells : Secrete proenzyme (pepsinogen)

(3) Parietal cells : Secrete intrinsic factor for the absorption of vitamin 8_{12}

(4) Peptic cells : Secrete HCl

Choose the **correct** answer among the following:

Gastric juice contains

(1) Pepsin, rennin, lipase (2) Trypsin, rennin, pepsin

(3) Pepsin, rennin, amylase (4) Pepsin, lipase, trypsin

Succus entericus is the name given to

(1) A junction between ileum and large intestine

(2) Intestinal juice

(3) Swelling in gut

(4) Appendix

Match Column I with Column II

Column I	**Column II**
a. Pancreatic juice	(i) Bilirubin and biliverdin
b. Intestinal juice	(ii) Maltase
c. Bile juice	(iii) Trypsin, Carboxypeptidase
d. Succus entericus	(iv) Enterokinase

(1) a(iv), b(iii), c(ii), d(i) (2) a(iii), b(iv), c(ii), d(i)

(3) a(iii), b(iv), c(i), d(ii) (4) a(ii), b(iii), c(i), d(iv)

Which of the following reaction is not catalysed by brush border enzymes?

(1) Maltose $\xrightarrow{\text{Maltase}}$ glucose + glucose (2) Lactose $\xrightarrow{\text{Lactase}}$ glucose + galactose

(3) Nucleotides $\xrightarrow{\text{Nucleotidase}}$ Nucleosides (4) Nucleic acids $\xrightarrow{\text{Nucleases}}$ Nucleotides

The enzymes of which of the following juice acts on the end products of reactions to form simple absorbable forms?

(1) Pancreatic juice (2) Succus entericus

(3) Saliva (4) Bile juice

Which of the following is **not** a function of large intestine?

(1) Absorption of water, minerals and certain drugs

(2) Secretion of mucus which helps in adhering the waste particles together and lubricating it for an easy passage

(3) Faeces enters into the caecum of the large intestine through ileocaecal valve

(4) Significant digestive activity occurs in large intestine

Ans. Q.21 (2), Q.22 (4), Q.23 (1), Q.24 (4), Q.25 (1), Q.26 (2), Q.27 (3), Q.28 (4), Q.29 (2), Q.30 (4)

Absorption of digested products

- Absorption is the process by which the end products of digestion pass through the intestinal mucosa into the blood or lymph.
- It is carried out by passive, active or facilitated transport mechanisms.
- Small amounts of monosaccharides like glucose, amino acids and some of electrolytes like chloride ions are generally absorbed by simple diffusion.
- The passage of these substances into the blood depends upon the concentration gradients.
- However, some of the substances like fructose and some amino acids are absorbed with the help of the carrier ions like Na^+.
- This mechanism is called the facilitated transport.
- Transport of water depends upon the osmotic gradient.
- Active transport occurs against the concentration gradient and hence requires energy.
- Various nutrients like amino acids, monosaccharides like glucose, electrolytes like Na^+ are absorbed into the blood by this mechanism.
- Fatty acids and glycerol being insoluble, cannot be absorbed into the blood.
- They are first incorporated into small droplets called **micelles** which move into the intestinal mucosa.
- They are re-formed into very small protein coated fat globules called the **chylomicrons** which are transported into the lymph vessels (Iacteals) in the villi.
- These lymph vessels ultimately release the absorbed substances into the blood stream.
- Absorption of substances takes place in different parts of the alimentary canal, like mouth, stomach, small intestine and large intestine.
- However, maximum absorption occurs in the small intestine. A summary of absorption (sites of absorption and substances absorbed) is given in table.

Table: The Summary of Absorption in Different Parts of Digestive System

Mouth	Stomach	Small Intestine	Large Intestine
Certain drugs coming in contact with the mucosa of mouth and lower side of the tongue are absorbed into the blood capillaries lining them.	Absorption of water, simple sugars, and alcohol etc. takes place.	Principal organ for absorption of nutrients. The digestion is completed here and the final products of digestion such as glucose, fructose, fatty acids, glycerol and amino acids are absorbed through the mucosa into the blood stream and lymph.	Absorption of water, some minerals and drugs takes place.

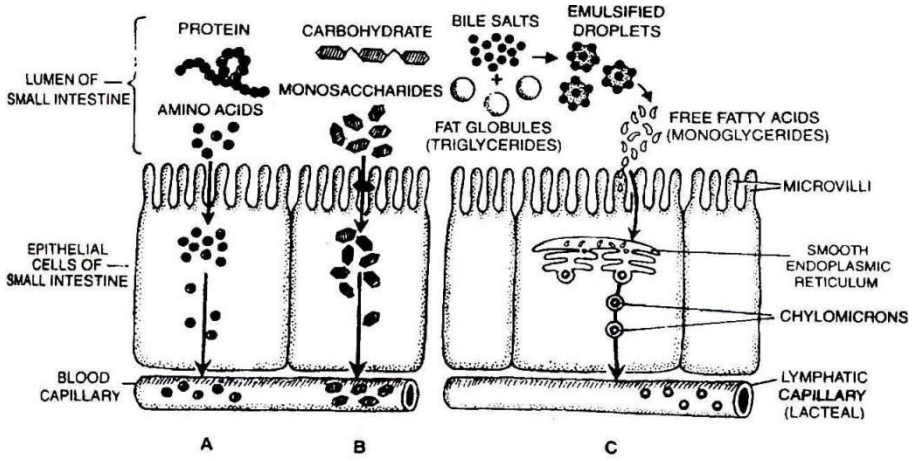
- The absorbed substances finally reach the tissues which utilise them for their activities. This process is called **assimilation**.
- The digestive wastes, solidified into coherent faeces in the rectum initiate a neural reflex causing an urge or desire for its removal.
- The egestion of faeces to the outside through the anal opening (defaecation) is a voluntary process and is carried out by a mass peristaltic movement.

Concept Builder

Absorption :

- Almost no absorption takes place in mouth and oesophagus.
- In the stomach, water, alcohol, simple salts and glucose are absorbed.
- In the small intestine, absorption of all digested materials takes place by active, passive and facilitated transport.
- Glucose, sodium and aminoacids are absorbed actively.
- Absorption of glucose or aminoacids involves carrier mediated transport which binds glucose/amino acid at one site and Na^+ at the other site.
- Therefore, the movement of glucose/amino acid is coupled to the concentration gradient of Na^+ (Go transport).
- Na^+ is moving along concentration gradient while glucose/amino acids are moving against the concentration gradient.
- Rate of absorption of galactose is the highest.
- Fructose is absorbed by facilitated diffusion.
- The products of fat digestion -monoglycerides, fatty acids and glycerol are first incorporated into water soluble droplets called **micelles** (a combination of fatty acids, monoacylglycerides and bile salts); reconstructed to triglycerides in the absorptive cells and released into lymph in the form of protein-coated water soluble fat droplets called **chylomicrons**.

- In the large intestine, only water is absorbed.
- Absorption of vitamin B_{12} (cobalamine) in man requires a glycoprotein called **intrinsic factor** (IF) secreted by the parietal cells of the stomach.
- Failure to absorb cobalamin causes pernicious anaemia associated with a failure of RBG maturation (megaloblastic anaemia) and neurological abnormalities.



Assimilation of Food

- The absorbed food materials are transported by **blood** and **lymph.**
- Lymph is finally transferred to the blood circulation.
- The blood transports absorbed food materials to different body cells where food materials become an integral component of the living protoplasm and are used for energy, growth and repair. This is called **assimilation** of food.

(i) **Amino acids** are not stored but are taken up by the cells for the synthesis of proteins. Proteins are used for growth, repair, etc. Excess amino acids can be converted into glucose and then to fat and are thus stored. Amino acids can also be converted to glucose and used as fuel for the cell. During their conversion to glucose the amino acids are deaminated (removal of amino groups $–NH_2$). The liver is chief site for **deamination,** *i.e.*, a process by which the amino group is removed from the amino acids resulting in the production of ammonia. The ammonia is soon converted into urea, which is filtered from the blood in the kidneys.

(ii) The excess of the **monosaccharides;** glucose, fructose and galactose are usually stored in the liver and muscle cells in the form of glycogen (glycogenesis). Whenever there is a deficiency of glucose in the blood, glycogen is converted into glucose (glycogenolysis). Muscle glycogen is utilized during muscle contraction. Glucose is utilized in the production of energy for various body activities. A considerable amount of glucose is converted into fat and stored as such.

(iii) The **fat** is stored in the fat deposits of the body, such as subcutaneous layers, mesenteries, etc. The fat stored is a readily available source of fuel for the cells. Fat has important insulating properties in connection with the conservation of heat and maintenance of body temperature. Fat also plays a protective role as filling or packing material between and around various organs. In liver, phospholipids are formed, which are returned to the blood to be used by all the cells.

Vitamins, salts and water are also useful for various metabolic processes.

Egestion

- Peristalsis gradually pushes the slurry of indigestible materials of the small intestine into the large intestine or colon.
- Approximately, 1500 ml of chyme normally passes into the large intestine each day.
- The colon absorbs most of the water, electrolytes and ions from these contents.
- This is accomplished by active pumping of sodium and water by osmosis from the chyme.
- The other function of colon is to help in the excretion of excess salts from the blood.
- The population of *Escherichia coli* (bacterium), which is resident species of the colon, lives on this undigested matter.
- This bacterium in turn, produces vitamin B_{12}, vitamin K, thiamine, and riboflavin that are absorbed across the waif of the colon.
- Later on the chyme is slowly solidified into coherent faeces, which are about three fourth water and one-fourth solid matter consisting of about 10-20% inorganic substance 30 per cent dead bacteria, 10 to 20 per cent fat, 2 to 3 per cent protein and 30 per cent undigested roughage and dry constituents of digestive juices.
- Faeces are given out through the anus by the process of defecation or **egestion.**
- Breakdown of bile pigments occurs forming stercobilin pigment which provides brownish colour to it.
- Foul smell of the faecal matter is because of microbial gases $\rightarrow$ skatole (3-methyl indole).
- Dark green mucilaginous material in the intestine of the full term fetus is called **meconium** (includes residue from the swallowed amniotic fluid by fetus and the residues of excretory products from intestinal mucosa and glands).

Disorders of Digestive System

- The inflammation of the intestinal tract is the most common ailment due to bacterial or viral infections. The infections are also caused by the parasites of the intestine like tape worm, round worm, thread worm, hook worm, pin worm, etc.

  Jaundice: The liver is affected, skin and eyes turn yellow due to the deposit of bile pigments.

  Vomiting : It is the ejection of stomach contents through the mouth. This reflex action is controlled by the vomit centre in the medulla. A feeling of nausea precedes vomiting.

  Diarrhoea: The abnormal frequency of bowel movement and increased liquidity of the faecal discharge is known as **diarrhoea**. It reduces the absorption of food.

  Constipation: In constipation, the faeces are retained within the rectum as the bowel movements occur irregularly.

  Indigestion: In this condition, the food is not properly digested leading to a feeling of fullness. The causes of indigestion are inadequate enzyme secretion, anxiety, food poisoning, over eating and spicy food.

NUTRITIONAL REQUIREMENTS OF HUMANS

Energy Yielding Nutrients

- Carbohydrates are used primarily as sources of chemical energy, to be either metabolised immediately as glucose or stored as glycogen.
- The synthesis of glycogen is called **glycogenesis.**

- The liver can store enough glycogen to maintain blood glucose level for several hours. Under acute starved conditions, the liver cells begin to convert fatty acids and the glycerol (digestive products of fat molecules) into glucose.
- Such production of new glucose is known as **gluconeogenesis.** Proteins are used as structural components of tissues, as channels, transporters, regulatory molecules and enzymes.
- Proteins can also be utilised as energy sources, when broken down to amino acids.
- Out of the 20 amino acids identified so far as the constituents of proteins, 8 (10 in children) cannot be synthesised in human body.
- These must be provided in the diet from outside are designated as **essential amino acids.**
- Lipid (fat) molecules are especially suitable as concentrated energy reserves.
- The fat cell of adipose tissues are often called the **fat depot** of body.
- Triglycerides are used as **fuel.**
- Human body is able to synthesise most of the lipids in enough quantity, except three polyunsaturated fats, such as linoleic, linolenic and arachidonic acids.
- These **essential fatty acids** must be provided to the human body through diets.

Minerals and Vitamins

- Both minerals and vitamins occur as small molecules and mostly, do not require digestion.
- Minerals are ingested as salts dissolved in water or as part of organic compounds (food).
- Still, a few of the minerals are absorbed with the aid of digestive Juices (like bile) and gastric juices.
- Of the twenty-one essential minerals required by man, some are important for maintaining fluid balance whereas others help to regulate metabolism by acting as a component of enzymes.
- Vitamins are essential for normal metabolism, growth and sound health.
- Humans can synthesise vitamin A (retinol) with the help of plant pigment, carotene, which is available in yellow and green leafy vegetables.
- Vitamin A forms retinal pigment of human eyes, such as rhodopsin of rod cells and iodopsin of cone cells.
- Humans can also synthesise vitamin D (calciferol) in their skin in presence of ultra-violet rays. Although most animals can synthesise vitamin C from glucose, humans cannot; hence, they require it in their diet.

Minerals

1. **Copper:** Present in all body tissues. Highest amounts in brain, heart and kidney. Deficiency causes anaemia. Excess deposition of copper in liver causes Wilson's disease.
2. **Iodine (I) :** Thyroxine and other compounds of thyroid gland which contain iodine (1_2) as essential component, serve important physiological functions. Energy metabolism is retarded in absence of thyroxine. Thyroxine is needed for normal growth and development. Hyposecretions of thyroxine retard growth.
3. **Sulphur (S) :** It is found in sulphur containing amino acids *i.e.* cysteine and methionine. It is also present in saliva, bile and insulin but synthesized in the body with the help of cysteine and methionine.

Mineral Nutrition

The mineral elements which perform certain essential functions in the animal bodies.

1. **Calcium (Ca) :** Helps in formation of body structure like bones. Serum calcium is maintained at the normal level by parathyroid. Certain enzymes as lipases and ATP ase etc. require calcium for activation. Ca^{++} is also necessary for blood coagulation.
2. **Phosphorus:** Organic phosphates are involved in the cellular function. The high energy compound ATP supplying energy to all cellular activities contains phosphorus. Phospholipids in cellular membranes provide the permeability.
3. **Magnesium (Mg) :** All enzyme reaction requiring thiamine pyrophosphate (TPP) and the various reactions in the lipid and protein metabolism need Mg^{++}. Mg deficiency may cause diarrhoea or excessive vomiting etc.
4. **Sodium (Na) :** Able to pass across cell membrane. Plays an important role in nerve conduction and muscle contraction. Aldosterone, a hormone of the adrenal cortex is responsible for the reabsorption of Na^{+} from kidney tubules.
5. **Potassium (K) :** Required in carbohydrate and protein metabolism, in the formation of glycogen and degradation of glucose.
6. **Chlorine (Cl^{-}) :** It is the chief anion of extracellular fluid. Greater part of it is found in the form of NaCl. The chlorine transfer between serum and erythrocyte is known as chloride shift and an example of homeostatic mechanism by which pH of blood is maintained. Low pH due to HCl inactivates the amylase of saliva.
7. **Iron (Fe) :** Constituent of respiratory pigment haemoglobin. Haem molecule is also component of cytochrome. Some iron is also present in myoglobin compound in muscles. Iron content is good in some green leaves and meat.
8. **Zinc (Zn) :** Respiratory enzyme, carbonic anhydrase present in RBC contains zinc.
9. **Cobalt (Co) :** It is present as a part of vitamin B_{12} . It is synthesized in the rumen with the help of bacteria. Cobalt is necessary in formation of RBCs.

Summary of Human Vitamins

Vitamin	Adult Daily requirement	Common Sources	Function	Deficiency	Destroyed by
A. Water Soluble					
1. B. Complex					
(i) B_1, Thiamine	1.5mg.	Yeast, wheat germ, peanuts, beans, lean meat.	Part of coenzymes for aerobic metabolism of carbohydrates, aids in pentose synthesis and metabolism	Beriberi	Cooking, baking soda.
(ii) B_2, Riboflavin	2mg.	Yeast,liver, milk, cheese, leafy vegetables, intestinal bacteria.	Part of coenzymes (FMN, FAD) in ETS, also needed for oxidation in endoplasmic reticulum.	Eye inflammation, lip sores	Light
(iii) Pantothenic Acid	5-10mg	Yeast, peas, liver	Part of coenzyme A in cell respiration	Abnormal adrenal functioning	Not clear
(iv) B_6 Pyridoxine	2mg	Meat, Milk, wheat germ, liver, banana	Part of coenzymes in amino acid metabolism and glycogen synthesis.	Skin lesions, CNS disorder.	Cooking, oral contraceptives

(v) Niacin or Nicotinamide	20mg	Yeast, wheat germ, peanuts, red meat.	Part of coenzymes (NAD, NADP) that act as hydrogen acceptors and donors.	Pellagra	Cooking
(vi) Folacin	0.5mg	Liver, green vegetables, banana, orange	Part of coenzymes in protein and nucleic acid metabolism	Anaemia, sprue	Cooking
(vii) Biotin	Enough in ordinary diet (10mg)	Fresh fruits and vegetables, liver, milk, eggs, whole grain cereals.	Coenzyme in fatty acid synthesis and in change of pyruvate to oxaloacetate.	Scaly and itchy skin	Prolonged use of antibiotics, sulpha drugs, raw egg White.
(viii) B_{12}, Cyanoco-balamin	0.003mg or 3µg	Liver, eggs	Coenzymes for nucleic acid metabolism	Pemicious anaemia	Grilling on excessive heat.
2. C, Ascorbic Acid	50 mg	Citrus fruits, tomatoes, peppers.	Playa role in collagen formation.	Scurvy	Heat and light
B. Lipid Soluble					
1. A, Retinol	2mg	Yellow vegetables, whole milk,butter.	Part of visual pigments, maintenance of epithelia, prevention of keratinization of epithelia, growth.	Night blindness, xerophthalmia, keratinization of epithelia, retarded growth	Strong light
2. D, Calciferol	0.01 mg or 10µg	Fish liveroil, egg yolk, milk, liver formed in skin by action of ultraviolet light.	Facilitates absorption of calcium and phosphrous by intestine and their retention in the body and deposition in bones.	Rickets in children, osteomalacia in adults.	Oral contraceptives
3. E, Tocoferol	15mg	Leafy vegetables, whole cereal grains, vegetable oils.	Antioxidant, some role in ETS. Antisterility factor	Destruction of RBCs, sterility	Heat
4. K, Phylloquinone	0.07-0.14mg	Leafy vegetables, soyabean oil, intestinal bacteria.	Synthesis of prothrombin for blood clotting.	Faulty blood clotting	Prolonged use of antibiotics and sulpha drugs

CALORIFIC VALUE :

The amount of heat liberated from complete combustion of 1 gm food in a bomb calorimeter (a closed metal chamber filled with O_2) is its gross calorific value or gross energy value (G.C.V.). The actual amount of energy liberated in the human body due to combustion of 1 gm of food is the physiologic calorific value (P.C.V.) of food.

Food substance	G.C.V. (in K.cal/gm)	P.C.V. (In K. cal/gm)
Carbohydrate	4.1	4.0
Protein	5.65	4.0
Fats	9.45	9.0

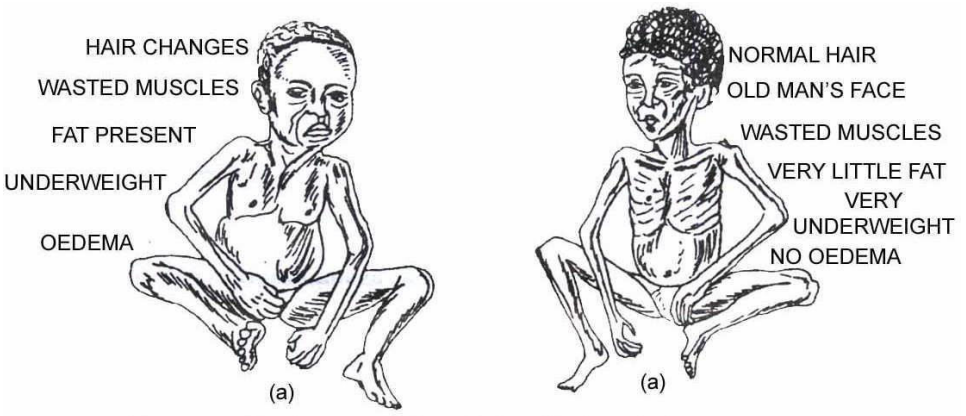
Nutritional Deficiencies and Disorders

- Deficiencies of nutrients, like vitamins, minerals and proteins, in the food are related to specific disorders, diseases and abnormalities in humans.

- Impairment of health due to improper intake of food or nutrients results in **malnutrition.**
- Malnutrition is a term which covers problems of both undernutrition and overnutrition.
- An individual or a group of individuals, may be undernourished due to non-availability of food, and hence, deficiency of minimum required food and nutrients.
- In this situation of **undernutrition,** the intake of food is too insufficient to meet the needs for metabolic energy.
- Consequently, the individual shall have to make up the shortfall by metabolising some molecules of its own body.
- Excess intake of food and nutrients may cause a great deal of harm to the body.
- The excess nutrients are stored as increased body mass. Such a situation is attributep as **overnutrition.**
- Excess intake of saturated fats, like butter, ghee, vegetable oils, red meat, eggs, etc., often leads to **hypercholesterolemia,** a condition in which blood cholesterol content becomes abnormally high, ultimately leading to cardiac disorder.
- Deposition of cholesterol on the walls of blood vessels stiffens the blood vessels and increases blood pressure.
- Besides, excessive intake of calories (sugar, honey, ghee etc.) may produce overweight and **obesity** (excessive accumulation of tat in tissues), which is the most common form of overnutrition.
- Very high intakes of minerals and fat-soluble vitamins (obtained from food sources alone) can be toxic.
- This is because they are stored in the body.
- With the exception of folic acid (women of child-bearing age), people who have well-balanced diet that supply enough energy, do not usually need to take dietary supplements.
- But, if they do decide to take supplements, then they should follow the advice on the label to reduce the risk of an overdose.

Differences between Kwashiorkor and Marasmus

Kwashiorkor	***Marasmus***
(1) It is caused by deficiency of protein in the diet.	(1) It is caused by prolonged deficiency of proteins and calories in the diet.
(2) It commonly affects babies between 1-3 years of age.	(2) It affects infants under one year of age.
(3) Subcutaneous fat persists.	(3) Subcutaneous fat is used up, making ribs very prominent.
(4) Oedema affects legs and face.	(4) No oedema occurs
(5) Skin and hair change colour.	(5) No change in skin and hair colour.
(6) Body becomes under weight.	(6) Body becomes very under weight.
(7) Appetite is reduced.	(7) Appetite is not effected.
(8) Patient needs proteins to recoup.	(8) Patient needs proteins as well as carbohydrates and fats to recover.



Two types of inadequate nutrition. (a) Kwashiorkor (b) Marasmus

Self Assessment

Which of the following are absorbed by the mechanism of facilitated transport with the help of the carrier ions like Na^+?

(1) Glucose and fructose (2) Fructose and some amino acids

(3) Fats and glucose (4) Fats and amino acids

Protein coated fat globules are called (i), which are transported into (ii) in villi. Select the option which correctly fills up both the blanks .

(1) Cholesterol, capillaries (2) Chylomicrons, lacteals

(3) Chylomicrons, capillaries (4) Phospholipids, lacteals

Which of the following nutrient(s) is/are absorbed in stomach?

(1) Water (2) Simple sugar (3) Alcohol (4) All of these

In jaundice, skin and eyes turn yellow due to the deposition of bile pigments. This disease is due to malfunctioning of which organ?

(1) Liver (2) Intestine (3) Brain (4) Pancreas

Vomiting is a reflex action and is controlled by the vomit centre. This is present in _____

(1) Cerebrum (2) Hypothalamus (3) Medulla (4) Cerebellum

In which of the following disorder of digestive system there is abnormal frequency of bowel movement and increased liquidity of the faecal discharge?

(1) Vomiting (2) Diarrhoea (3) Constipation (4) Indigestion

Which of the following can cause indigestion?

(1) Inadequate enzyme secretion (2) Food poisoning and spicy food

(3) Anxiety and over eating (4) All of these

In which of the following disorder the faeces are retained within the rectum as the bowel movements occur irregularly?

(1) Constipation (2) Vomiting (3) Diarrhoea (4) Jaundice

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

(1) Pellagra (2) Marasmus (3) Rickets (4) Kwashiorker

Which of the following pairs is not correctly matched?

(1) Vitamin B12 Pernicious anaemia (2) Vitamin B6 Loss of appetite

(3) Vitamin B1 Beri-beri (4) Vitamin B1 Pellagra

Ans. Q.31 (2), Q.32 (2), Q.33 (4), Q.34 (1), Q.35 (3), Q.36 (2), Q.37 (4), Q.38 (1), Q.39 (2), Q.40 (4)

Concept Builder

1. **Assimilation:** Utilization of absorbed material by the cell.
2. **Hunger** and **Satiety** are centre in **hypothalamus.**
3. **Heart burn** has nothing to do with the heart. It is caused by the regurgitation of acid from stomach into the oesophagus.
4. **Splanchnology** is the study of the viscera.
5. **NIN** : National Institute of Nutrition, Hyderabad.
6. **Anorexia:** loss of appetite
7. Spoilt hay of sweet clover *Melilotus indica* (fodder and green manure) contains a substance called **dicumarol** that prevents the action of vitamin K as it is antagonistic to it.
8. **What destroys the vitamins?** Over cooling and excessive boiling, medicines like aspirin, antacids, diuretics, oestrogens, excessive alcohol, tobacco and coffee.
9. Tea/coffee inhibit the absorption of iron from the diet. Prolonged consumption of tea or coffee after meals can lead to iron deficiency-anaemia.
10. In the upper one third of oesophagus, only skeletal muscles are found
11. Chief seat of water absorption is small intestine.
12. Liver produces proteins like albumin, fibrinogen, prothrombin, but does not produce g-globulin.
13. **Poison glands of a snake** are modified **labial glands** homologous to parotid salivary glands.
14. Vomerine teeth of frog kill the prey.
15. Tongue of whale is not movable.
16. Gall bladder is absent in adult lamprey Uawless vertebrate), grain eating birds, rats, whales, all the perissodactyla (odd toed hoofed mammals, such as horse), and some artiodactyla (even toed hoofed mammals).
17. Alcoholics are short of vitamin C.
18. A 'u' shaped duodenum is a characteristic of man.
19. During high fever, one does not feel like taking meals because high temperature shuts off the appetite centre.
20. Bile is alkaline in man but acidic in cats and dogs.
21. **Basal Metabolic Rate** (B.M.R.). It is the minimum energy requirement for maintenance of body during rest or sleep. For normal human adult is 1600 kcal/day.
22. **Routine Metabolic Rate (RMR)** : It is the energy requirement of a moderately active person. R.M.R. is 2800 K cal day for adult males and 2200 kcal per day for adult females.

23. **Entero-Hepatic circulation:** Of the total bile salts which enter the duodenum, 90-95% are reabsorbed actively from the terminal ileum in the portal vein and returned to the liver, to be excreted again, this is enterohepatic circulation. Approximately 93% of the cellular material is composed of C, H and O, 2% is composed of N, P, Cl and S, I, F, B and these are present in traces.
24. **'Choloretics'** are substances which increase bile secretion from liver *e.g.,* bile salts.
25. **'Cholagogues'** are substances which cause the contraction of gall bladder.
26. **'Achalasia Cardia'** condition is characterised by failure of cardiac sphincter to relax completely on swallowing causing food accumulation in oesophagus and proximal oesophagus dilates.
27. **Achlorohydria** means lack of HCl secretion in stomach. The capacity of the human stomach is 1.5-1.7 litre.
28. In prawn, most of digestion of food takes place in cardiac part of stomach
29. Elephant tusks are modified incisor teeth.
30. Tusks of walrus are modified canines.
31. Teeth of sloths and armadillos have no enamel.
32. Spiny ant eaters, scaly ant eaters and some whales are toothless.
33. Nasopharynx has a pair of openings of Eustachian tubes which connect it to the into middle ear.
34. Carbohydrates, lipids and proteins are macronutrients or proximate principles of food because these constitute the energy sources for the production of heat and different organic functions.
35. Minerals, vitamins and water are micronutrients or protective principles of food because although these do not provide energy, yet their deficiencies are related to specific diseases.
36. **Inflamation of intestinal tract:** Most common due to bacterial viral infection may be caused by intestinal parasites like tape worm , round worm, thread worm, hook worm, pin worm.
37. **Jaundice:** Liver is affected, skin and eyes turn yellow due to deposition of bile pigments.
38. **Vomiting:** This reflex action is controlled by vomiting centre in the medulla. A feeling of nausea preceeds vomiting.
39. **Diarrhoea:** It reduces the absorption of food, due to abnormal frequency of bowel movement.
40. **Constipation:** Due to irregular bowel movement faeces are retained within the rectum,
41. **Indigestion:** Feeling of fullness as the food is properly digested. It is due to inadequate enzyme secretion, anxiety, food poisoning, over eating and spicy food.
42. **Belching:** It occurs usually when the stomach is over dilated, air rises and is expelled through the mouth producing burping sound.
43. **Flatus:** It is accumulation of gase~ in gastro-intestinal tract which are expelled through anus producing characteristic sound.
44. **Hepatitis:** It is a condition of inflammation of liver caused by infection of bacteria, virus or protozoa. It may cause cirrhosis.

45. **Colitis:** It is a disorder in which inflammation of colon and rectum occurs. Loose motions, bloody faeces and dehydration occurs. It is caused due to infection by protozoans like *Entamoeba.*
46. **Appendicitis:** The wall of vermiform appendix ruptures, bacteria are released in the coelomic cavity. Severe infection may cause death. By surgery the appendix is removed.
47. **Hernia:** It is protrusion of the intestine into inguinal canal and may extend into scrotal sac. Hernia may be of different types affecting protrusion of an organ into the cavity of other organ.
48. **Jaundice:** In this disorder bile pigments like bilirubin increase in blood and are not excreted hence their concentration increase in the blood causing yellowness in skin and eyes.
49. **Nausea :** It refers to the discomfort which leads to vomiting. It may be caused by distension of stomach or of the gastro-intestinal tract.

SUMMARY

- The digestive system of humans consists of an alimentary canal and associated digestive glands.
- The alimentary canal consists of the mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and the anus.
- The accessory digestive glands include the salivary glands, the liver (with gall bladder) and the pancreas.
- Inside the mouth the teeth masticate the food, the tongue tastes the food and manipulates it for proper mastication by mixing with the saliva.
- Saliva contains a starch digestive enzyme; salivary amylase that digests the starch and converts it into maltose (disaccharide).
- The food then passes into the pharynx and enters the oesophagus in the form of bolus, which is further carried down through the oesophagus by peristalsis into the stomach.
- In stomach mainly protein digestion takes place.
- Absorption of simple sugars, alcohol and medicine also takes place in the stomach.
- The mucosa of stomach has gastric glands. Gastric glands have three *major* types of cells namely :

(i) Mucus neck cells which secrete mucus.

(ii) Peptic or chief cells which secrete the proenzyme pepsinoger.

(iii) Parietal or oxyntic cells which secrete HCl and intrinsic factor, which is responsible for the absorption of B_{12}.

- Small amounts of Iipases are also secreted by intrinsic glands.
- The chyme (food) enters into the duodenum portion of the small intestine and is acted on by the pancreatic juice, bile and finally by the enzymes in the succus entericus, so that the digestion of carbohydrates, proteins and fats is completed.
- Pancreatic juice contains inactive enzymes -trypsinogen, chymotrypsinogen, procarboxypeptidases, amylases, lipases and nucieases.
- Trypsinogen is activated by an enzyme, enterokinase, secreted by intestinal juice into active trypsin, which in turn activates the other enzymes of pancreatic juice.
- Bile released into the duodenum contains the bile pigments, bile salts, cholesterol, phospholipids but no enzymes. It helps in emulsification of fats.
- The intestinal mucosal epithelium secretes succus entericus/intestinal juice.
- This juice contains a variety of enzymes like maltase, dipeptidases, lipases, nucleosidases etc.
- The mucus along with the bicarbonates from the pancreas protects the intestinal mucus from acid as well as provides an alkaline medium (pH 7-8) for enzymatic activities. Submucosal glands (Brunner's glands) also help in this.
- Food then enters jejunum and ileum portions of the small intestine.
- Carbohydrates are digested and converted into monosaccharides like glucose.
- Proteins are finally broken down into amino acids.

- The fats are converted to fatty acids and glycerol.
- The digested end products are absorbed into the body through the epithelial lining of the intestinal villi.
- The undigested food (faeces) enters into the caecum of the large intestine through ileo-caecal valve, which prevents the back flow of the faecal matter.
- Most of the water is absorbed in the large intestine.
- The undigested food becomes semi-solid in nature and then enters into the rectum, anal canal and is finally egested out through the anus.

EXERCISE–1

Section – A

Type of nutrition where the whole plant or their parts are taken either in solid or liquid form through mouth is called

(1) Saprozoic (2) Holophytic (3) Holozoic (4) Autotrophic

Vitamins and water are included under

(1) Micronulrients or proximate principles of food

(2) Micronutrients or protective principles of food

(3) Macronutrients or proximate principles of food

(4) Macronutrients or protective principles of food

In Coelenterates digestion is

(1) Intracellular (2) Intercellular (3) Both (1) & (2) (4) None of these

Which part of the alimentary canal of cockroach is not lined with cuticle?

(1) Stomodaeum (2) Mesenteron (3) Hepatic caeca (4) Both (2) & (3)

Number of chitinous teeth in the gizzard part of the cockroach is

(1) 6 (2) 8 (3) 4 (4) 10

Each salivary gland of cockroach consists of

(1) Paired receptacle and single glandular part

(2) Single receptacle and paired glandular part

(3) Single receptacle and single glandular part

(4) Paired receptacle and paired glandular part

Formation of peritrophic membrane occurs in which portion of digestive system of cockroach?

(1) Stomodaeum (2) Crop (3) Mesenteron (4) Proctodaeum

The link between the tongue and the buccal floor is

(1) Labial frenulum (2) Lingual frenulum (3) Ungual papilla (4) Sulcus terminalis

Thecodont teeth are present in

a. Sphenodon b. Crocodiles c. Mammals d. Scoliodon

(1) c only (2) b & c only (3) a, b, & c only (4) a, b, c & d

Monophyodont teeth occur in

(1) Humans (2) Frog (3) Whale (4) Ral

Types of teeth in human are

(1) Homodont, Lophodont, Diphyodont (2) Heterodont, Selenodont, Monophyodont

(3) Bunodont, Thecodont. Heterodont (4) Diphodont, Heterodont, Acrodont

Dental formula for the monophyodont teeth of human is

(1) $\frac{0021}{0021}$ (2) $\frac{0003}{0003}$ (3) $\frac{2120}{2120}$ (4) $\frac{2102}{2102}$

Lower molars in human dentition have

(1) Four roots (2) Three roots (3) Two rools (4) Singte root

Enamel part of tooth is secreted by

(1) Odontoblast, mesodermal (2) Ameloblast, mesodermal

(3) Odontoblast, ectodermal (4) Ameloblast, ectodermal

Regurgitation of food from stomach is prevented by

(1) Pyloric sphincter (2) Cardiac sphincter (3) Circular muscle (4) Muscularis mucosa

Which of the following can be taken as true stomach in ruminants?

(1) Rumen (2) Reticulum (3) Omasum (4) Abomasum

First and largest chamber in stomach of ruminants like cattle, buffalo, sheep. goat and came) is

(1) Reticulum (2) Rumen (3) Omasum (4) Abomasum

Zymogen cells and chief cells secrete

(1) Hel (2) Mucus (3) Pepsinogen (4) Trypsin

HCl of gastric juice is produced by

(1) Chief cells (2) Oxyntic cells (3) Goblet cells (4) Columnar cells

Before opening into the duodenum, hepatopancreatic ampulla has a thickening called

(1) Plica circulares (2) Sacculus rotundus

(3) Sphincter of Boyden (4) Sphincter of Oddi

Crypts of Lieberkuhn are present in

(1) Pancreas and secrete pancreatic juice (2) Small intestine and secrete digestive enzymes

(3) Stomach and secrete dilute HCl (4) Stomach and secrete trypsin

Sphincter of Boyden which helps in the filling up of gall bladder is present in

(1) Ductus choledoccus (2) Duct of Wirsurg

(3) Ampulla of Vater (4) Duct of Santorini

Smallest part of colon lacking mesentry is

(1) Ascending (2) Descending (3) Transverse (4) Sigmoid

Lamina propria is associated with which part of the alimentary canal?

(1) Mucosa (2) Submucosa

(3) Muscularis externa (4) Serosa

Auerbach's plexus is present in

(1) Submucosa

(2) Between mucosa and submucosa

(3) Between circular and longitudinal muscles of muscularis interna

(4) Between circular and longitudinal muscles of muscularis extema

Oblique muscle layer is present in

(1) Stomach (2) Duocenum (3) Colon (4) All of These

Location of the Brunner's gland is

(1) Mucosa, duodenum (2) Mucosa ileum

(3) Submucosa, duodenum (4) Submucosa, ileum

Brunner's glands are intestinal glands and secrete

(1) Mucus (2) Enzymes

(3) Enzymes and mucus (4) None of these

Which of the following papillae are without taste buds in human tongue?

(1) Vallale (2) Fungifonn (3) Fusiform (4) Filiform

pH of saliva is

(1) 6.7 (2) 7.4 (3) 8.0 (4) 2.5

Tonsils are enlargements of

(1) Lymphoid tissue (2) Adenoid tissue (3) Larynx (4) Sub-lingual gland

One of the following ions is used for activation of ptyalin and maltase

(1) Sodium ions (2) Potassium ions (3) Chloride ions (4) None of these

Largest gland in the body of man is

(1) Liver (2) Pancreas (3) Gastric gland (4) Adrenal

Cholecystitis refers to

(1) Gall bladder (2) Stomach (3) Spleen (4) Lungs

Alkaline nature of bile is due to

(1) NaCl (2) $NaHCO_3$ (3) KOH (4) NaOH

Enterokinase or enteropeptidase found in intestinal juice helps in converting

(1) Casein into paracasein (2) Pro-rennin into rennin

(3) Trypsinogen into trypsin (4) Proteins into peptides

Milk protein casein is coagulated by

(1) Pepsin (2) Trypsin (3) Rennin (4) Bolh (1) & (3)

Chyme formed in stomach is further transformed into

(1) Chyle (2) Colloidal material

(3) Soft solid substance (4) Fats

Paneth cells are found in

(1) Crypts of Lieberkuhn (2) Peyer's patches

(3) Islets of Langerhans (4) Gastric glands

In acute constipation, purgatives that are used to stimulate intestinal peristalsis and evacuation of fluid faeces contain salts of

(1) Sodium (2) Magnesium (3) Potassium (4) Calcium

A prolonged constipation may cause

(1) Hemorrhoids (2) Ulcers (3) Cholera (4) Dysentry

The functional units for absorption of digested food are

(1) Crypts of Lieberkuhn (2) Peyer's patches

(3) Villi (4) Brunners glands

The foul odour of the faeces is due to the presence of the compound

(1) Skatole (2) Methyl mercaptan

(3) Hydrogen sulphide (4) Ammonia

Mark the odd one out

(1) Gaslrin (2) Trypsin (3) Secretin (4) Enterocrinin

Which of the following hormones inhibit the release of gastric juice?

(1) Enlerogaslrone (2) GIP (3) Bolh (1) & (2) (4) Enterocrinin

When a piece of bread is chewed it tastes sweet because

(1) The sugar contents are drawn out (2) Saliva converts starch into maltose

(3) It does not taste sweet (4) The taste buds are stimulated by chewing

Digestion is completed in

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

Enterocrinin acts on

(1) Gall bladder (2) Intestinal glands (3) Trypsinogen (4) Gastric glands

Lactase converts lactose into

(1) Glucose + maltose (2) Glucose + fructose

(3) Fructose (4) Glucose + galactose

In small intestine, pH value is

(1) 7.00 (2) 8.00 (3) 8.5-9.00 (4) 2.5-4.5

The blood capillaries of intestinal villi cannot absorb

(1) Glucose (2) Salls

(3) Fatty acids and glycerides (4) Amino acids

Which of the following vegetarian meals will supply all essential amino acids in the correct proportions for synthesizing human proteins?

(1) Spinach and beans (2) Com and rice (3) Beans and rice (4) Peas and beans

Vitamin containing cobalt cyanide linkage is

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

Recently discovered vitamin having anticancer properties is

(1) Vitamin B_5 (2) Vitamin B_{15} (3) Vitamin B_{17} (4) Vitamin Q

Tonics made out of the liver are very effective in curing haemopoietic disorder because

(1) They contain proteins (2) They contain RBGs

(3) They contain bile juice (4) They contain vitamin B_{12}

Find the odd one out

(1) Vitamin K, Prothrombin (2) Zinc, Carbonic anhydrase

(3) Vitamin B_1, Paralysis (4) Sulphur, Phosphatase

People who eat excess of maize in their diet suffer from

(1) Pellagra (2) Rickets (3) Beri-beri (4) Pemicious anaemia

Pernicious anaemia is caused by the deficiency of vitamin

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

A man is said to be starving when

(1) Food that he eats does not meet the loss of energy

(2) Food that he eats meets the loss of energy

(3) He begins to store reserve food

(4) None of these

Black tongue disease in dogs is associated with the deficiency of

(1) Menadione (2) Niacin (3) Retinol (4) Calciferol

Section – B

Gastric juice contains which of the following enzymes

(1) Pepsin and renin (2) Amylase & pepsin, and lipase

(3) Amylase & pepsin (4) Insulin & glucagon

Which of the following kinds of papilla (taste buds) occur over the tip of tongue of Rabbit-

(1) Fungiform and fili form (2) Circumvallate

(3) Circumvallate (4) Foliate

Absorption of a solution against a concentration gradient by the intestinal epithelium is accompanied by

(1) Osmotic pressure (2) Active transport

(3) Brownian movement (4) Donanum equilibrium

Which of the following teeth appear only once in the life of a man-

(1) Incisors (2) Canines (3) Premolars (4) Molars

Hydrolysis of phospholipids yields

(1) Glycerol, phosphoric acid and fatty acids

(2) Glycerol, phosphoric acid and nitrogen base

(3) Glycerol & fatty acids (4) Acetyl Co A

The food that gives more calories per unit mass of food is

(1) Protein (2) Carbohydrates (3) Fat (4) Water

Which is the element that hardens the tooth enamel ?

(1) Calcium (2) Fluorine (3) Iodine (4) Sodium

Canine teeth are absent in rabbit because it is-

(1) Herbivorous (2) Carnivorous (3) Omnivorous (4) Saprophytic

The secretions that mix with food in the small intestine are

(1) Saliva, gastric juice & bile

(2) Gastric juice, bile & pancreatic juice

(3) Bile, pancreatic juice & intestinal juice

(4) Pancreatic juice, intestinal juice and gastric juice

Essentially the work digestion means

(1) Breaking food for energy

(2) Building of proteins from amino acids

(3) Changing organic molecules

(4) Breaking complex organic molecules into smaller ones

Which of the following part in Rabbit have hare lip or cleft lip

(1) Lower lip (2) Upper lip (3) Both of these (4) None of these

When teeth are different in shape, size & function then these are called

(1) Acrodont (2) Pleurodont (3) Homodont (4) Heterodont

Dental formula of Rabbit is

(1) $\frac{2}{2}\frac{1}{1}\frac{2}{2}\frac{3}{3}$ (2) $\frac{1}{1}\frac{0}{0}\frac{2}{1}\frac{4}{3}$ (3) $\frac{2}{1}\frac{0}{0}\frac{3}{2}\frac{3}{3}$ (4) $\frac{1}{1}\frac{0}{0}\frac{2}{0}\frac{0}{3}$

The incisor teeth are meant for

(1) Biting & cutting (2) Mulching

(3) Munching and chewing (4) Chewing

The enormously long tusks in elephant are-

(1) Upper incisors (2) Upper canines (3) Lower canines (4) Lower incisors

How many teeth in man are monophyodont ?

(1) 4 (2) 12 (3) 22 (4) 32

In Rabbit incisor teeth keep on growing because of

(1) Persistence open pulp cavity (2) Open apical pore

(3) Constant division of odontoblasts (4) All of the above

Due to the absence of canines in Rabbit a gap is left in between incisor and premolar teeth, it is called

(1) Dental lamina (2) dental groove (3) Diastema (4) Dental cavity

Which of the following food reserves would be first used in a starving person-

(1) Muscle proteins (2) Skin adipose tissue

(3) Liver glycogen (4) Liver proteins

The digestions of starch in alimentary canal of human starts in

(1) Buccal cavity (2) Ileum (3) Stomach (4) Duodenum

Which of the following substance can be assimilated unchanged

(1) Vitamin (2) Starch (3) Proteins (4) Lipids

Root of tooth contains all the following except-

(1) Cementum (2) Enamel (3) Dentine (4) Pulp cavity

Which of the following part of gut does not posses mesentery ?

(1) Jejunum (2) Ileum (3) Appendix (4) Ascending colon

Which is true about parotid gland ?

(1) Stenson's and Wharton's ducts join and open at upper 2nd molar

(2) Stenson's duct open opposite upper 2nd molar

(3) Parotid duct pierces master (4) Developed from mesoderm

Oxyntic cells are found in-

(1) Kidney and secrete renin (2) Gastric epithelium and secrete HCl

(3) Gastric epithelium and secrete pepsin (4) Islets of langerhans & secrete glucagon

Which of the following is not a salivary gland

(1) Brunner's gland (2) sublingual gland

(3) Submaxillary gland (4) Parotid gland

Maltose on digestion gives

(1) Two molecules of glucose (2) One molecule of glucose and fructose

(3) Two molecules of fructose (4) One molecule of glucose and galactose

The foul smell of faeces is due to

(1) Skatol, Indole (2) Ammonia

(3) Small and large intestine (4) Methyl mercaptan

Maximum ammonia is formed during metabolism in

(1) Stomach (2) Liver (3) Large intestine (4) Small intestine

The main purpose of large intestine is to absorb

(1) Alcohol (2) Water (3) Fatty acids (4) Disaccharides

Hydrolysis of lactose yields

(1) Glucose and fructose (2) Glucose and galactose

(3) Fructose and galactose (4) Glucose and xylose

Pepsin differ from trypsin in that it digests-

(1) Protein in alkaline medium in stomach (2) Protein in acidic medium in duodenum

(3) Protein in acidic medium in stomach (4) Protein in alkaline medium in duodenum

Man cannot digest cellulose but cow and other herbivorous animals can take food containing cellulose because-

(1) They have enzyme cellulase in their stomach

(2) They masticate it well by chewing teeth

(3) They have bacteria in their alimentary canal which digest cellulose

(4) None of the above

Enzyme responsible for coagulating milk in stomach of calves-

(1) Lactase (2) Trypsin (3) Rennin (4) Pepsin

The receptors for the bitter taste on our tongue are located on its

(1) Posterior portion (2) Middle part (3) Lateral portion (4) Tip part

Pseudormination is a process of

(1) Eating own faeces (2) Egesting faecal matter

(3) Swallowing the bolus (4) Chewing the regurgitated food

Which of the following acts both as an endocrine as well as exocrine glands

(1) Thymus (2) Ovary (3) Pancreas (4) All of the above

Gastric glands are

(1) Simple tubular (2) Simple coiled tubular

(3) Branched tubular (4) Compound tubular

Referred pain of gall bladder is felt at the tip of-

(1) Left shoulder (2) Right shoulder (3) Sternum (4) Cystic duct

Jaundice may be caused by retarded function of-

(1) Lungs (2) Liver (3) Heart (4) Kidneys

Which cells of liver act as phagocytes ?

(1) Acinar cells (2) Kupffer cells (3) Hansen's cells (4) Dieter's cells

Dentition of most of the mammals is

(1) Heterodont (2) Diphyodont (3) Thecodont (4) All of the above

The normal method of feeding in Rabbit is called

(1) Gnawing (2) Rumination (3) Pseudo rumination (4) Coprophagy

Which of the following substances is most quickly absorbed by buccal cavity

(1) Alcohol (2) Morphine (3) Sugar (4) Salts

Crypts of Lieberkuhn are the examples of which kind of glands

(1) Simple coiled tubular (2) Simple alveolar

(3) Tubular alveolar (4) Compound tubular

Duct of Santorini is-

(1) Accessory pancreatic duct (2) Main pancreatic duct

(3) Parotid duct (4) Bile duct

If liver becomes functionless, percentage of which will increase in blood ?

(1) Uric acid (2) Ammonia (3) Urea (4) Proteins

Surgical removal of gall bladder in Rabbit would lead to

(1) Jaundice (2) Impairment of digestion of fats

(3) Increased acidity in the intestine (4) Stop the process of glycogenesis in liver

Sacculus rotundas is found at the junction of

(1) Oesophagus & stomach (2) Small & large intestine

(3) Ileum, colon & caecum (4) Duodenum & ileum

The liver lobe is an aggregation of

(1) Glisson's capsules (2) Lobules (3) Lobes (4) Hepatic chords

Food and air passages in buccal cavity are separated by

(1) Palate (2) Tongue (3) Upper jaw (4) None of the above

Right and left lobes of human liver are separated by falciform ligament. The right lobe is differentiated into-

(1) Right lobe proper (2) Quadrate lobe (3) Caudate lobe (4) All of these

A common site of gall stones is-

(1) Cystic duct (2) Ampulla of gall bladder

(3) Fundus of gall bladder (4) Hepatic duct

Assimilation of food takes place in

(1) Stomach (2) Ileum (3) Duodenum (4) Body tissues

In people addicted to alcohol the liver gets damaged because liver

(1) Has to detoxify the alcohol (2) Is over stimulated to secrete bile

(3) Stores much glycogen (4) Accumulates excess fats

Wharton's ducts are associated with

(1) Salivary glands (2) Caecum (3) Sacculus rotandus (4) Colon

Stenson's ducts carry saliva from which salivary glands

(1) Infra orbital (2) Parotid (3) Sub lingual (4) Sub maxillary

Jacobson's organ in Rabbit is located

(1) On the floor of buccal cavity (2) On the roof of buccal cavity

(3) Inside nasopalatine ducts (4) Over the tongue

Caecum is meant for

(1) Digestion of cellulose (2) Digestion & absorption of cellulose

(3) Storage of fats (4) Storage of faecal matter

The movement in the alimentary canal is known as-

(1) Systole (2) Diastole (3) Peristalsis (4) Metachronal

The human intestine is long because-

(1) Bacteria in food can be killed gradually

(2) It provides more space for food storage

(3) It increases surface area for absorption of food

(4) None of the above

Outer most layer of crown part of a tooth is

(1) Dentine (2) Enamel (3) Cement (4) Pulp

Gall bladder of Rabbit is located in which lobe of liver

(1) Right central lobe (2) Left central lobe (3) Caudate lobe (4) Spigelian lobe

Kupffer's cells are found in

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

Teeth forming cells are called

(1) Chondroblasts (2) Osteoblasts (3) Odontoblasts (4) Osteoclasts

The sphincter of Boyden surrounds the-

(1) Opening of the bile duct before it is jointed with the pancreatic duct

(2) Opening of the hepatopancreatic ampulla into the duodenum

(3) Opening of the pancreatic duct into the hepatogen creatic ampulla

(4) Opening of the accessory pancreatic duct into the duodenum

Digestion of proteins is necessary because-

(1) Proteins are not absorbed as such (2) Proteins are large molecules

(3) Proteins have complex structure (4) Proteins are made up of amino acids

Which one of the following does not aid in increasing surface area in the small intestine ?

(1) Plicae circularis (2) Taenia coli (3) Villi (4) Microvilli

Three longitudinal muscular bands found in the wall of colon are called

(1) Haustra (2) Taeniae (3) Beads (4) Acini

Largest gland found in the body of Rabbit is

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

The secretory units of pancreas are called

(1) Alveoli (2) Acini (3) Crypts (4) Lobules

The toxic substances of diet are detoxified in body by

(1) Stomach (2) Liver (3) Spleen (4) Kidney

Drowsiness after a heavy meal is due to-

(1) Increased blood pressure (2) Decreased pulse rate

(3) Reduced blood pressure (4) Increased pulse rate

Deficiency of calcium causes-

(1) Rickets (2) Scurvy (3) Gigantism (4) Addison's disease

Which of the following minerals is responsible to control our heart beat-

(1) Sulphur (2) Sodium (3) Potassium (4) Iron

The centre of liver lobule is formed by

(1) Portal vein (2) Hepatic artery (3) Bile duct (4) Intralobular vein

The portal tract or radical or canal is composed of

(1) Central vein, portal vein and hepatic artery

(2) Central vein, bile duct, lymphatics & artery

(3) Portal vein, hepatic artery, bile duct & lymphatics

(4) Arteries, veins & bile ducts

The sinusoids found between radical cords of hepatic cells connect

(1) Portal vein to hepatic artery

(2) Hepatic artery & Portal vein to the intralobular vein

(3) Central vein to the bile duct

(4) Hepatic artery to bile duct

Deficiency of Riboflavin causes-

(1) Beri-beri (2) Cheilosis (3) Pellagra (4) Megaloblastic anaemia

Most important property of water for which it is needed in the body is-

(1) It is tasteless, colourless and odourless (2) It is a universal solvent

(3) It is a liquid (4) Its O_2 is used in cellular metabolism

Xerophthalmia in children and nyctalopia (night blindness) in adults is caused by the deficiency of vitamin-

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

Liver sinusoids are lined by

(1) Kupffer's cells (2) Paneath's cells (3) Peyer's patches (4) Goblet cells

Peyer's patches manufacture

(1) Erythrocytes (2) Lymphocytes (3) Mucous (4) Digestive enzymes

The enzyme invertase converts

(1) Lactose into glucose & galactose (2) Sucrose into glucose & fructose

(3) Maltose into glucose (4) Starch into maltose

Enzymes in the body of Rabbit occur

(1) Only in pancreas (2) Only in liver

(3) Almost in all cells (4) Only in kidney

Secretin is

(1) An enzyme (2) A hormone (3) A vitamin (4) An excretory product

Pellagra is caused due to deficiency of vitamin-

(1) Thiamine (2) Calcified

(3) Nicotinic acid (Niacin) (4) Ascorbic acid

Which of the following pair is characterized by swollen lip, thick pigmented skin of hands and legs and irritability ?

(1) Thiamine – Beri beri (2) Protein – Kwashiorkor

(3) Nicotinamide – Pellagra (4) Iodine – Goitre

Vitamin containing cobalt is-

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

Inner most surface of small intestine of Rabbit has

(1) Only epithelial tissue (2) Only muscular tissue

(3) Both of the above (4) Muscles & connective tissue

Dental formula of Homo sapiens is

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

Glycogen is stored in Rabbit's body in

(1) Muscles only (2) Liver cells only (3) Muscles & spleen (4) Liver & muscle cells

If the intake of food in Rabbit is more than its energy use, it will be deposited in the form of

(1) Proteins (2) Fats (3) Glycogen (4) Fats & glycogen

In digestion of food some energy is produced in the form of

(1) Kinetic energy (2) Potential energy (3) Heat (4) Radiant energy

Hormone responsible for initiating the secretion of pancreatic juice is

(1) Enterogastrones (2) Cholecystokinin

(3) Secretin & pancreozymin (4) Gastrin & pancreozymin

Scurvy which is caused by the lack of vitamin C is characterised by-

(1) Nervous disorders (2) Haemorrhage in the gums

(3) Intestine disorders (4) Malfunction of kidney

Antihaemorrhagic vitamin is also known as-

(1) Vitamin A (2) Vitamin B (3) Vitamin E (4) Vitamin K

Lamina propria is

(1) A connective tissue component of mucosa

(2) An epithelium

(3) A fibrosa

(4) A connective tissue component of muscular is mucosae

Salivary secretion in Rabbit is controlled by

(1) Reflex action (2) Hormones (3) Pressure (4) Will power

Glisson's capsules in Rabbit are present

(1) In cortex of kidney (2) In seminiferous tubules

(3) Between two adjacent hepatic lobules (4) Between two adjacent hepatic lobes

Answer Key

Section–A

Q.1	3	Q.2	2	Q.3	3	Q.4	4	Q.5	1	Q.6	2	Q.7	3
Q.8	2	Q.9	2	Q.10	3	Q.11	3	Q.12	1	Q.13	3	Q.14	4
Q.15	2	Q.16	4	Q.17	2	Q.18	3	Q.19	2	Q.20	4	Q.21	2
Q.22	1	Q.23	1	Q.24	1	Q.25	4	Q.26	1	Q.27	3	Q.28	1
Q.29	4	Q.30	1	Q.31	1	Q.32	3	Q.33	1	Q.34	1	Q.35	2

Q.36	3	Q.37	4	Q.38	1	Q.39	1	Q.40	2	Q.41	1	Q.42	3
Q.43	1	Q.44	2	Q.45	3	Q.46	2	Q.47	2	Q.48	2	Q.49	4
Q.50	2	Q.51	3	Q.52	3	Q.53	4	Q.54	3	Q.55	4	Q.56	4
Q.57	1	Q.58	2	Q.59	1	Q.60	2						

Section–B

Q.1	1	Q.2	1	Q.3	2	Q.4	3	Q.5	1	Q.6	3	Q.7	2
Q.8	1	Q.9	3	Q.10	4	Q.11	2	Q.12	4	Q.13	3	Q.14	1
Q.15	1	Q.16	2	Q.17	4	Q.18	3	Q.19	3	Q.20	1	Q.21	1
Q.22	2	Q.23	3	Q.24	4	Q.25	2	Q.26	1	Q.27	1	Q.28	1
Q.29	2	Q.30	2	Q.31	2	Q.32	3	Q.33	3	Q.34	3	Q.35	1
Q.36	1	Q.37	3	Q.38	1	Q.39	1	Q.40	2	Q.41	2	Q.42	4
Q.43	1	Q.44	2	Q.45	4	Q.46	1	Q.47	2	Q.48	2	Q.49	2
Q.50	2	Q.51	1	Q.52	4	Q.53	1	Q.54	4	Q.55	1	Q.56	1
Q.57	2	Q.58	3	Q.59	1	Q.60	3	Q.61	3	Q.62	2	Q.63	1
Q.64	2	Q.65	3	Q.66	1	Q.67	2	Q.68	2	Q.69	2	Q.70	2
Q.71	2	Q.72	2	Q.73	3	Q.74	1	Q.75	2	Q.76	4	Q.77	3
Q.78	2	Q.79	2	Q.80	2	Q.81	1	Q.82	1	Q.83	2	Q.84	4
Q.85	3	Q.86	2	Q.87	3	Q.88	3	Q.89	4	Q.90	1	Q.91	1
Q.92	4	Q.93	4	Q.94	3	Q.95	3	Q.96	2	Q.97	4	Q.98	1
Q.99	1	Q.100	3										

Which one is not an enzyme of digestive system– **[CPMT 1990]**

(1) Enterokinase (2) Amylase (3) Trypsin (4) Enterogasterone

Mainly Secretin stimulates the production of – **[AIPMT 1990]**

(1) Saliva (2) Gastrin (3) Bile (4) Pancreatic juice

Peyer's patches produce – **[CPMT-1990]**

(1) Enterokinase (2) Lymphocyte (3) Mucous (4) Trypsin

Which teeth are absent in rabbit – **[CPMT 1991]**

(1) Incisor (2) Canine (3) Molar (4) Premolar

In mammals carbohydrate are stored in the form of – **[CPMT 1991]**

(1) Lactic acid in muscles (2) Glycogen in liver and muscles

(3) Glucose in liver and muscles (4) Glycogen in liver and spleen

The cells in the wall of intestine are stimulated to produce secretin by – **[CPMT 1991]**

(1) Cholycystochynin (2) Bile juice

(3) Acid in Chyme (4) Gastrin

Types of teeth in Rabbit – **[CPMT 1991]**

(1) Thecodont (2) Acrodont (3) Pleurodont (4) Homodont

Which of these will leave the stomach first in Man – **[CPMT 1992]**

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

Amount of fat increases in the body due to excess intake of – **[CPMT 1992]**

(1) Vitamins (2) Minerals (3) Carbohydrates (4) None of these

Bile is formed in – **[CPMT 1992]**

(1) Gall bladder (2) Liver (3) Spleen (4) Blood

Cholecystokinin is secretion of – **[MPPMT 1992]**

(1) Duodenum that causes contraction of gall bladder

(2) Goblet cells of ileum stimulates secretion of succus entericus

(3) Liver and controls secondary sex characters

(4) Stomach that stimulates pancreas to release juice

Enzyme trypsinogen is changed to trypsin by – **[RPMT 1990]**

(1) Gastrin (2) Enterogastrone (3) Enterokinase (4) Secretin

Castle's intrinsic factor is connected with internal absorption of – **[AMU 1992]**

(1) Pyridoxine (2) Riboflavin (3) Thiamine (4) Cobalamine

Aminopeptidase, a digestive enzyme produces– **[AMU 1992]**

(1) Dipeptides (2) Smaller peptides (3) Peptones (4) Amino acids

Highest BMR occurs in – **[AMU 1992]**

(1) Elephant (2) Rabbit (3) Human (4) Whale

Beri-Beri, Scurvy and Rickets are respectively caused by def. of – **[CPMT 1993]**

(1) B_1, D & C (2) B_1, C & D (3) D, B_1 & A (4) A, D & C

Which of the following pair is characterised by swollen lips, thick pigmented skin of hands and legs and irritability - **[AIPMT 1993]**

(1) Thiamine-Beri-Beri (2) Protein-Kwashiorkor

(3) Nicotinamide-Pellagra (4) Iodine-goitre

Maximum number of enzymes occur in – **[CPMT 1993]**

(1) Omnivores (2) Herbivores (3) Carnivores (4) None of the above

Excessive intake of alcohol caused – **[MPPMT 1993]**

(1) Jaundice (2) Dermatitis (3) Liver Cirrhosis (4) Lung Fibross

Inhibition of gastric and stimulation of gastric, Pancreatic and bile secretion are controlled by– **[AIPMT 1994]**

(1) Gastrin, secretin, Enterokinin and CCK

(2) Enterogasterone, gastrin, pancreozymin and CCK

(3) Gastrin, Enterogasterone, CCK and pancreozymin

(4) Secretin, Enterogasterone, Secretin and enterokinin

Lacteals take part - **[CPMT 1994]**

(1) Digestion of Milk (2) Absorption of fat

(3) Digestion of lactic acid (4) None of the above

Muscular contraction of Alimentary canal are – **[MPPMT 1994]**

(1) Circulation (2) Deglutition (3) Churning (4) Peristalsis

Vit-D is produced in human body by – **[J.K.M. CEE 1994]**

(1) Muscles (2) Nerves (3) Skin (4) None of these

Fatty acids and glycerol are first absorbed by – **[AFMC 1994]**

(1) Lymph Vessels (2) Blood (3) Blood Capilaries (4) Hepatic portal Vein

During rest, metabolic requirements are minimum. This is indicated by - **[AFMC 1994]**

(1) Pulse (2) Breathing

(3) O_2 take and CO_2 output (4) All the above

During Prolonged fasting - **[AFMC 1994]**

(1) First fats are used up, followed by carbohydrate from liver and muscles, and protein in the end

(2) First carbohydrate are used up, followed by fat and proteins towards end

(3) First lipids, followed by proteins and carbohydrates towards end.

(4) None of the above

A dental disease characterised by mottling of teeth due to ingredient in drinking water, namely- **[AIPMT 1995]**

(1) Fluorine (2) Chlorine (3) Boron (4) Mercury

In which animal tongue control the temperature – **[RPMT 1990]**

(1) Rabbit (2) Dog (3) Man (4) Cow

Largest gland of body – **[RPMT 1990]**

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

Which food substance is absorbed during digestion - **[RPMT 1991]**

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

Which substance of saliva destroy the harmful bacteria - **[RPMT 1991]**

(1) Cerumin (2) Chyme (3) Lysozyme (4) Secretin

Contraction in gall bladder stimulated by : - **[AIPMT 1998]**

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

Enamel of teeth is secreted by : - **[AIPMT 1998]**

(1) Ameloblast (2) Odontoblast (3) Osteoblast (4) Osteoclast

Deficiency of protein leads to : - **[AIPMT 1998]**

(1) Rickets (2) Scurvy (3) Kwashiorker (4) Carotenemia

Lactose composed of : - **[AIPMT 1998]**

(1) Glucose + galactose (2) Glucose + fructose

(3) Glucose + glucose (4) Glucose + mannose

Vitamin which induces maturation of R.B.C. : **[AIPMT 1998]**

(1) B_1 (2) A (3) B_{12} (4) D

Lower jaw composed of in Rabbit : - **[AIPMT 1998]**

(1) Dentry (2) Maxilla (3) Premaxilla (4) Palatine

Which of the following stimulates the secretion of gastric juice : - **[AIPMT 1998]**

(1) Gastrin (2) Enterogasterone (3) Secretin (4) Hepatocrinin

CCK and secretin secreted by : - **[AIPMT 1999]**

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

In stomach after physical and chemical digestion food is called : - **[AIPMT 1999]**

(1) Chyme (2) Chyle (3) Amino acid (4) Bolus

A normal human being requires how much calories per day : - **[AIPMT 1999]**

(1) 2500 k. cal (2) 4000 k. cal (3) 5000 k.cal (4) 686 k cal

Fully digested food reaches to liver by : - **[AIPMT 1999]**

(1) Hepatic portal vein (2) Hepatic artery

(3) Hepatic vein (4) All the above

Dental formula of adolescent human being before seventeen year : - **[AIPMT 1999]**

(1) $\frac{2122}{2122}$ (2) $\frac{2123}{2123}$ (3) $\frac{2102}{2102}$ (4) $\frac{2023}{1023}$

In mammals milk is digested by action of : **[AIPMT 2000]**

(1) Rennin (2) Amylase (3) Intestinal bacteria (4) Invertase

Which food should be eaten in deficiency of Rhodopsin in eyes - **[AIPMT 2000]**

(1) Carrot & ripe papaya (2) Guava, banana

(3) Mango & Potato (4) None

Which one correctly matched : **[AIPMT 2001]**

(1) Vit. E – Tocopherole (2) Vit. D – Riboflavin

(3) Vit. B – Calciferole (4) Vit. A – Thiamine

Most abundant organic compound on earth is – **[AIPMT 2001]**

(1) Protein (2) Cellulose (3) Lipids (4) Steroids

Stool of a person contain whitish grey colour due to malfunction of which type of organ : - **[AIPMT 2002]**

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

Fluoride pollution mainly affects : - **[AIPMT 2003]**

(1) Brain (2) Heart (3) Teeth (4) Kidney

Which one of the following pairs is not correctly matched : - **[AIPMT 2003]**

(1) Vitamin C — Scurvy (2) Vitamin B_5 — Pellagra

(3) Vitamin B_{12} — Pernicious anaemia (4) Vitamin B_6 — Beri–beri

Which one of the following mineral elements plays an important role in biological nitrogen fixation : **[AIPMT 2003]**

(1) Copper (2) Manganese (3) Zinc (4) Molybdenum

Which hormones induce secretion of succus entericus : - **[RPMT 2000]**

(1) Insulin (2) Secretin and cholycystokinin

(3) Glucagon (4) Secretin

If the dental formula of Rabbit is $\frac{2033}{1023}$. What does it show? **[RPMT 2001]**

(1) Total no. of teeth in Rabbit is 15

(2) No. of total incisors in Rabbit is 3

(3) Diastema is present between incisors & premolars

(4) In the formula 2033 is for adult and 1023 is for young ones

Which of the following is a disaccharide : - **[RPMT 2002]**

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

Which is correct about the bile of rabbit : - **[RPMT 2002]**

(1) It is synthesised by gall bladder & also stored there

(2) It is an enzyme which emulsify the fats

(3) It contain bile salts & bile pigments

(4) Bilirubin present in it decomposes fats

If all the peptide bonds of protein are broken, then remaining part is : - **[RPMT 2002]**

(1) Amide (2) Oligosaccharide (3) Polypeptide (4) Amino acid

Hydrolysis of lipid yields : - **[RPMT 2002]**

(1) Fats (2) Fatty acids and glycerol

(3) Mannose and glycerol (4) Maltose and fatty acid

Which cells of mucous layer of stomach secrete pepsinogen **[RPMT 2003]**

(1) Chief cell (2) Goblet cell (3) Parietal cell (4) Oxyntic cell

Glucose and galactose unite to form **[RPMT 2003]**

(1) Maltose (2) Sucrose (3) Isomaltose (4) Lactose

Dental formula in adult man is : - **[RPMT 2003]**

(1) $\frac{2123}{2123}$ (2) $\frac{2123}{2124}$ (3) $\frac{2122}{2122}$ (4) $\frac{2132}{2132}$

Vitamin–C is : - **[RPMT 2004]**

(1) Ascorbic acid (2) Citric acid (3) Phosphoric acid (4) Glutamic acid

Injury to vagus nerve in humans is not likely to affect - **[AIPMT 2004]**

(1) Gastrointestinal movement (2) Pancreatic secretion

(3) Cardiac movements (4) Tongue movements

Which one of the following is the correct matching of a vitamin, its nature and its deficiency disease : **[AIPMT 2004]**

(1) Vitamin K-Fat-soluble-Beri-Beri (2) Vitamin A-Fat-soluble-Beri-Beri

(3) Vitamin K-Water-soluble-Pellagra (4) Vitamin A-Fat-soluble-Night blindness

Brunner's gland are found in which of the following layers : **[MPPMT 2003]**

(1) Submucosa of stomach (2) Mucosa of ileum

(3) Submucosa of duodenum (4) Mucosa of oesophagus

The chief function of bile is to : **[BHU 2003]**

(1) Digest fat by enzymatic action (2) Emulsify fats for digestion

(3) Eliminate waste products (4) Regulate digestion of proteins

The toxic substance are detoxicated in the human body by : **[AIIMS 2001]**

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

Crypts to Leiberkuhn are found in between the villi. They secrete : **[MPPMT 2003]**

(1) Glucagon (2) Succus entericus (3) Insulin (4) None

Function of HCl in stomach is to : **[CPMT 1995]**

(1) Kill micro-organisms of food (2) Facilitate absorption of food

(3) Dissolve enzymes (4) Activate pepsinogen to pepsin

Parotid salivary gland are present : **[MPPMT 1993]**

(1) Below the tongue (2) Below the external auditory canal

(3) Below the eye orbit (4) In the angle between two jaws

The end product of carbohydrate metabolism is : **[AIIMS 1993]**

(1) CO_2 and H_2O (2) NH_3 and CO_2 (3) NH_3 and H_2O (4) CO_2

In rabbit, the digestion of cellulose takes place in : **[MPPMT 2000]**

(1) Colon (2) Ileum (3) Caecum (4) Rectum

The muscular contraction in the alimentary canal is known as : **[RPMT 1999]**

(1) Systole (2) Diastole (3) Peristalsis (4) Metachronal

How many teeth in man grows twice in life : **[AFMC 2002]**

(1) 32 (2) 28 (3) 20 (4) 12

End products of protein hydrolysis are : **[RPMT 2002]**

(1) Mixture of amino acids (2) Sugars

(3) Peptides (4) 25 amino acid

Ptyalin is an enzyme of **[CPMT 2003]**

(1) Salivary juice (2) Pancreatic juice (3) Intestinal juice (4) None of these

The hormone 'Secretin' stimulates secretion of **[BHU 2000]**

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

Brunner's glands are present in : **[AFMC 03]**

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

Which one of the following is fat-soluble vitamin and its related deficiency disease ? **[AIPMT 2007]**

(1) Ascorbic acid – Scurvy (2) Retinol – Xerophthalmia

(3) Cobalamine – Beri – beri (4) Calciferol – Pellagra

Chymotrypsinogen is produced by **[Uttarachal 2004]**

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

Scurvy is caused due to deficiency of vitamin : **[Uttarachal 2005]**

(1) 'B' complex (2) C (3) K (4) D

In human teeth, which help in cutting **[Bihar 2004]**

(1) Canine (2) Incisor (3) Molar (4) Premolar

HCl is secreted by which of the following cell of stomach **[Bihar 2004]**

(1) Chief cells (2) Parietal cell (Oxyntic cells)

(3) Peptic cells (4) Goblet cells

Fatty liver syndrome is due to excessive intake of **[Bihar 2003]**

(1) Morphine (2) Alcohol (3) Tobacco (4) both 1 and 2

Glisson's capsules are present in **[UP CPMT 2003]**

(1) Liver (2) Lung (3) Kidney (4) Stomach

Pulp cavity of teeth is lined by **[UP CPMT 2002]**

(1) Odontoblast (2) Chondroblast (3) Osteoblast (4) Amyloblast

Secretion of gastric juice is controlled by **[UP CPMT 2002]**

(1) Gastrin (2) Chlolecystokinin (3) Enterogastrin (4) None of these

Enzyme present in saliva is **[UP CPMT 2003]**

(1) Maltase (2) Ptyalin (3) Sucrase (4) Invertase

Which of the following metal is present in vitamin B_{12} **[UP CPMT 2003]**

(1) Cobalt (2) Copper (3) Zinc (4) Magnesium

Kupffer cells are present in **[UP CPMT 2003]**

(1) Liver (2) Pancreas (3) Small intestine (4) Large intestine

Teeth of rabbits are **[UP CPM 2004]**

(1) Thecodont (2) Diphyodont (3) Heterodont (4) All of these

Crypts of lieberkuhn are present in : **[UP CPMT 2006]**

(1) Intestine (2) Stomach (3) Oesophagus (4) All of these

Succus entericus is also called : **[UP CPMT 2006]**

(1) Gastric juice (2) Intestine juice (3) Bile juice (4) Saliva

Dental formula of rabbit is : **[UP CPMT 2007]**

(1) $\frac{2}{1}\frac{0}{0}\frac{3}{2}\frac{3}{3}$ (2) $\frac{2}{1}\frac{1}{0}\frac{3}{2}\frac{3}{3}$ (3) $\frac{2}{1}\frac{0}{0}\frac{2}{2}\frac{3}{3}$ (4) $\frac{1}{1}\frac{3}{2}\frac{0}{0}\frac{3}{3}$

Deamination occurs in **[UP CPMT 2007]**

(1) Kidney (2) Liver (3) Nephron (4) Both 1 and 2

Digestion of protein is completed in **[UP CPMT 2007]**

(1) Stomach (2) Duodenum (3) Ileum (4) Duodenum and ileum

Enterogasterone is **[UP CPMT 2007]**

(1) Hormone secreted by mucosa

(2) Enzyme secreted by mucosa

(3) Hormone secreted by duodenal mucosa

(4) Secreted by endocrine gland related to digestion

Part of bile juice useful in digestion is **[UP CPMT 2007]**

(1) Bile salt (2) Bile pigment (3) Bile matrix (4) All of them

bile secretion is proportional to the concentration of **[MPPMT 2007]**

(1) Protein (2) Fat (3) Carbohydrate (4) None of these

Secretion of pancreatic juice is stimulated by **[MPPMT 2007]**

(1) Gastrin (2) Secretion (3) Enterogastrone (4) Enterokinase

Just as hydrochloric acid is for pepsinogen, so is the : **[MPPMT 2004]**

(1) haemoglobin oxygen (2) enterokinase to typsinogen

(3) bile juice to fat (4) glucagons to glycogen

What is the function of globlet cells **[MPPMT 2004]**

(1) Production of enzyme (2) Production of mucin

(3) Production of hormone (4) Production of HCl

Where the lysozymes are found **[MPPMT 2004]**

(1) In saliva and tears both (2) In tears

(3) In saliva (4) In mitochondria

The hormone which lowers the secretion of hydro chloric acid and gastric juice is **[MPPMT 2005]**

(1) Secretin (2) Enterogastrone (3) Enterokinin (4) Gastrin

Which of the following is different from other : **MPPMT 2005]**

(1) Gastrin (2) Ptyalin (3) Glucagon (4) Secretin

Trypsin differs from pepsin because it digests : **[MPPMT 2005]**

(1) Carbohydrate in alkaline medium in stomach

(2) Protein, in alkaline medium in stomach

(3) Protein, in acidic medium of stomach

(4) Protin, in alkaline medium in duodenum

Pancreatic juice is : **[MPPMT 2005]**

(1) Alkaline in nature (2) Acidic in nature

(3) Enzymatic in nature (4) Both acidic and alkaline in nature

Scurvy disease is due to the **[MPPMT 2005]**

(1) Presnce of h-factor in blood (2) Deficiency of vitamin E

(3) Virus (4) Deficiency of vitamin C

The chemical name of vitamin D is **[MPPMT 2005]**

(1) Riboflavin (2) Ascorbic acid (3) Niacin (4) Calciferol

From which of the following pepsin is secreted **[MPPMT 2007]**

(1) Lungs (2) Stomach (3) Salivary gland (4) Sebaceous gland

Crypts of Lieberkuhn involved in : **[MPPMT 2006]**

(1) Secretion of succus entericus (2) Secretion of rennin

(3) Secretion of ptyalin (4) digestion of food

Which of the following vitamin synthesized in animal body by bacteria **[MPPMT 2006]**

(1) B_1 (2) A (3) E (4) B_{12}

Vitamin-C is mainly helpful in : **[MPPMT 2006]**

(1) Growth of bones (2) Formation of connective tissue

(3) Treatment of anaemia (4) Formation of visual pigment

A person addict for alcohol gets his liver destroyed because : **[MPPMT 2006]**

(1) Liver stores excess of protein (2) Liver stores excess of fat

(3) Liver stores excess of starch (4) Liver stores excess of glycogen

Bilirubin and Biliverdin are present in : **[MPPMT 2001]**

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

Marasmus disease is caused due to **[MPPMT 2001]**

(1) Protein deficiency (2) Obesity

(3) Dwarfism (4) Deficiency of vitamins

Brunner's gland are found in : **[MPPMT 2001]**

(1) Submucosa of stomach (2) Submucosa of duodenum

(3) Mucosa of oesophagus (4) Mucosa of ileum

Specific cells found in liver are : **[MPPMT 2001]**

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

Which of the following does not belong to vitamin B group : **[MPPMT 2002]**

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

Deficiency of which vitamin causes night blindness : **[MPPMT 2002]**

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

Certain B vitamins are : **[MPPMT 2002]**

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

Deficiency of thiamine causes : **[MPPMT 2002]**

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

Anti-sterility vitamin is : **[MPPMT 2002]**

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

The longitudinal muscular folds of inner wall of stomach are called : **[MPPMT 2007]**

(1) Papilla of vater (2) Rugae (3) Villi (4) Fissure

Cells of liver which act as phagocytes are : **[MPPMT 2002]**

(1) Dieter's cells (2) Kupffer's cells (3) Hensen cells (4) Aciner cells

The crypts of lieberkuhn secret : **[MPPMT 2003]**

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

In adults the deficiency of vitamin D causes: **[MPPMT 2003]**

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

The function of enterogasterone hormone is : **[MPPMT 2003]**

(1) to control excretion

(2) to inhibit gastric juice secretion

(3) regulate the absorption of food

(4) to stimulate gastric glands to release gastric juice

Brunner's glands are located in : **[MPPMT 2003]**

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

Which of the following inhibits secretion of gastric juice : **[MPPMT 2003]**

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

Pepsinogen is secreted from : **[MPPMT 2002]**

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

Cells of the pancreas is not digested by their own enzymes because : **[MPPMT 2003]**

(1) enzymes are secreted in inactive form (2) cells are lined by mucous membrane

(3) enzymes are released only when needed (4) none of the above

Carrier ions like Na^+ facilitate the absorption of substances like – **[CPMT 2010]**

(1) amino acids and glucose (2) glucose and fatty acids

(3) fatty acids and glycerol (4) fructose and some amino acids

If for some reason our goblet cells are non-functional, this will adversely affect – **[CPMT 2010]**

(1) production of somatostatin

(2) secretion of sebum from the sebaceous glands

(3) maturation of sperms

(4) smooth movement of food down the intestine

Consumption of which one of the following foods can prevent the kind of blindness associated with vitamin 'A' deficiency ? **[AIPMT Pre 2012]**

(1) Canolla (2) Golden rice (3) Bt-Brinjal (4) 'Flaver Savr' tomato

Cirrhosis of liver is caused by the chronic intake of : **[AIPMT Pre 2012]**

(1) Alcohol (2) Tobacco(Chewing)

(3) Cocaine (4) Opium

Anxiety and eating spicy food together in an othewise normal human, may lead to : **[AIPMT Pre 2012]**

(1) Jaundice (2) Diarrhoea (3) Vomiting (4) Indigestion

Where do certains symbiotic microorganisms normally occur in human body ? **[AIPMT Mains 2012]**

(1) Caecum (2) Oral lining and tongue surface

(3) Vermiform appendix and rectum (4) Duodenum

Select the correct match of the digested products in humans given in column I with their absorption site and mechanism in column II. **[AIPMT 2013]**

Column I	**Column II**
(1) Fructose, Na^+	small intestine, passive absorption
(2) Glycerol, fatty acids	duodenum, move as chilomicrons
(3) Cholesterol, maltose	large intestine, active absorption
(4) Glycine, glucose	small intestine, active absorption

Fructose is absorbed into the blood through mucosa cells of intestine by the process called: **[AIPMT 2014]**

(1) simple diffusion (2) co-transport mechanism
(3) active transport (4) facilitated transport

The initial step in the digestion of milk in humans is carried out by? **[AIPMT 2014]**

(1) Rennin (2) Pepsin (3) Lipase (4) Trypsin

Answer Key

Q.1	4	Q.2	4	Q.3	2	Q.4	2	Q.5	2	Q.6	3	Q.7	1
Q.8	1	Q.9	3	Q.10	2	Q.11	1	Q.12	3	Q.13	4	Q.14	2
Q.15	2	Q.16	2	Q.17	3	Q.18	1	Q.19	3	Q.20	2	Q.21	2
Q.22	4	Q.23	3	Q.24	1	Q.25	4	Q.26	2	Q.27	1	Q.28	2
Q.29	3	Q.30	3	Q.31	3	Q.32	1	Q.33	1	Q.34	3	Q.35	1
Q.36	3	Q.37	1	Q.38	1	Q.39	3	Q.40	1	Q.41	1	Q.42	1
Q.43	1	Q.44	1	Q.45	1	Q.46	1	Q.47	2	Q.48	4	Q.49	3
Q.50	4	Q.51	4	Q.52	4	Q.53	3	Q.54	3	Q.55	3	Q.56	4
Q.57	2	Q.58	1	Q.59	4	Q.60	1	Q.61	1	Q.62	4	Q.63	4
Q.64	3	Q.65	2	Q.66	3	Q.67	2	Q.68	4	Q.69	2	Q.70	1
Q.71	3	Q.72	3	Q.73	3	Q.74	3	Q.75	1	Q.76	1	Q.77	2
Q.78	2	Q.79	2	Q.80	2	Q.81	3	Q.82	2	Q.83	2	Q.84	1
Q.85	1	Q.86	1	Q.87	2	Q.88	1	Q.89	1	Q.90	4	Q.91	1
Q.92	2	Q.93	1	Q.94	4	Q.95	4	Q.96	3	Q.97	4	Q.98	2
Q.99	2	Q.100	2	Q.101	2	Q.102	1	Q.103	2	Q.104	2	Q.105	4
Q.106	1	Q.107	4	Q.108	4	Q.109	2	Q.110	1	Q.111	1	Q.112	2
Q.113	2	Q.114	3	Q.115	1	Q.116	2	Q.117	3	Q.118	4	Q.119	3
Q.120	2	Q.121	1	Q.122	3	Q.123	2	Q.124	2	Q.125	4	Q.126	4
Q.127	2	Q.128	2	Q.129	1	Q.130	3	Q.131	1	Q.132	4	Q.133	1
Q.134	2	Q.135	1	Q.136	4	Q.137	1	Q.138	4	Q.139	4	Q.140	1

EXERCISE – 3 AIIMS Special Questions

Instruction :

In the following questions, a statement of assertion (A) is followed by a statement of reason (R).

(1) If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark (1).

(2) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark (2).

(3) If Assertion is true statement but Reason is false, then mark (3).

(4) If both Assertion and Reason are false statements, then mark (4).

A : Gastrectomy causes iron deficiency anaemia.

R : Hydrochloric acid secreted by oxyntic cells converts ferric into ferrous and iron is absorbed as ferrous ions.

A : Cholagogues are substances that cause contraction of gall bladder.

R : These substances cause release of CCK-PZ from duodenum.

A : Aptyalism patients have higher than normal incidences of dental caries.

R : Aptyalism is caused by the action of Parasympathetic nervous system.

A : In humans, duct of wirsung from pancreas combines with bile duct before opening into duodenum.

R : Blockage in duct of wirsung will prevent the endocrine function of pancreas.

A : In acute constipation , purgatives containing magnesium salts are generally used.

R : The osmotic effect of Mg^{2+} in the intestinal lumen prevents water reabsorption from intestine. Mg^{2+} increases the solute concentration in the intestinal lumen because Mg^{2+} is absorbed very slowly.

A : Tonsils are located near the of the alimentary and respiratory tract

R : Tonsils produces digestive enzymes

A : Mucous glands occur throughout the alimentary canal

R : Mucous substances facilitate movement of food through the alimentary canal

A : Vitamins are essential for healthy life.

R : Vitamins regulate metabolism.

A : In human, maximum digestion occurs in duodenum.

R : Amupla of vater opens in duodenum.

A : Chief cells of gastric gland secrete intrinsic castle's factor.

R : This factor help in vita. B_2 absorption.

A : Emulsification is necessary for the digestion of fat.

R : After fats are emulsified, the action of enzyme amylase gets significantly increase.

A : Abomassum of alimentary canal of reminant animals harbour numerous bacteria & protozoa.

R : Bacteria & protozoa help in the secretion of gastric juice in abomassum.

A : Vitamin ‘C’ occurs only in animal tissue.

R : The vegetarian patients are suggested to take carrot & green vegetables when they suffer from Vita. ‘C’ deficiency.

A : Pancreatic amylase digest protein to amino acids.

R : Pancreatic amylase the peptide bond of protein.

A : Digestion is necessary for the absorption of all macro elements.

R : Digestion makes large complex molecule to simple smaller molecule which can be easily absorbed.

A : Rumen is regarged as the true stomach in ruminant animal.

R : Fermentation of protein takes place in Rumen.

A : Carbohydrates are more suitable for the production of energy in the body than protein and fats.

R : Carbohydrate can be stored in epithelial tissue as glycogen for use in the production of energy, whenever necessary.

A : Gastrectomy causes iron deficiency anaemia

R : Hydrochloric acid secreted by oxyntic cells converts ferric into ferrous and iron is absorbed as ferrous ions.

A : Cholagogues are substance that cause contraction of gall bladder.

R : These substance cause release of CCK-PZ from duodenum.

Answer Key

Q.1	1	Q.2	1	Q.3	3	Q.4	3	Q.5	1	Q.6	3	Q.7	1
Q.8	1	Q.9	2	Q.10	1	Q.11	3	Q.12	4	Q.13	4	Q.14	4
Q.15	3	Q.16	4	Q.17	3	Q.18	1	Q.19	1				