

16. Digestion and Absorption

Introduction

Food is one of the basic requirements of all living organisms. The major components of our food are carbohydrates, proteins and fats. Vitamins and minerals are also required in small quantities. Food provides energy and organic materials for growth and repair of tissues. A substance which is taken to supply the necessary nutrients to the body is termed food or diet. The water we take in, plays an important role in metabolic processes and also prevents dehydration of the body. Biomacromolecules in food cannot be utilised by our body and their original form. They have to be broken down and converted into simple substances in the digestive system. 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.

Green plants can directly utilise the energy of sunlight to synthesize organic molecules (Autotrophic nutrition) but animals derive organic food materials by consuming products of plants, hence have Heterotrophic nutrition.

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 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 in human nutrition.

Types of Nutrition in Animals : The mechanism by which organisms obtain food is referred to as the modes of nutrition. The organisms either synthesize their own food or obtain food prepared by other organisms in various ways. There are basically two modes of nutrition - autotrophic and heterotrophic.

- **Autotrophic nutrition**

'auto' means self and 'trophic' refers to food. So, the organisms, which synthesize their own food using CO_2 , are called the autotrophs and the process is called autotrophic nutrition.

Autotrophs include all green plants and some bacteria such as the nitrifying bacteria.

- **Heterotrophic nutrition**

'hetero' refers to other or different and 'trophic' refers to food. Thus, the organisms that obtain their food from other organisms are called heterotrophs and the process of obtaining the food from other organisms is called heterotrophic nutrition. All heterotrophs depend directly or indirectly on the autotrophic organisms for their food and energy requirements. Heterotrophs include most of the bacteria, fungi and all animals.

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 through mouth, e.g., most of the animals.
- (2) **Saprophytic** : When decaying organic materials of plant or animal origin are consumed. They secrete digestive enzymes directly onto their 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 incompare 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 on blood e.g. leech, female mosquitoes, vampirebats.
- (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 which 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** : Every organism requires energy to be active.^[1] However, to obtain energy from its outside environment, cells must not only retrieve molecules from their surroundings but also break them down. This process is known as intracellular digestion.

Intracellular digestion is the breakdown of substances within the cytoplasm of a cell. In detail, a phagocyte's duty is obtaining food particles and digesting it in a vacuole. For example, following phagocytosis, the ingested particle (or phagosome) fuses with a lysosome containing hydrolytic enzymes to form a phagolysosome; the pathogens or food particles within the phagosome are then digested by the lysosome's enzymes. Digestion within cells e.g. Amoeba.

- (ii) **Extracellular digestion** : Extracellular digestion is a process in which saprobionts feed by secreting enzymes through the cell membrane onto the food. The enzymes catalyze the digestion of the food into molecules small enough to be taken up by passive diffusion, transport or phagocytosis. Since digestion occurs outside the cell, it is said to be extracellular. It takes place either in the lumen of the digestive system, in a gastric cavity or other digestive organ, or completely outside the body. Digestion outside the cell. e.g. frog, rabbit, man.

Differences between intracellular and extracellular digestion

Intracellular digestion		Extracellular digestion
1.	The digestion of food occurs within the cell.	The digestion occurs outside the cell in the cavity of alimentary canal.
2.	Digestive enzymes are secreted by the surrounding cytoplasm into the food vacuole.	Digestive enzymes are secreted by special cells into the cavity of alimentary canal.
3.	Digestive products are diffused into the cytoplasm.	Digestive products diffuse across the intestinal wall into various parts of the body.
4.	It is a less efficient method.	It is a more efficient method of digestion.
5.	It occurs in unicellular organisms.	It occurs in multicellular organisms.

Digestive System of Mammals

Digestive system of man consist of alimentary canal and some accessory digestive organ.

The Alimentary Canal : It is coiled muscular tube about 6 - 9 metres long extending from moth 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 vestibulae.

The roof of buccal cavity is palate consisting of hard palate (maxilla, premaxilla and palatine bones) and soft palate. 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

Teeth present on upper and lower jaws are

- Incisors : for cutting, have one root.
- Canines : for tearing, have one root.
- Premolars : in upper premolar 2 roots and lower premolar 1 root.
- Molars : for chewing, in upper molar 3 roots and lower molar 2 roots.

Classification according to position

- Acrodont : These teeth arise from jaw bone. (reptiles), amphibians and fishes.
- Pleurodont : Teeth fixed to lateral surface of jaw ridge e.g., fangs of snakes.
- Thecodont : Embedded in sockets (mammals and crocodiles).

Classification according to arrangement of enamel and dentine :

- Bunodont : Small cusps e.g., human
- Lophodont : Long transverse dentine covered by enamel e.g., elephants.
- Selenodont : Crescent shaped cusps e.g., sheep / cattle.
- Secodont : Pointed cusps e.g., carnivores

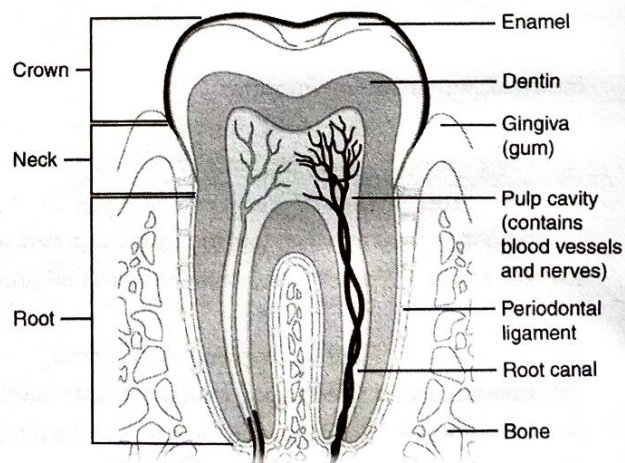


Fig. Section of human molar

Dental formulate

Rabbit : i 2/1, c 0/0, pm 3/2, m 3/3 $\times 2 = 28$

Man : i 2/2, c 1/1, pm 2/2, m 3/3 $\times 2 = 32$. In man 20 teeth twice during life time i.e., diphyodont $\begin{pmatrix} 2102 \\ 2102 \end{pmatrix}$ Premolars and lat molar absent) and 12 teeth appear only once i.e. Monophyodont $\begin{pmatrix} 0021 \\ 0021 \end{pmatrix}$.

Points to Remember :

- (1) Canines are absent in rodents, this gap is called diastema.
- (2) In carnivores one premolar and one molar are long called-carnassial teeth
- (3) In elephant two incisors of upper jaw keep on growing throughout called tusks. Tooth with persistent pulp
- (4) Large number of teeth are present in house and pig.
- (5) Enamel (secreted by ameloblast). Hardest substance of the body – Ectodermal in origin.
- (6) Dentine (secreted by odontoblast) – main part of tooth – mesodermal origin.
- (7) Caries – Decay of teeth due to degeneration of enamel and formation of cavities.
- (8) Pyorrhoea : Infected gums, and tooth sockets.

Tonsils

Lymphoid tissue of pharynx is called tonsils. It include

- (i) Nasopharyngeal/pharyngeal tonsil/adenoids,
- (ii) Palatine/faucial tonsils
- (iii) Lingual tonsils

These are arranged in a ring like manner – Waldeyer's ring.

Oesophagus

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

Oesophagus is characterized 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-keratinized stratified squamous epithelium some of which are ciliated.
- (iv) Presence of voluntary (anterior 1/3rd) and involuntary muscle fibres (posterior 2/3rd)

Stomach

Stomach is oval and pouch like, 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.

The wall of stomach has three layers of muscles outermost longitudinal layer, middle circular layer and innermost 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.

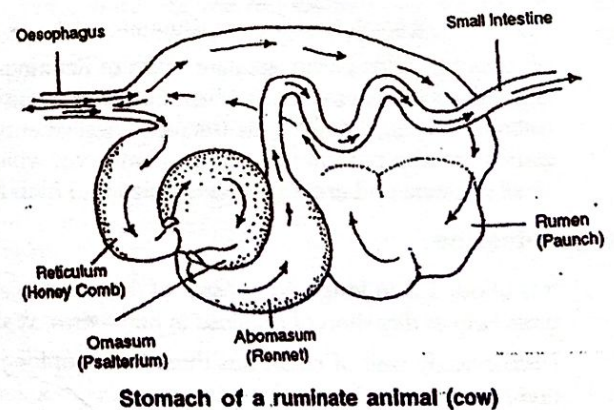
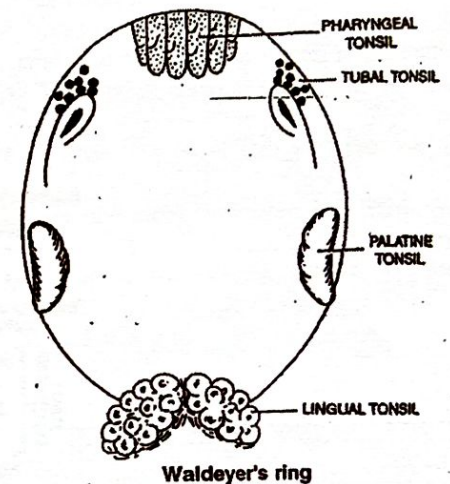
The peptic cells or chief cell or zymogenic cells release large quantity of pepsinogen.

Stomach of Ruminants

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.

Rabbits eat their own faeces (coprophagy) to complete the digestion of cellulose. It is taken as pseudoruminant.

Semisolid food mixed with gastric juices in stomach known as Chyme (it is highly acidic).

Small intestine

First part is duodenum, it is 25 cm long, C-shaped in humans and has opening of hepatopancreatic duct (Bile duct + Pancreatic duct). A small swelling is present at the opening of hepatopancreatic duct and is called 'Ampulla of Vater' or Hepatopancreatic ampulla and the opening is regulated by sphincter of Oddi.

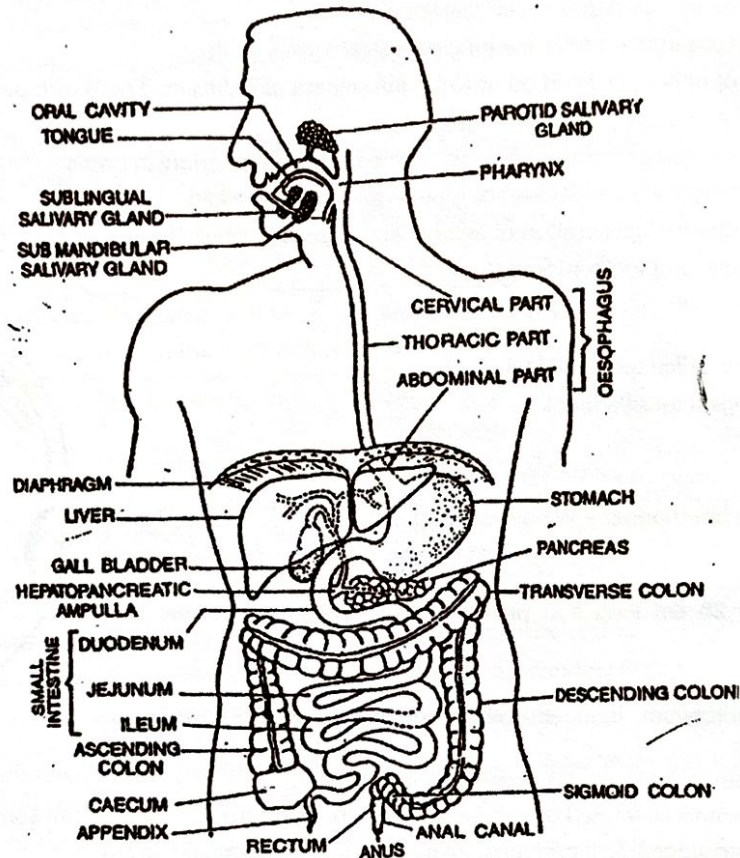


Fig. : Human digestive system

Next parts of small intestine are jejunum and ileum. The wall of intestine has thin layers of longitudinal and circular muscles.

Mucosa has folds plicae circulares (folds of Kerkrings or Valvulae conniventes) and villi towards lumen of the intestine. Epithelial cells lining the villi have microvilli which further increase the absorptive area. Intestinal glands or Crypts of Lieberkuhn have epithelial cells (secrete mucus), Paneth cells (secrete digestive enzymes) and argentaffin cells (probably secrete hormones). In duodenum Brunner's glands are also present (located in submucosa) which secrete mucus. Diffused patches of lymphoid 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 part is divisible into ascending, transverse, descending and sigmoid colon. Ascending colon is the smallest and is without mesentery. Last part of rectum is anal canal having a strong sphincter. It opens outside by anus.

Important

In certain condition (like persistent constipations) rectal veins can get distended enlarged due, to weakening of valves of it (varicosity). It leads to swollen areas called **hemorrhoids**.

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 (= Serosus membrane or Serosa)** : It is the outer most layer made up of squamous epithelium. It is continuous with the mesentery.

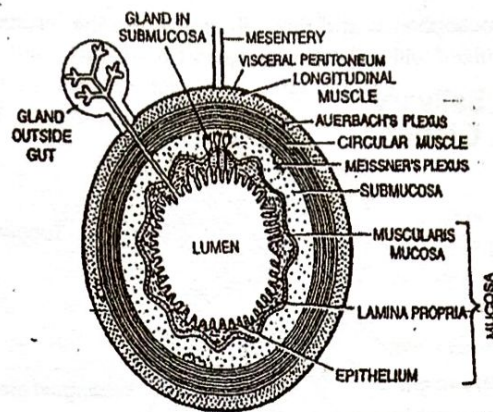


Fig. : General structure of the wall of the mammalian gut and associated structure

- (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 unstriated (smooth). The muscularis coat also contain the major nerve supply to the gastrointestinal tract - the myenteric plexus (plexus of Auerbach) which consist of fibers 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 unstriated.
 - (ii) The lamina propria, the middle layer of mucosa, consists of loose connective tissue, blood vessels, glands and some lymphoid tissue.
 - (iii) The inner most layer is the epithelium, which forms gastric glands in stomach, and villi and intestinal glands in small intestine.

In upper one third of the oesophagus both Auerbach and Meissner's plexuses are absent.

Digestive Organs

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 termed the sulcus terminalis divides the upper surface, of the tongue into anterior oral part and posterior pharyngeal part. The apex of the sulcus terminalis projects backward 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 papilla on its surface.

- (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
Tips and sides	—	Salt
Sides	—	Sour
Base	—	Bitter

Sweat glands of dogs are present on tongue (panting of dog).

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 – Whartons act
- (iii) Sublingual : Smallest – located below the tongue – Rivinus duct.
- (iv) Infra orbital : Absent in man otherwise present below eyes e.g., in rabbit.

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 innervations 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.

Salivary Glands

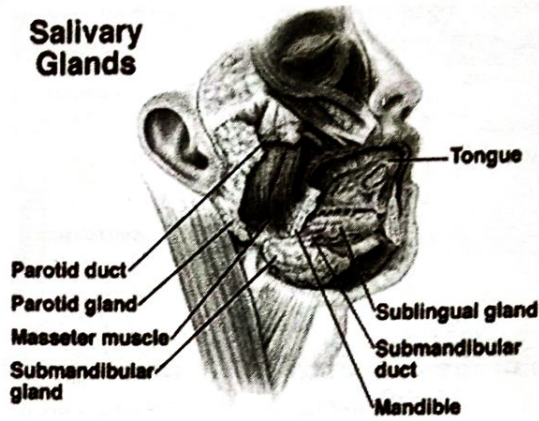


Fig : Human Salivary Glands

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 lobe. 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 on the-posterior surface. 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.

Gall bladder is situated on the inferior surface of right lobe. It is 8 cm long and 2 cm wide.

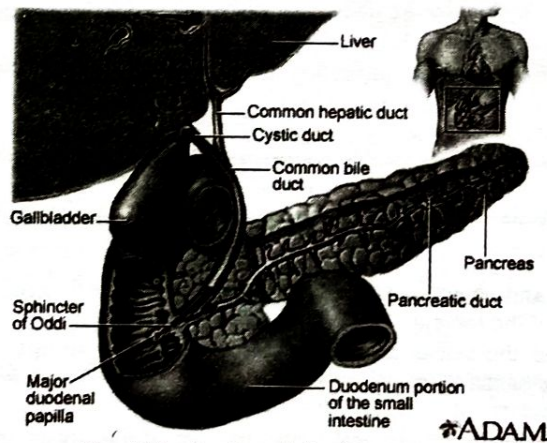


Fig: Bile duct and the Pancreatic duct

Bile is secreted by hepatocytes into the bile canaliculi, a series of narrow spaces between adjacent liver cells. The canaliculi 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.

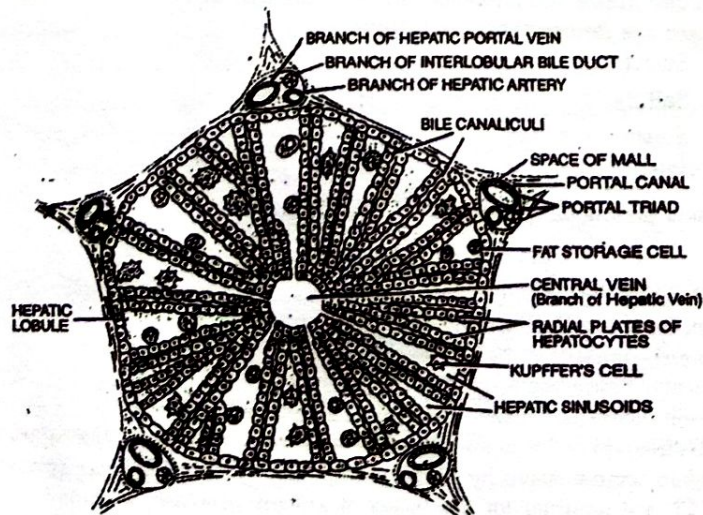


Fig. : A Part of transverse section of mammalian liver

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 into the pancreatic duct. Sphincter of Oddi surrounds the ampulla of Vater.

Functions of Liver

- (1) **Secretion of bile** : Daily secretion 700–1000 ml. In the gall bladder, electrolytes and water are reabsorbed concentrating bile approximately 10 to 15 times. Bile contains bile pigments bilirubin and biliverdin, bile salts sodium glycocholate, sodium taurocholate and sodium bicarbonate. Sodium bicarbonate is mainly responsible for alkaline nature of bile (pH = 8.0). Cholesterol is insoluble in water but the association with bile acid and phospholipid makes it soluble. In subjects who regularly produce bile supersaturated with cholesterol, the cholesterol may be deposited in the gall bladder as gallstones (cholelithiasis). Inflammation of gall bladder is called cholecystitis.
- (2) **Storage of fat.**
- (3) **Urea synthesis.**
- (4) **Erythropoiesis (during embryonic period only)**
- (5) **Breakdown of RBCs.**
- (6) **Iron is stored as ferritin.**

Pancreas

It is a racemously 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 with 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.

Mobility of Alimentary Canal

Alimentary canal undergoes regular contraction for proper digestion, absorption of food. Food enters into buccal cavity where it is mixed with saliva. Food is masticated with the help of teeth mechanical breakdown of food as well as 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 –

Important -

In the stomach mechanical churning of the food occurs by waves of contractions passing from cardiac to pyloric and also mixing of food with gastric juice occurs. During this activity, cardiac and pyloric sphincter remain closed. If cardiac sphincter remains open, acidic gastric content may escape into the esophagus leads to heart burn condition due to burning sensation in oesophagus.

Cardia achalasia.

From stomach, acidic chyme enters the small intestine where digestion is complete followed by absorption of digested food. From small intestine, chyle enters large intestine and finally egested out.

Movements in the alimentary canal are caused by myenteric plexus as well as hormones like motilin, serotonin, villikin, gastrin etc. It shows 3 types of movements.

Peristalsis

It involves contractions and relaxation resulting in wave like movement. 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 movement starts 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.

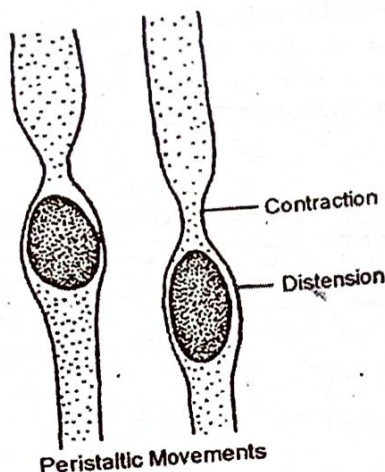


Fig. : Digestion And Gastro-Intestinal Secretions

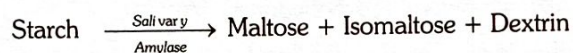
Digestion of Carbohydrates :

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.

Knowledge Plus

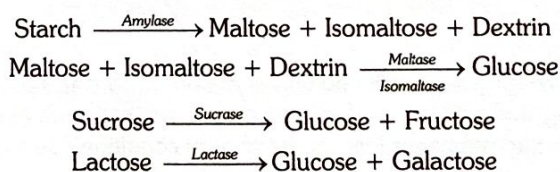
In the mouth cavity, the food is mixed with saliva. It contains an enzyme called salivary amylase or ptyalin. Salivary amylase acts on starch and converts it into maltose, isomaltose and small dextrins or limit dextrin (disaccharides). Chewing and mastication of food increases the action of salivary amylase.



On starch by increasing the surface area of food on which the enzyme acts. Cooking of food also helps the action of salivary amylase by causing breaches in the cellulosic cell walls. The amylase hydrolyzes in the mouth itself. The action of salivary amylase continues for some time even in the stomach but soon HCl present in the gastric juice destroys all the enzyme.

Salivary amylase is absent from the saliva of many mammals like cows, buffaloes; and predatory carnivores like lions and tigers. However, pigs have got amylase in their saliva.

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. Intestinal juice contains a number of carbohydrases like maltase, isomaltase, sucrase and lactase. Maltase and isomaltase act on maltose, isomaltose and dextrin and convert them into glucose; sucrase acts on sucrose to convert it into glucose and fructose; and lactase acts on lactose to convert it into glucose and galactose.



Galactosemia : Galactosemia is a metabolic disorder due to the absence of the enzyme uridyl transferase. As a result, galactose will accumulate leading to mental retardation. It can be prevented in galactosemic children by giving them a milk-free diet.

Knowledge Plus

Human beings can digest lactose present in the milk. But with advancing age, they also cannot digest milk. This is because less of lactase is produced. In them, lactose remains undigested and gets fermented in the intestine producing gases and acids. This results in flatulence, intestinal cramps and diarrhoea. So these persons must consume curd or yoghurt (sweetened curd) as lactose is fermented to lactic acid in them. This will not pose any digestive problem to them.

Digestion of Proteins

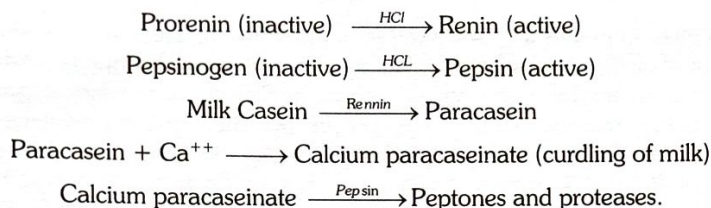
Proteins are complex organic compounds made up of smaller units called amino acids. So in the process of digestion, all proteins are broken down to amino acids. Enzymes that hydrolyse proteins are collectively known as proteases or peptidases. Many of these enzymes are secreted in their inactive form 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 convert 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 in them. Pepsin then acts on it. These reactions are summarized below :

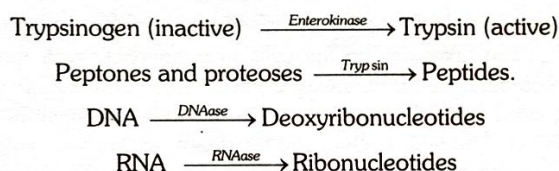


Knowledge Plus

Pepsin can digest collagen of connective tissues fibres, but it cannot act on keratin of horns hair skin or nail.

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 amyllopsin, 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 :



Knowledge Plus

In predatory animals trypsin can hydrolyze fibrinogen of blood into fibrin leading to blood coagulation. But it is unable to bring about coagulation of milk. Also, trypsin cannot hydrolyze keratins.

Chymotrypsinogen (inactive) is activated to chymotrypsin by trypsin itself. Chymotrypsin is another important milk coagulating enzyme and can hydrolyze 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.

Note :

- (1) Carboxypeptidase hydrolyses the terminal carboxyl group from peptide bonds to release the last amino acid from the peptides thus making the peptide shorter.
- (2) Intestinal juice or succus entericus contains two protein digesting enzymes amino peptidases 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 acid. Enterokinase is also released which activates trypsinogen to trypsin.

Digestion of Fats :

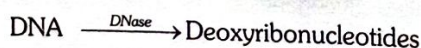
Fat digestion starts only when the food reaches the stomach. Some amount of gastric lipase is present. Gastric lipase is of little importance except in pancreatic insufficiency.

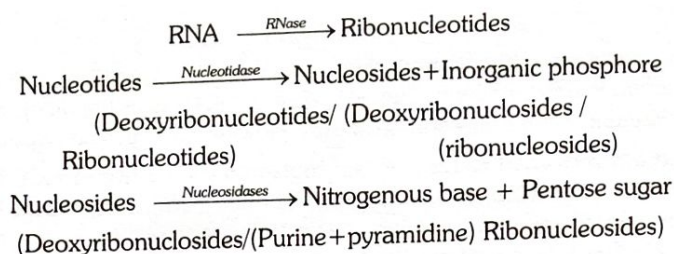
Most of fat digestion begins in the duodenum, pancreatic lipase being one of the most important enzymes involved. Bile juice, contains bile salts that break down the bigger molecules of fat globules into smaller droplets by reducing the surface tension of fat droplets. This process is known as emulsification 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 acid 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.





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 amino acids are absorbed actively. Absorption of glucose or amino acids 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^+ (Co transport). Na^+ is moving along concentration gradient while glucose/amino acids are moving against concentration gradient. Rate of absorption of galactose is highest. Fructose is absorbed by facilitated diffusion.

The product of fat digestion - monoglycerides, fatty acids and glycerol are first incorporated into water soluble droplets called micelles (a combination of fatty acid, 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 (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 RBC 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 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 in connection with 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 kidney.
- (ii) The excess of the monosaccharides; the 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 the 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 in 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 around packing material and between organs. In the 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, thiamin, and riboflavin that are absorbed across the wall 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 also, the residues of excretory products from intestinal mucosa and glands).

Nutritional Requirements of Humans

Energy Yielding Nutrients

Carbohydrates are used primarily as sources of chemical energy, to be either metabolized 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 utilized as energy sources, when broken down to amino acids. Out of the 22 amino acids identified so far as the constituents of proteins, 8 (10 in children) cannot be synthesized 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 synthesize 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.

Knowledge Plus

The caloric value : The energy requirement of animals, and the energy content of food, is expressed in terms of a measure of heat energy because heat is the ultimate form of all energies. This is often referred to as calorie (cal) or joule (J), which is the amount of heat energy required to raise the temperature of 1 g water 1°C. Since this value is a tiny amount of energy, physiologists commonly use kilocalorie (kcal) as a unit of measure (1 kcal = 1,000 calories) or kilojoule (kJ). One kilocalorie is the amount of energy required to raise the temperature of 1 kg capitalized). The amount of heat liberated from complete combustion of 1 g food in a bomb calorimeter (a closed metal chamber filled with O₂) is its gross calorific or gross energy value. The actual amount of energy liberated in the human body due to combustion of 1 g of food is the physiologic value of food. Gross calorific values of carbohydrates, proteins and fats are 4.1 kcal/g, 5.65 kcal/g and 9.45 kcal/g, respectively. Whereas their physiologic value are 4.0 kcal/g, 4.0 kcal/ and 9.0 kcal/g, respectively.

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 synthesize 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 synthesize vitamin D (calciferol) in their skin in presence of ultra-violet rays of sunlight. Although most animals can synthesize 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 compound of thyroid gland which contain iodine (I₂) 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. cystine and methionine. It is also present in saliva, bile and insulin but are synthesized in the body with the help of cystine and methionine.

Mineral Nutrition

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

- (1) Calcium (Ca) : Help. 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 deficiency may cause diarrhoea or excessive vomiting etc.
- (4) Sodium (Na) : Capable 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. CC' is a compound of HCl which 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 contents are good in some green leaves and present also in meat.
- (8) Zinc (Zn) : Respiratory enzyme, carbonic anhydrase present in RBC contains zinc.
- (9) Cobalt (Co) : It is present as a part of vitamin B₁₂. It is synthesized in the rumen with the help of bacteria. Cobalt is necessary in formation of RBCs

Summary of Digestion

Part of alimentary tract	Name of glands	Enzyme	Optimum pH	Substrate (acted upon)	End products
1. Buccal cavity	Salivary glands	Salivary amylase (Ptyalin)	6.8	Starch	Maltose
2. Oesophagus	–	No enzyme	–	–	–
3. 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
4. Liver	Hepatocytes	Bile (no enzyme)	7.1 – 8.2	Fats	Emulsify fats
5. Pancreas	Acini	1. Trypsin 2. Chymotrypsin 3. Carboxy-peptidase 4. Amylase (Amylopsin) 5. Lipase (Steapsin) 6. Nucleases	7.1 – 8.3	Proteins Blood Proteins Milk Proteins Peptides Starch Fats RNA, DNA	Peptones and polypeptide Coagulation Coagulation Dipeptides and amino acids Maltose Glycerol and fatty acids Nucleotides
6. Small intestine	Crypts of Leiberkuhn	1. Enterokinase 2. Erepsin 3. Dipeptidase 4. Lipase 5. Maltase 6. Sucrase 7. Lactase 8. Nucleotidases 9. Nucleosidase	7.6	Trypsinogen Peptides Dipeptide Fats Maltose Sucrose Lactose Nucleotides Nucleosides	Trypsin Dipeptide and amino acids Amino acids Glycerol and fatty acids Glucose Glucose, fructose Glucose, galactose Nucleosides Free bases
7. Large intestine		No digestive enzyme, only mucus	–	Lubricates faeces	–

Nutritional Deficiencies and Disorders

Dietary deficiencies of proteins and total food calories are widespread in many underdeveloped countries of South and South-east Asia, South America, and West and Central Africa. Protein-energy malnutrition (PEM) may affect large sections of the populations during drought, famine and political turmoil. This happened in Bangladesh during the liberation war and in Ethiopia during the severe drought in mid-eighties. PEM affects infants and children to produce Marasmus and Kwashiorkor.

Marasmus is produced by a simultaneous deficiency of proteins and calories. It is found in infants less than a year in age, if mother's milk is replaced too early by other foods which are poor in both proteins and caloric value. This often happens if the mother has second pregnancy or childbirth when the older infant is still too young.

In Marasmus, protein deficiency impairs growth and replacement of tissue proteins; extreme emaciation of the body and thinning of limbs results, the skin become dry, thin and wrinkled. Growth rate and body weight decline considerably. Even growth and development of brain and mental faculties are impaired.

Kwashiorkor is produced by protein deficiency unaccompanied by calorie deficiency. It results from the replacement of mother's milk by a high calorie-low protein diet in a child more than one year in age. Like marasmus, kwashiorkor shows wasting of muscles, thinning of limbs, failure of growth and brain development. But unlike marasmus, some fat is still left under the skin; moreover, extensive oedema and swelling of body parts are seen.

Control of Enzyme Secretion

Part of alimentary canal	Hormone	Stimulation	Inhibition
1. Epithelium of stomach	Gastrin	HCl and pepsin	–
2. 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 enzymes in pancreatic juice contraction of gall bladder	–
3. Epithelium of duodenum and ileum	Enterocrinin	Succus entericus	
4. Intestinal villi	Villikin	Movement of villi to increase absorption	–

Summary of Human Vitamin

Vitamin	Common Sources	Function	Deficiency
A. Water Soluble			
1. B. Complex			
(i) B ₁ Thiamine	Yeast, wheat germ, peanuts, beans, lean meat.	Part of coenzymes for aerobic metabolism of carbohydrates, aids in pentose synthesis and metabolism	Beriberi
(ii) B ₂ Riboflavin	Yeast, liver, milk, cheese, leafy vegetables, intestinal bacteria.	Part of coenzymes (FMN, FAD) in ETS, also needed for oxidation endoplasmic reticulum.	Eye inflammation, lip sores
(iii) B ₃ Pantothenic Acid	Yeast, peas, liver	Part of coenzyme A in cell respiration	Abnormal adrenal functioning
(iii) B ₆ Pyridoxine	Meat, Milk, wheat germ, liver, banana	Part of coenzymes in amino acid and glycogen syntheses.	Skin lesions, CNS disorder.
(v) B ₅ Niacin	Yeast, wheat germ, peanuts, meat.	Part of coenzymes (NAD, NADP) that act as hydrogen acceptors and donors.	Pellagra
(vi) B ₉ Folic acid	Liver, green vegetables, banana, orange	Part of coenzymes in protein and nucleic acid metabolism	Anaemia, sprue
(vii) Biotin	Fresh fruits and vegetables, liver, milk, eggs, whole grain, cereals,	Coenzyme in fatty acid synthesis and in charge of pyruvate to oxaloacetate.	Scaly and itchy skin
(viii) B ₁₂ , Cyanocobalamin	Liver, eggs	Coenzymes for nucleic acid metabolism	Pernicious anaemia
2. C, Ascorbic Acid	Citrus fruits, tomatoes, peppers,	Play a role in collagen formation.	Scurvy
B. Lipid Soluble			
1. A, Retinol	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
2. D, Calciferol	Fish liver oil egg yolk milk liver formed in skin by action of ultraviolet light.	Facilitates absorption of calcium and phosphorus by intestine and their retention in the body and deposition bones.	Rickets children, osteomalacia in adults.
3. E, Tocoferol	Leafy vegetables, whole cereal grains, vegetable oils.	Antioxidant, some role in ETS.	Destruction RBC's
4. K, Phylloquinone	Leafy vegetables, soyabean oil, intestinal	Synthesis of prothrombin for	Faulty blood

Overnutrition

Overnutrition is defined as the overconsumption of nutrients and food to the point at which health is adversely affected.

Overnutrition can be either

General, i.e. due to excessive amounts of food of any or all types, leading to obesity and the many life-threatening conditions associated with it.

Specific, i.e. excess of a single nutrient e.g. a single vitamin or mineral. The health consequences of such excess depend on the nutrient and the severity of the excess.

The most common consequence of overnutrition or over eating is obesity.

However, even people of a healthy weight (or who are under-weight) can experience adverse effects of 'overnutrition' as a result of consuming an excessive amount of a single nutrient, e.g. a vitamin or mineral. That can happen for various reasons such as:

- (1) Only having access to a limited range of foods hence consuming too much of some dietary components as well as, perhaps, not enough of others.
- (2) Having a healthy diet and lifestyle and also consuming unnecessary dietary supplements such that the combination of food and supplement intake result in an overall dangerous excess of one or more nutrients. This can be a particular risk when taking several different types of supplements without studying the labels carefully to ensure that the combination is appropriate for the person.
- (3) 'Fad diets', meaning extreme eating regimes which are often promoted with claims about achieving desired goals, e.g. for weight loss, in a very short time, can be unsafe if they involve consuming excessive quantities of a limited range of foods. Such regimes can place people at risk from excessive amounts of some nutrients as well as from under nutrition diseases.

Some Important Points

- (1) Assimilation : Utilization of absorbed material by the cell.

- (2) Hunger centre is in hypothalamus
 - (3) Satiety centre is also in hypothalamus.
 - (4) Heart burn has nothing to do with the heart. It is caused by the regurgitation of acid from stomach into the oesophagus.
 - (5) Splanchnology is the study of the viscera.
 - (6) NIN : National institute of Nutrition Hyderabad.
 - (7) Anorexia : loss of appetite
 - (8) Spoilt hay of sweet clover *Melilotus indica* (fodder and green manure) contains a substance called dicumarol. Dicumarol prevents the action of vitamin K as it is antagonistic to it.
 - (9) What destroy the vitamin? Over cooling and excessive boiling, medicines like aspirin, antacids, diuretics and oestrogens, excessive alcohol, tobacco and coffee.
 - (10) Tea/coffee inhibits the absorption of iron from the diet. Prolonged consumption of tea or coffee after meals can lead to iron deficiency – anaemia.
 - (11) In the upper one third of oesophagus, only skeletal muscles are found
 - (12) Chief site of water absorption is small intestine.
 - (13) Liver produces like albumin, fibrinogen, prothrombin, but does not produce g-globulin
 - (14) Poison glands of a snake are modified salivary glands homologous to parotid salivary glands.
 - (15) Vomerine teeth of frog kill the prey
 - (16) Tongue of whale is not movable.
 - (17) Gall bladder is absent in adult lamprey (jawless vertebrate). Grain eating birds, rats, whales, all the perissodactyla (odd toed hoofed mammals, such as horse). And some artiodactyla (even toed hoofed mammals.)
 - (18) Alcoholics are short of vitamin C
 - (19) A 'U' shaped duodenum is a characteristic of man
 - (20) During high fever, one does not feel like taking meals because high temperature shuts off the appetite centre.
 - (21) Bile is alkaline in man but acids in cats and dogs.
 - (22) 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
 - (23) 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.
 - (24) Entero-Hepatic circulation : Or 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.
- (25) 'Choloretic' are substances which increase bile secretion from liver e.g., bile salts.
 - (26) 'Cholagogues' are substances which causes the contraction of gall bladder.

Quick Recap

- (1) 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 masticates 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.
- (2) The mucosa of stomach has gastric glands. Gastric gland have three major types of cells namely :
 - (i) Mucus neck cell which secrete mucus.
 - (ii) Peptic of chief cells which secrete the proenzyme pepsinogen.
 - (iii) Parietal or oxyntic cells which secrete HCl and intrinsic factor, which is responsible for the absorption of B₁₂. Small amounts of lipases are also secreted by intrinsic glands.
- (3) 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 nucleases. Trypsinogen is activated by an enzyme, enterokinase, secreted by intestinal juice into active trypsin, which in turn activates the other enzymes of pancreatic juice.
- (4) Bile released into the duodenum contains the bile pigments, bile salts, cholesterol, phospholipids but no enzymes. But helps in emulsification of fats.
- (5) The intestinal mucosal epithelium secretes succus entericus/intestinal juice. This juice contains a variety of enzymes like maltase, dipeptidases, lipases, nucleosidases etc.,. The mucus alongwith the bicarbonates from the pancreas protects the intestinal mucus from acid as well as provide an alkaline medium (pH 7-8) for enzymatic activities. Submucosal glands (Brunner's glands) also help in this.
- (6) The food then enters into the 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.

16. Digestion and Absorption – Multiple Choice Questions

1. Digestive System

1. The hardest substance of vertebrate body is
 - (a) Keratin
 - (b) Enamel
 - (c) Dentine
 - (d) Chondrin
2. Dental formula of rabbit is

(a) $\frac{1023}{1023}$	(b) $\frac{3023}{3023}$
(c) $\frac{1023}{2023}$	(d) $\frac{2103}{2304}$
(e) $\frac{2023}{1023}$	
3. In rabbit, the digestion of cellulose takes place in
 - (a) Colon
 - (b) Ileum
 - (c) Caecum
 - (d) Rectum
4. Two friends are eating together on a dining table. One of them suddenly starts coughing while swallowing some food. This coughing would have been due to improper movement of
 - (a) Tongue
 - (b) Epiglottis
 - (c) Diaphragm
 - (d) Neck
5. The function of tongue is to
 - (a) Help in the act of swallowing
 - (b) Help in mixing saliva with the food
 - (c) Help in speaking
 - (d) All the above
6. Tusk of an elephant is an enormously enlarged
 - (a) Upper canine
 - (b) Lower incisor
 - (c) Upper incisor
 - (d) Lower canine
7. Pulp cavity of teeth is lined by
 - (a) Odontoblast
 - (b) Chondroblast
 - (c) Osteoblast
 - (d) Amyloblast
8. Teeth in frog are
 - (a) Acrodont
 - (b) Homodont
 - (c) Polyphyodont
 - (d) All of these
9. Dental formula of human being is

(a) I_2, C_2, P_1, M_3	(b) I_2, C_1, P_2, M_3
(c) I_3, C_1, P_2, M_2	(d) I_2, C_2, P_3, M_1
10. The muscular contraction in the alimentary canal is known as
 - (a) Systole
 - (b) Diastole
 - (c) Peristalsis
 - (d) Metachronal
11. Inner lining of gut, stomach and liver is composed of
 - (a) Simple squamous epithelium
 - (b) Simple columnar epithelium
 - (c) Simple cuboidal epithelium
 - (d) Compound epithelium
12. Peyer's patches contain
 - (a) Mucus
 - (b) Sebum
 - (c) Lymphocytes
 - (d) Red blood cells
13. A rabbit eats a lot of gram. Then its digestion starts in
 - (a) Mouth
 - (b) Stomach
 - (c) Duodenum
 - (d) Ileum
14. Select what is not true of intestinal villi among followings
 - (a) They possess microvilli
 - (b) They increase the surface area
 - (c) They are supplied with capillaries and the lacteal vessels
 - (d) They only participate in digestion of fats
15. One of the following is not a common disorder associated with digestive system

(a) Tetanus	(b) Diarrhoea
(c) Jaundice	(d) Dysentery
16. Where do certain symbiotic microorganisms normally occur in human body
 - (a) Caecum
 - (b) Oral lining and tongue surface
 - (c) Vermiform appendix and rectum
 - (d) Duodenum
17. Anxiety and eating spicy food together in an otherwise normal human, may lead to

(a) Indigestion	(b) Jaundice
(c) Diarrhoea	(d) Vomiting
18. In the empty stomach, mucosal folds appear. They are called

(a) Fiveoles	(b) Ancinura angularis
(c) Rugae	(d) None
19. Lamina propria is related with

(a) Human intestine	(b) Liver of human being
(c) Graffian follicle	(d) Acinus of pancreas
20. How many teeth in man grows twice in life

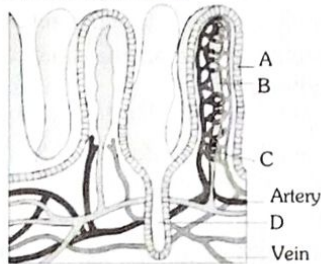
(a) 32	(b) 28
(c) 20	(d) 12
21. The back flow of faecal matter in the large intestine is prevented by the presence of
 - (a) Epiglottis
 - (b) Sphincter of Oddi
 - (c) Ileo-Caecal valve
 - (d) Gastro-oesophageal sphincter
 - (e) Pyloric sphincter
22. A pair of small lymphatic tissue present at the sides of root tongue is called as

(a) Thyroid	(b) Tonsils
(c) Epiglottis	(d) Adenoids
23. The mucosal layer in the stomach form irregular folds known as

(a) Villi	(b) Lumen
(c) Rugae	(d) Crypts of Lieberkuhn
(e) Lacteals	
24. Crown of teeth is covered by

(a) Dentine	(b) Enamel
(c) Both (a) and (b)	(d) None of these
25. "Chief cells" or "Zymogen cells" secrete the enzymes of the gastric juice, are found in the
 - (a) Isthmus of the gland
 - (b) Neck of the tubular gland
 - (c) Base of the tubular region
 - (d) All the above

26. Wisdom teeth's are
(a) Last molars (b) Last premolars
(c) Incisors (d) Canines
27. Narrower distal end of stomach is called
(a) Cardiac (b) Duodenum
(c) Pharynx (d) Pylorus
28. Brush bordered epithelium is found in
(a) Trachea (b) Stomach
(c) Small intestine (d) Fallopian tube
29. Which of the following is correct regarding diastema
(a) Gap between bones
(b) Gap between the teeth
(c) Gap between nerves
(d) Gap between cells
30. The given figure shows a section of small intestinal mucosa showing villi. Identify A to D



- (a) A - Crypts, B - Lacteal, C - Capillaries, D - Villi
(b) A - Villi, B - Lacteal, C - Crypts, D - Capillaries
(c) A - Lacteal, B - Villi, C - Capillaries, D - Crypts
(d) A - Villi, B - Lacteal, C - Capillaries, D - Crypts
31. Sacculus rotundus is present in
(a) Duodenum of rabbit (b) Ileum of frog
(c) Ileum of rabbit (d) Colon of rabbit
32. Part of the stomach which opens into the duodenum
(a) Cardiac (b) Pyloric
(c) Fundus (d) Body
33. Match the two columns and select the correct among options given
- | Column I | | Column II | |
|----------|---------------------------|-----------|---------------------------------------|
| A. | Biomacromolecules of food | i. | Alimentary canal and associated gland |
| B. | Human digestive system | ii. | Embedded in jawbones |
| C. | Stomach | iii. | Outer wall of visceral organs |
| D. | Thecodont | iv. | Converted into simple substances |
| E. | Serosa | v. | J-shaped bag like structure |
- (a) A-ii, B-i, C-v, D-iii, E-iv
(b) A-iv, B-i, C-v, D-ii, E-iii
(c) A-i, B-ii, C-iii, D-iv, E-v
(d) A-i, B-iii, C-ii, D-iv, E-v
34. Match the two columns and select the right one among options given

Column I	Column II
A. Duodenum	i. A cartilaginous flap
B. Epiglottis	ii. Small blind sac
C. Glottis	iii. 'U' shaped structure emerging from the stomach
D. Caecum	iv. Opening of wind pipe

Options:

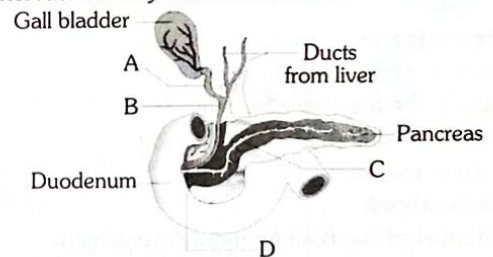
- (a) A-i, B-ii, C-iii, D-iv (b) A-iv, B-iii, C-ii, D-i
(c) A-iii, B-i, C-iv, D-ii (d) A-ii, B-iv, C-i, D-iii

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

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

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

36. Meckel's diverticulum is found in
(a) Ileum (b) Appendix
(c) Pylorus (d) Rectum
37. The given figure is a duct system of liver, gall bladder and pancreas. Identify the names of ducts from A to D



- (a) A - Cystic duct, B - Pancreatic duct, C - Bile duct, D - Hepato - pancreatic duct
(b) A - Cystic duct, B - Bile duct, C - Hepato - pancreatic duct, D - Pancreatic duct
(c) A - Bile duct, B - Cystic duct, C - Pancreatic duct, D - Hepato - pancreatic duct
(d) A - Cystic duct, B - Bile duct, C - Pancreatic duct, D - Hepato - pancreatic duct
38. Jaundice is caused by
(a) Contaminated water
(b) Pork
(c) Excessive sugar
(d) Excessive eating of curcuma
39. Which one of the following is a protein deficiency disease
(a) Eczema (b) Cirrhosis
(c) Kwashiorkor (d) Night Blindness

2. Digestive glands

1. Pancreatic juice contains
(a) Trypsin, lipase and maltase
(b) Pepsin, trypsin and maltase
(c) Trypsin, chymotrypsin, amylase and lipase
(d) Trypsin, pepsin and amylase
2. A good source of lipase is
(a) Saliva (b) Pancreatic juice
(c) Bile (d) Gastric juice

3. Parotid salivary gland are present
 - (a) Below the tongue
 - (b) Below the ear
 - (c) Below the eye orbit
 - (d) In the angle between two jaws
4. Argentaffin cells are found in
 - (a) Pancreas
 - (b) Internal ear
 - (c) Gastric glands
 - (d) Liver
5. Ptyalin is
 - (a) Strongly acidic
 - (b) Slightly acidic
 - (c) Slightly neutral
 - (d) Strongly alkaline
6. HCl is secreted by
 - (a) Zymogen cells
 - (b) Oxyntic cells
 - (c) Kupffer cells
 - (d) Mucous cells
7. Goblet cells are
 - (a) Unicellular mucous gland
 - (b) Multicellular mucous gland of stomach
 - (c) Tubula-veolar gland
 - (d) All of the above
8. Brunner's gland are found in which of the following layers
 - (a) Submucosa of stomach
 - (b) Mucosa of ileum
 - (c) Submucosa of duodenum
 - (d) Mucosa of oesophagus
9. Pepsinogen is secreted by
 - (a) Chief cells
 - (b) Parietal cells
 - (c) Gastric glands
 - (d) Intestinal cells
10. Crypt of Lieberkuhn is example for
 - (a) Simple tubular gland
 - (b) Coiled tubular gland
 - (c) Compound alveolar gland
 - (d) Compound tubular gland
11. In pancreas, pancreatic juice and hormones are secreted by
 - (a) Same cells
 - (b) Different cells
 - (c) Same cells at different times
 - (d) None of these
12. The pH of amylase present in saliva is
 - (a) 6
 - (b) 6.8
 - (c) 7.2
 - (d) 8
13. Succus entericus is the name given to
 - (a) Junction between ileum and large intestine
 - (b) Intestinal juice
 - (c) Swelling in the gut
 - (d) Appendix
14. Glisson's capsule is found in
 - (a) Pancreas
 - (b) Liver
 - (c) Gall bladder
 - (d) Intestine
15. The number of salivary glands in man is
 - (a) Two pairs
 - (b) Three pairs
 - (c) Four pairs
 - (d) Five pairs
16. Ptyalin is an enzyme of
 - (a) Salivary juice
 - (b) Pancreatic juice
 - (c) Intestinal juice
 - (d) None of these
17. The trypsin enzyme is secreted by
 - (a) Stomach
 - (b) Duodenum
 - (c) Pancreas
 - (d) Liver
18. Bilirubin and billiverdin are found in
 - (a) Blood
 - (b) Bile
 - (c) Pancreatic juice
 - (d) Saliva
19. Brunner's glands are found in Submucosa of
 - (a) Stomach
 - (b) Pancreas
 - (c) Intestine
 - (d) Oesophagus
20. Which one of the following does not produce any digestive enzyme
 - (a) Intestinal mucosa
 - (b) Gastric mucosa
 - (c) Pancreas
 - (d) Liver
21. The largest gland in the human body is
 - (a) Liver
 - (b) Brain
 - (c) Pancreas
 - (d) Thyroid
22. Lysozymes are found in
 - (a) Saliva
 - (b) Tears
 - (c) Saliva and tears both
 - (d) Mitochondria
23. Amount of saliva secreted daily in humans is
 - (a) 250 ml
 - (b) 500 ml
 - (c) 100 ml
 - (d) 1000 ml
24. Which of the following statement is not correct
 - (a) Goblet cells are present in the mucosa of intestine and secrete mucus
 - (b) Oxyntic cells are present in the mucosa of stomach and secrete HCl
 - (c) Acini is present in the pancreas and secretes carboxypeptidase
 - (d) Brunner's glands are present in the submucosa of stomach and secrete pepsinogen
25. Gastric juice of infants contains
 - (a) Nuclease, pepsinogen, lipase
 - (b) Pepsinogen, lipase, rennin
 - (c) Amylase, rennin, pepsinogen
 - (d) Maltase, pepsinogen, rennin
26. Which is correct about the bile of rabbit
 - (a) It is synthesized by gall bladder and also stored there
 - (b) It is an enzyme which emulsify the fats
 - (c) It contain bile salts and bile pigments
 - (d) Bilirubin present in it decomposed fats
27. One of the constituents of the pancreatic juice while poured into the duodenum in humans, is
 - (a) Trypsin
 - (b) Enterokinase
 - (c) Trypsinogen
 - (d) Chymotrypsin
28. Enzymes which acts similarly are called as
 - (a) Isoenzymes
 - (b) Cofactor
 - (c) Coenzymes
 - (d) All the above
29. Zymogen cells and chief cells secrete
 - (a) Hydrochloric acid
 - (b) Mucus
 - (c) Pepsin
 - (d) Trypsin
30. Bile synthesis occurs in
 - (a) Liver
 - (b) Duodenum
 - (c) Pancreas
 - (d) Stomach
31. Pepsin is produced by
 - (a) Salivary glands
 - (b) Stomach
 - (c) Duodenum
 - (d) Small intestine
32. Which of the following is a gastro-intestinal enzyme
 - (a) Cholinesterase
 - (b) Enterokinase
 - (c) Secretin
 - (d) Prolactin
33. Deoxyribonuclease and ribonuclease are secreted by
 - (a) Liver
 - (b) Stomach
 - (c) Pancreas
 - (d) Kidney
34. Hepato-pancreatic duct opens into the duodenum and carries
 - (a) Bile
 - (b) Pancreatic Juice
 - (c) Both bile and pancreatic juice
 - (d) Saliva

35. A gland not associated with the alimentary canal is
(a) Pancreas (b) Adrenal
(c) Liver (d) Salivary glands
36. Mark the right statement among the following
(a) Trypsinogen is an inactive enzyme
(b) Trypsinogen is secreted by intestinal mucosa
(c) Enterokinase is secreted by pancreas
(d) Bile contains trypsin
37. This is the common passage for bile and pancreatic juices
(a) Ampulla of Vater (b) Ductus Choledochus
(c) Duct of Wirsung (d) Duct of Santorini
38. Erythropoiesis starts in
(a) Kidney (b) Liver
(c) Spleen (d) Red bone marrow
39. Match column I with column II and choose the correct option

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

- (a) A-3, B-1, C-4, D-2 (b) A-1, B-3, C-4, D-2
(c) A-2, B-3, C-1, D-4 (d) A-4, B-1, C-2, D-3
(e) A-2, B-1, C-4, D-3
40. In man, Glisson's capsule is associated with the
(a) Digestive system (b) Excretory system
(c) Nervous system (d) Reproductive system
(e) Endocrine system
41. pH of gastric juice is
(a) 2 (b) 4
(c) 6 (d) 8
42. Characteristic of mammalian liver is
(a) Kupffer's cells and leucocytes
(b) Leucocytes and canaliculi
(c) Glisson's capsules and Kupffer cells
(d) Glisson's capsules and leucocytes
43. Which one of the following is not the reason for very high load of bilirubin in a newborn
(a) Excessive red blood corpuscles in the newborn burst, releasing the bilirubin
(b) The liver of the newborn is too young to cope up with the heavy load of bilirubin
(c) Mother's milk contain a high amount of bilirubin
(d) Insoluble bilirubin in the intestine is reabsorbed by the blood
44. Cholesterol is synthesized in
(a) Pancreas (b) Brunner's gland
(c) Spleen (d) Liver
45. The amount of gastric juice secreted per day from man's stomach is about
(a) 5000ml to 10000ml (b) 2000ml to 3000ml
(c) 100ml to 500ml (d) 10ml to 15ml
46. Kupffer cells of liver are
(a) Loose connective tissue (b) Phagocytic cell
(c) Mast cell (d) Fat cell
47. Kupffer cells are found in
(a) Mouth (b) Liver
(c) Kidney (d) Stomach

48. Find out the correct match

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

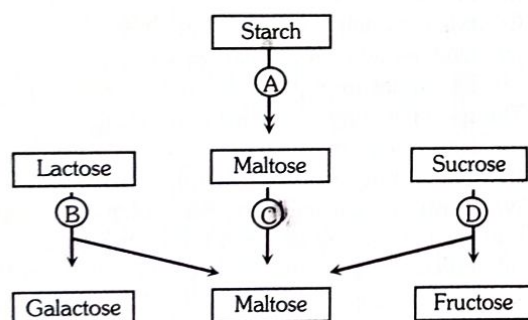
- (a) A-3, B-6, C-2, D-5, E-4
(b) A-5, B-2, C-3, D-6, E-1
(c) A-3, B-1, C-2, D-5, E-4
(d) A-4, B-6, C-5, D-2, E-1
(e) A-4, B-2, C-6, D-5, E-3

3. Physiology of digestion

- In mammals, the digestion of starch starts from
(a) Mouth (b) Stomach
(c) Oesophagus (d) Duodenum
- Lacteals are central lymph vessels which are found in
(a) Liver (b) Pancreas
(c) Villi (d) Spleen
- Which one of the following is the correct pairing of the site of action and the substrate of rennin
(a) Stomach-Casein (b) Stomach-Fat
(c) Small intestine-Protein (d) Mouth-Starch
- The site of protein digestion is
(a) Gullet (b) Stomach
(c) Small intestine (d) Oral cavity
- The glucose is converted into glycogen in liver and stored in
(a) Liver (b) Liver and muscles
(c) Liver and spleen (d) Spleen and muscles
- Which word best describes the action of bile on fats
(a) Neutralizes (b) Digests
(c) Emulsifies (d) Absorbs
(e) Dissolves
- If pancreas is removed, the compound which remain undigested is
(a) Carbohydrates (b) Fats
(c) Proteins (d) All of these
- Chylomicrons are
(a) Undigested proteins
(b) Undigested carbohydrates
(c) Fat droplets coated with glycerol and protein
(d) Fat droplets coated with phospholipids
- The end product of carbohydrate metabolism is
(a) CO_2 and H_2O (b) NH_3 and CO_2
(c) NH_3 and H_2O (d) CO_2
- Which one of the following statements about glycogen is correct
(a) It is a disaccharide stored in liver which can react with ammonia to form proteins
(b) It is synthesized in the liver and takes part in the formation of bile and lipase, besides being a source of energy
(c) It is a polysaccharide which is synthesized and stored in liver cells
(d) It is synthesized in blood and stored in liver and muscles to provide glucose in times of need

11. If for some reason the parietal cells of the gut epithelium become partially non-functional, what is likely to happen
 - (a) The pancreatic enzymes and specially the trypsin and lipase will not work efficiently
 - (b) The pH of stomach will fall abruptly
 - (c) Steapsin will be more effective
 - (d) Proteins will not be adequately hydrolyzed by pepsin into proteoses and peptones
12. Some proteolytic enzymes are
 - (a) Trypsin, Erepsin, pepsin
 - (b) Amylopsin, steapsin, ptyalin
 - (c) Amylase, lipase, zymase
 - (d) Urease, zymase, dehydrogenase
13. Pepsin acts on
 - (a) Fats
 - (b) Proteins
 - (c) Carbohydrates
 - (d) Glucose
14. Trypsin differs from pepsin in that
 - (a) It digests protein in alkaline medium while pepsin does so in acidic medium
 - (b) It digests protein in acidic medium while pepsin does so in alkaline medium
 - (c) Both (a) and (b)
 - (d) None of these
15. In man cellulose is digested in
 - (a) The caecum
 - (b) The colon
 - (c) The appendix
 - (d) Not digested at all
16. Essentially the word 'digestion' means
 - (a) Burning of food
 - (b) Oxidation of food
 - (c) Hydrolysis of food
 - (d) Breakdown of food
17. Rennin acts on milk proteins and converts
 - (a) Caseinogen into casein
 - (b) Casein into paracasein
 - (c) Caseinogen into paracasein
 - (d) Paracasein into caseinogen
18. Fructose is absorbed into the blood through mucosa cells of intestine by the process called
 - (a) Simple diffusion
 - (b) Co-transport Mechanism
 - (c) Active transport
 - (d) Facilitated transport
19. If this enzyme were to be absent in our small intestine, digestion of proteins in our body would be severely affected
 - (a) Pancreatic amylase
 - (b) Maltase
 - (c) Lipase
 - (d) Enterokinase
20. Which one of the following enzymes initiates protein digestion
 - (a) Aminopeptidase
 - (b) Carboxypeptidase
 - (c) Trypsin
 - (d) Pepsin
21. Which one of the following is the correct match of digestive enzyme and substrate
 - (a) Lactose–Renin
 - (b) Starch–Maltose
 - (c) Fat–Steapsin
 - (d) Casein–Trypsin
22. What is common among amylase, rennin and trypsin
 - (a) These all are proteins
 - (b) These all are proteolytic enzymes
 - (c) These are produced in stomach
 - (d) These act at a pH lower than 7
23. Liver is the largest gland and is associated with various functions, choose one which is not correct
 - (a) Metabolism of carbohydrate
 - (b) Digestion of fat
 - (c) Formation of bile
 - (d) Secretion of hormone called gastric
24. Fatty acid and glycerol are first taken up from alimentary canal by
 - (a) Villi
 - (b) Blood capillaries
 - (c) Hepatic portal vein
 - (d) Lymph vessels
25. One of the following is needed for the conversion of trypsinogen into trypsin
 - (a) HCl
 - (b) Enterokinase
 - (c) Lipase
 - (d) Zymase
26. Which of the following carries glucose from digestive tract to liver
 - (a) Hepatic artery
 - (b) Pulmonary vein
 - (c) Hepatic portal vein
 - (d) Renal portal system
27. Which of the following sugars is absorbed from the small intestine by facilitated diffusion
 - (a) Fructose
 - (b) Glucose
 - (c) Sucrose
 - (d) Lactose
28. If for some reason our goblet cells are non-functional, this will adversely affect
 - (a) Smooth movement of food down the intestine
 - (b) Production of somatostatin
 - (c) Secretion of sebum from the sebaceous glands
 - (d) Maturation of sperms
29. A infant may be feeding entirely on mother's milk which is white in color but the stools which the infant passes out is quite yellowish. What is this yellow color due to
 - (a) Intestinal juice
 - (b) Bile pigments passed through bile
 - (c) Undigested milk protein casein
 - (d) Pancreatic juice poured into duodenum
30. The special feature of bile juice is that it
 - (a) Has no enzyme
 - (b) Has amylase
 - (c) Contains lipase
 - (d) Contains H₂O
31. Which one of the following pairs of food components in humans reaches the stomach totally undigested
 - (a) Protein and starch
 - (b) Fat and starch
 - (c) Fat and cellulose
 - (d) Starch and cellulose
32. Digestion of both starch and protein is done by
 - (a) Gastric juice
 - (b) Gastric lipase
 - (c) Pancreatic juice
 - (d) Ptylin
33. Which one of the following statements is true regarding digestion and absorption of food in humans
 - (a) Oxyntic cells in our stomach secrete the proenzyme pepsinogen
 - (b) Fructose and amino acids are absorbed through intestinal mucosa with the help of carrier ions like Na⁺
 - (c) Chylomicrons are small lipoprotein particles that are transported from intestine into blood capillaries
 - (d) About 60% of starch is hydrolyzed by salivary amylase in our mouth
34. Fats and lipids are absorbed in
 - (a) Lymph capillaries
 - (b) Blood capillaries
 - (c) Hepatic portal vein
 - (d) None of these
35. In the gastrointestinal tract the Meissner's plexus and the Auerbach's plexus occur respectively in the
 - (a) Lamina propria and muscularis mucosa
 - (b) Submucosa and muscularis external
 - (c) Submucosa and mucosa
 - (d) Mucosa and muscularis external

36. Which one of the following is the correct matching of the site of action on the given substrate, the enzyme acting upon it and the end product
- (a) Small intestine \longrightarrow Proteins Pepsin Amino acids
 (b) Stomach \longrightarrow Fats Lipase micelles
 (c) Duodenum \longrightarrow Triglycerides Trypsin monoglycerides
 (d) Small intestine \longrightarrow Starch α Amylase Disaccharide-de (Maltose)
37. Most digestion and absorption of food takes place in
 (a) Stomach (b) Small intestine
 (c) Large intestine (d) Caecum
38. Carrier ions like Na^+ facilitate the absorption of substances like
 (a) Fructose and some amino acids
 (b) Amino acids and glucose
 (c) Glucose and fatty acids
 (d) Fatty acids and glycerol
39. Digestion of starch takes place in
 (a) Stomach and duodenum
 (b) Buccal cavity and duodenum
 (c) Buccal cavity and oesophagus
 (d) Duodenum only
40. Function of HCl in stomach is to
 (a) Kill micro-organisms of food
 (b) Facilitate absorption of food
 (c) Dissolve enzymes
 (d) Activate pepsinogen to pepsin
41. The following is a scheme showing the fate of carbohydrates during digestion in the human alimentary canal. Identify the enzymes acting at stages indicated as A, B, C and D. Choose the correct option from those given



- (a) A = amylase, B = maltase, C = lactase, D = invertase
 (b) A = amylase, B = maltase, C = invertase, D = lactase
 (c) A = amylase, B = invertase, C = maltase, D = lactase
 (d) A = amylase, B = lactase, C = maltase, D = invertase
42. The food that enters intestine from stomach is called
 (a) Chyle (b) Chyme
 (c) Fundus (d) None of these
43. Match list I with list II and choose the correct option
- | List I | List II |
|----------------------|----------------------------|
| (A) Salivary amylase | (1) Proteins |
| (B) Bile salts | (2) Milk proteins |
| (C) Rennin | (3) Starch |
| (D) Pepsin | (4) Lipids |
| (E) Steapsin | (5) Emulsification of fats |
- (a) (A) — (5), (B) — (4), (C) — (1), (D) — (2), (E) — (3)
 (b) (A) — (2), (B) — (3), (C) — (4), (D) — (5), (E) — (1)
 (c) (A) — (2), (B) — (4), (C) — (3), (D) — (1), (E) — (5)
 (d) (A) — (3), (B) — (5), (C) — (2), (D) — (1), (E) — (4)
 (e) (A) — (3), (B) — (5), (C) — (1), (D) — (2), (E) — (4)

44. Glucagon secreted by the alpha-cells of the islets of Langerhans does this function
 (a) Glucagon converts glucose into glycogen and increases the concentration of blood sugar
 (b) Glucagon converts glycogen into glucose and increases the concentration of blood sugar
 (c) Glucagon converts glucose into glycogen
 (d) None of these
45. Match the enzyme with their respective substrate and choose the right one among options given

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

Options :

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

4. Gastro intestinal hormones / Digestive enzymes

- What will happen if the secretion of parietal cells of gastric glands is blocked with an inhibitor
 (a) In the absence of HCl secretion, inactive pepsinogen is not converted into the active enzyme pepsin
 (b) Enterokinase will not be released from the duodenal mucosa and so trypsinogen is not converted to trypsin
 (c) Gastric juice will be deficient in chymosin
 (d) Gastric juice will be deficient in pepsinogen
- Mechanical stimulation of villi by the food produces a hormone which is known as
 (a) Gastrin (b) Progesterone
 (c) Enterocrinin (d) Pancreozymin
- When fat is in the stomach the secretion of gastrin is inhibited. This inhibition is due to
 (a) Presence of fat
 (b) Non-stimulation of vagus
 (c) Slow digestion of fat
 (d) Release of enterogastron
- Secretin
 (a) Stimulates enzyme secretion by pancreas, inhibits acid secretion in stomach, stimulates gall bladder
 (b) Stimulates bicarbonate secretion by pancreas, inhibits acid secretion in stomach, stimulates bicarbonate secretion by liver
 (c) Stimulates acid secretion in stomach, potentiates action of CCK, inhibits intestinal movement
 (d) Stimulates gall bladder, inhibits acid secretion in stomach, stimulates bicarbonate secretion by pancreas
- Which part of body secretes the hormone Secretin
 (a) Ileum (b) Stomach
 (c) Duodenum (d) Oesophagus
- The activator of intestinal juice is
 (a) Succus entericus (b) Secretin
 (c) Enterocrinin (d) Enterozymase
- Duodenum has characteristic Brunner's glands which secrete two hormones called
 (a) Prolactin, parathormone
 (b) Estradiol, progesterone
 (c) Kinase, estrogen
 (d) Secretin, Cholecystokinin

5. Nutrition and Nutritional requirement

1. When breast feeding is replaced by less nutritive food low in proteins and calories; the infants below the age of one year are likely to suffer from
 - (a) Marasmus
 - (b) Rickets
 - (c) Kwashiorkor
 - (d) Pellagra
2. What is the common between amino acids, fatty acids and glycerol
 - (a) These are all rich source of calories
 - (b) These are the builders of protoplasm
 - (c) These are the end products of digestion of two categories of food constituents
 - (d) These can be stored in the form of fat
3. To get sufficient carbohydrates one should take
 - (a) Meat
 - (b) Rice
 - (c) Carrots
 - (d) Ground nuts
4. Milk protein is
 - (a) Rennin
 - (b) Casein
 - (c) Galactose
 - (d) Glycine
5. Lactose is composed of
 - (a) Glucose + fructose
 - (b) Glucose + glucose
 - (c) Glucose + galactose
 - (d) Fructose + galactose
6. Which one of the following set is a polysaccharide group
 - (a) Glucose, fructose, lactose
 - (b) Starch, glycogen, cellulose
 - (c) Sucrose, maltose, glucose
 - (d) Galactose, starch, sucrose
7. Role of carbohydrates is to function as
 - (a) Catalyst
 - (b) Source of energy
 - (c) Enzyme
 - (d) Building material
8. Deficiency of vitamin C causes
 - (a) Anaemia
 - (b) Rickets
 - (c) Scurvy
 - (d) Xerophthalmia
9. Water soluble vitamins are
 - (a) Vitamin A, B and C
 - (b) Vitamin B and C
 - (c) Vitamins C and D
 - (d) None of these
10. Vitamin C is
 - (a) Ascorbic acid
 - (b) Nicotinic acid
 - (c) Lipoic acid
 - (d) Aspartic acid
11. Term "vitamin" was given by
 - (a) James Lind
 - (b) Sterling
 - (c) Funk
 - (d) J.C. Drummond
12. Synthesis of vitamin A in the body takes place in
 - (a) Blood
 - (b) Pancreas
 - (c) Spleen
 - (d) Liver
13. Fluorine helps in maintaining the
 - (a) Dentine to deposit normally in teeth
 - (b) Enamel deposition and prevents the dental carries
 - (c) Erythropoiesis
 - (d) Absorption of certain substances by the cell
14. The following are needed for blood-clotting in mammals
 - (a) Ca^{++} and Vitamin E
 - (b) Ca^{++} and Vitamin K
 - (c) Ca^{++} and Vitamin A
 - (d) K^{+} and Vitamin K
15. Examination of blood of a person suspected of having anaemia, shows large, immature, and nucleated erythrocytes without haemoglobin. Supplementing his diet with which of the following is likely to alleviate his symptoms
 - (a) Riboflavin
 - (b) Iron compounds
 - (c) Thiamine
 - (d) Folic acid and Cobalamine
16. Rickets in children and osteomalacia in adults is caused by the deficiency of
 - (a) Vitamin A
 - (b) Vitamin B
 - (c) Vitamin C
 - (d) Vitamin D (calciferol)
17. Which one of the following is the best source for vitamin A (Antixerophthalmic)
 - (a) Apples
 - (b) Carrots
 - (c) Honey
 - (d) Peanuts
18. A man having deficiency of vitamin C should take
 - (a) Milk
 - (b) Milk and eggs
 - (c) Carrots
 - (d) Citrus juice
19. Pellagra is caused due to the deficiency of
 - (a) Thiamine
 - (b) Ascorbic acid
 - (c) Niacin (Nicotinic Acid) (B_3)
 - (d) Calciferol
20. Which of the following is the correct match
 - (a) Vitamin A—calciferol
 - (b) Vitamin E—tocopherol
 - (c) Vitamin D—thiamine
 - (d) Vitamin K—ascorbic acid
21. Vitamin-C is mainly helpful in
 - (a) Growth of bones
 - (b) Formation of connective tissue
 - (c) Treatment of anaemia
 - (d) Formation of visual pigment
22. The disease due to inflammation of vermiform appendix of digestive system is known as
 - (a) Amoebic dysentery
 - (b) Intestinal cancer
 - (c) Appendicitis
 - (d) None of the above
23. An average man needs approximately
 - (a) 2900 K cal. energy/day
 - (b) 500 K cal. energy/day
 - (c) 1000 K cal. energy/day
 - (d) 2000 K cal. energy/day
24. *E. coli* in human colon behave as
 - (a) Parasite
 - (b) Commensal
 - (c) Saprophyte
 - (d) Mutualism
25. Which one of the following pairs is not correctly matched
 - (a) Vitamin B_6 – Beri-beri
 - (b) Vitamin C – Scurvy
 - (c) Vitamin B_3 – Pellagra
 - (d) Vitamin B_{12} – Pernicious anaemia
26. What does the doctor advise to the patients suffering from high blood cholesterol
 - (a) Red mutton with fat layer
 - (b) Vegetable and margerin
 - (c) Vegetable oil such as ground-nut oil
 - (d) Pure deshi ghee or butter
27. The main cause of anaemia (Hypochromic or macrocytic) is
 - (a) Deficiency of Ca
 - (b) Deficiency of Fe
 - (c) Deficiency of Na
 - (d) Deficiency of Mg
28. Mode of nutrition in Amoeba is
 - (a) Saprozoic
 - (b) Holophytic
 - (c) Coprozoic
 - (d) Holozoic

29. Continuous bleeding from an injured part of body is due to deficiency of
 (a) Vitamin A (b) Vitamin B
 (c) Vitamin K (d) Vitamin E
30. Which one of the following vitamins can be synthesized by bacteria inside the gut
 (a) B_1 (b) A
 (c) D (d) K
31. Which of the following is related with vitamin B_2

Or

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

- (a) FMN / FAD (b) NAD
 (c) NADH (d) $NADH_2$
32. One of the factors required for the maturation of erythrocytes is
 (a) Vitamin D (b) Vitamin A
 (c) Vitamin B_{12} (d) Vitamin C
33. Which one of the following statements is **not correct**
 (a) Retinal is a derivative of vitamin C
 (b) Rhodopsin is the purplish red protein present in rods only
 (c) Retinal is the light absorbing portion of visual photopigments
 (d) In retina the rods have the photopigment rhodopsin while cones have three different photopigments
34. Select the mismatch between a vitamin and its deficiency disease, among the following
 (a) Riboflavin-slow clotting of blood
 (b) Niacin-damage to skin and lining of intestine
 (c) Ascorbic acid-scurvy
 (d) Thiamine-damage to nerves and heart
35. Protein deficiency in children is called
 (a) Obesity (b) Marasmus
 (c) Diabetes (d) Kwashiorkor
36. Weakening of limb bones may be due to deficiency of
 (a) Riboflavin (b) Cyanocobalamin
 (c) Tocopherol (d) Calciferol
37. Inadequate protein intake leads to kwashiorkor. The subsequent edema is most closely related to inadequate synthesis of which protein
 (a) Gamma globulin (b) Glucagon
 (c) Insulin (d) Albumin
38. Which of the following is a reducing sugar
 (a) Sucrose (b) Galactose
 (c) Gluconic acid (d) β -methyl galactoside
39. This trace element is needed for insulin to exert its maximal effect in glucose uptake
 (a) Vanadium (b) Chromium
 (c) Molybdenum (d) Selenium
40. During prolonged fasting
 (a) The first to be used up are carbohydrates, next fat is withdrawn and proteins are metabolized at the last
 (b) The first to be used up are the fats, next carbohydrates are withdrawn from stored glycogen in the liver and muscles and proteins are withdrawn at the last
 (c) First lipids are used up, then proteins and finally carbohydrate
 (d) None of these
41. Glucose and amino acids are absorbed in the intestine by
 (a) Active transport (b) Passive transport
 (c) Selective absorption (d) Osmosis

42. Digestion of protein takes place in
 (a) Duodenum and stomach
 (b) Stomach and oesophagus
 (c) Small and large intestine
 (d) Intestine and rectum
43. Fat soluble vitamins are
 (a) Vitamin A, B and C (b) Vitamin A, B and D
 (c) Vitamin A, D, E and K (d) Vitamin C and D
44. Higher animals cannot synthesize few fatty acids which are very essential for their growth and development. These fatty acids are typically
 (a) Saturated (b) Cycle
 (c) Unsaturated (d) Branched
45. Which of the following vitamins is water soluble as well as an anti-oxidant
 (a) Vitamin B_1 (b) Vitamin A
 (c) Vitamin D (d) Vitamin C
46. A non-essential amino acid is
 (a) Lysine (b) Methionine
 (c) Alanine (d) Isoleucine
47. Certain vitamin B acts as
 (a) Enzymes (b) Coenzymes
 (c) Digestive enzymes (d) Hormones
48. Which one of the following is a fat-soluble vitamin and its related deficiency disease
 (a) Ascorbic acid - Scurvy
 (b) Retinol - Xerophthalmia
 (c) Cobalamine - Beri-beri
 (d) Calciferol - Pellagra
49. In beri-beri
 (a) The coagulation time increases
 (b) Dermatitis in organs exposed to sun rays
 (c) The depigmentation of skin and hair starts
 (d) The affect over peripheral nervous system, gastrointestinal tract and cardiovascular is pronounced
50. Which one is the most abundant protein in the animal world
 (a) Trypsin (b) Haemoglobin
 (c) Collagen (d) Insulin
51. Defective red blood corpuscles can be seen when there is a deficiency of
 (a) Retinol
 (b) Vitamin K
 (c) Vitamin B_2 (Riboflavin)
 (d) Vitamin B_6 (Pyridoxine)
52. A person suffers from beri-beri, rickets and scurvy if he is not taking adequate amounts of
 (a) Vitamin B_{12} , A and C (b) Vitamin B_1 , D and C
 (c) Vitamin A, B and E (d) Vitamin B_6 , and K
53. The richest sources of vitamin B_{12} are
 (a) Rice and hen's egg
 (b) Carrot and chicken's breast
 (c) Goat's liver and Spirulina
 (d) Chocolate and green gram
54. Tonics made out of the liver are very effective in curing hematopoiesis or anaemia because
 (a) They contain proteins
 (b) They contain RBCs
 (c) They contain bile juice
 (d) They contain Vitamin B_{12}

55. Xerophthalmia in children and nyctalopia (Night blindness) in adults is caused by the deficiency of vitamin
(a) A (b) D
(c) E (d) K
56. Which one of the following pairs is **not** correctly matched
(a) Vitamin B₁ – Beri-beri
(b) Vitamin B₅ – Pellagra
(c) Vitamin B₁₂ – Pernicious anaemia
(d) Vitamin B₆ – Loss of appetite
57. Which one of the following is very rich in magnesium
(a) Meat (b) Egg
(c) Soybean (d) Milk
58. Starch is converted to maltose by the action of
(a) Invertase (b) Amylase
(c) Sucrose (d) Maltase
59. Rhodopsin is synthesized with the help of
(a) Vitamin A (b) Vitamin B₁₂
(c) Vitamin D (d) Vitamin B₆
60. For normal absorption and deposition of calcium and phosphate the vitamin that is very necessary
Or
Calcium deficiency in the body occurs in the absence of
(a) B₁ (b) B₂
(c) A (d) D
61. Which group of three of the following five statement (1-5) contain is all three correct statements regarding beri-beri
1. A crippling disease prevalent among the native population of sub-Saharan Africa
2. A deficiency disease caused by lack of thiamine (vitamin B₁)
3. A nutritional disorder in infants and young children when the diet is persistently deficient in essential protein
4. Occurs in those countries where the staple diet is polished rice
5. The symptoms are pain from neuritis, paralysis, muscle wasting, progressive oedema mental deterioration and finally heart failure.
(a) 2, 4 and 5 (b) 1, 2 and 4
(c) 1, 3 and 5 (d) 2, 3 and 5
62. Average kilocalorie of energy needed by woman is
(a) Less than man (b) More than man
(c) Equal to man (d) Cannot be predicted
63. The people dependent exclusively on maize diet, are more likely to suffer from
(a) Rickets (b) Pellagra
(c) Beri-beri (d) Dysentery
64. Which one of the following is the correct matching of a vitamin, its nature and its deficiency disease
(a) Vitamin A – Fat-soluble – Beri-beri
(b) Vitamin K – water-soluble – Pellagra
(c) Vitamin A – Fat-soluble – Night blindness
(d) Vitamin K – Fat-soluble – Beri-beri
65. Organisms, which obtain energy by oxidation of reduced inorganic compounds, are
(a) Phototrophs (b) Saprozoic
(c) Copro-heterotrophs (d) Chemo-autotrophs
66. One who gets food and other things on the cost of other is called
(a) Parasite (b) Commensal
(c) Saprophyte (d) Insectivorous
67. The water soluble materials pass through the proteins called
(a) Glycoprotein (b) Glycocalyx
(c) Extrinsic proteins (d) Channel proteins
68. Vitamins, we must consume daily are
(a) Fat soluble (b) Water soluble
(c) Both (a) and (b) (d) None of these
69. Balanced diet should have approximately
(a) 1/5 protein, 3/5 fat and 1/5 carbohydrate
(b) 3/5 protein, 1/5 fat and 1/5 carbohydrate
(c) 1/5 protein, 1/5 fat and 3/5 carbohydrate
(d) 1/2 protein, 1/4 fat and 3/5 carbohydrate
70. To which of the following family do folic acid and pantothenic acid belong
(a) Vitamin K (b) Vitamin A
(c) Vitamin C (d) Vitamin B complex
71. Which one of the following is dominant intracellular cation
(a) Potassium (b) Chloride
(c) Phosphate (d) Calcium
72. Which of the following is mismatched
(a) Vitamin K – Beri-beri (b) Vitamin C – Scurvy
(c) Vitamin A – Xerophthalmia (d) Vitamin D – Rickets
73. Cyanocobalamine is essential for the formation of
(a) RBC (b) WBC
(c) Lymph (d) Platelets

6. NEET

1. The primary dentition in human differs from permanent dentition is not having one of the following type of teeth
[2015]

Or

A baby boy aged two years is admitted to play school and passes through a dental check-up. The dentist observed that boy had twenty teeth. Which teeth were absent

- (a) Premolars (b) Molars
(c) Incisors (d) Canine
2. In the stomach, gastric acid is secreted by the [2016]
(a) Gastrin secreting cells (b) Parietal cells
(c) Peptic cells (d) Acidic cells
3. A baby boy aged two years is admitted to play school and passes through a dental check up. The dentist observed that the boy had twenty teeth. Which teeth are absent [2017]
(a) Canines (b) Molars
(c) Pre – molars (d) Incisors
4. Which of the following guards the opening of hepatopancreatic duct into the duodenum [2016]
(a) Semilunar valve (b) Ileocaecal valve
(c) Pyloric sphincter (d) Sphincter of Oddi
5. Which cells of crypts of Lieberkuhn secrete antibacterial lysozyme [2017]
(a) Paneth cell (b) Kupffer cell
(c) Zymogen cells (d) Argentaffin cells

6. Which of the following option best represents the enzyme composition of pancreatic juice [2017]
 (a) Amylase, Pepsin, Trypsinogen, Maltase
 (b) Peptidase, Amylase, Pepsin, Rennin
 (c) Lipase, Amylase, Trypsinogen, Procarboxypeptidase
 (d) Amylase, Peptidase, Trypsinogen, Rennin

7. Which of the following gastric cells indirectly help in erythropoiesis [2018]
 (a) Parietal cells (b) Goblet cells
 (c) Mucous cells (d) Chief cells

8. Which enzymes are likely to act on the baked potatoes eaten by a man, starting from the mouth and as it moves down the alimentary canal [2013]
 (a) Pancreatic amylase → salivary amylase → lipases
 (b) Disaccharidase like maltase → lipases → nucleases
 (c) Salivary amylase → pancreatic amylase → Disaccharidase
 (d) Salivary maltase → carboxy peptidase → trypsinogen

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

	Column I	Column II
(a)	Cholesterol, maltose	Large intestine, active absorption
(b)	Glycine, glucose	Small intestine, active absorption
(c)	Fructose, Na ⁺	Small intestine, passive absorption
(d)	Glycerol, fatty acids	Duodenum, move as chylomicrons

10. A healthy person eats the following diet-5gm raw sugar, 4 gm albumin, 10 gm pure buffalo ghee adulterated with 2gm vegetable ghee (hydrogenated vegetable oil) and 5 gm lignin. How many calories he is likely to get [2013]
 (a) 126 (b) 164
 (c) 112 (d) 144

11. Which of the following terms describe human dentition [2018]
 (a) Pleurodont, Diphyodont, Heterodont
 (b) Pleurodont, Monophyodont, Homodont
 (c) Thecodont, Diphyodont, Heterodont
 (d) Thecodont, Diphyodont, Homodont

12. Which of the following hormones induce secretion of succus entericus [2000]

Or

Which hormones do stimulate the production of pancreatic juice and bicarbonate [2016, 2016]

- (a) Insulin (b) Secretin and cholecystokinin
 (c) Glucagon (d) Secretin
13. Which of the following elements is a constituent of biotin [2013]
 (a) Magnesium (b) Calcium
 (c) Phosphorus (d) Sulphur

14. A triglyceride molecule has [2003, 2016]
 (a) Three fattyacids with one glycerol molecule
 (b) Three fattyacids with two glycerol molecule
 (c) Two fattyacids with two glycerol molecules
 (d) One fattyacid with one glycerol molecule

15. A pregnant female delivers a baby who suffers from stunted growth, mental retardation, low intelligence quotient and abnormal skin. This is the result of [2013]
 (a) Over secretion of pars distalis
 (b) Deficiency of iodine in diet
 (c) Low secretion of growth hormone
 (d) Cancer of the thyroid gland

7. AIIMS

1. Which of the following teeth are lophodont [1998, 2002]
 (a) Incisor and canine (b) Premolar and molar
 (c) Canine and premolar (d) Premolar and incisor
2. The intestine is different from the stomach by the presence of [1993]
 (a) Digestive gland (b) Villi
 (c) Sub-mucosa (d) Serosa
3. Cyanosis refers to [1988]
 (a) Bluish colouration of the body
 (b) Reddish colouration of the body
 (c) Pale colouration of the body
 (d) Goose flesh of the body
4. Liver in our body stores [1999]
 (a) Vitamin A (b) Vitamin D
 (c) Vitamin B₁₂ (d) All of these
5. Which of the following is not a human salivary gland [1993]
 (a) Parotid (b) Submaxillary
 (c) Sublingual (d) Infra-orbital
6. Which of the following digestive juices have the minimum pH [2002]
 (a) Bile (b) Saliva
 (c) Gastric juice (d) Pancreatic juice
7. Surgical removal of gall bladder in human beings would lead to [1992, 1992]
 (a) Impairment of the digestion of fat
 (b) Increased acidity in the intestine
 (c) Jaundice
 (d) None of the above
8. Which one of the following pairs of the kind of cells and their secretion of correctly matched [2008]
 (a) Oxyntic cells - A secretion with pH between 2.0 and 3.0
 (b) Alpha cells of islets - Secretion that decreases blood sugar level
 (c) Kupffer cells - A digestive enzyme that hydrolyses nucleic acids
 (d) Sebaceous glands - A secretion that evaporates for cooling
9. The toxic substance are detoxicated in the human body by [2001]
 (a) Lungs (b) Kidneys
 (c) Liver (d) Stomach
10. The process by which digested food of the alimentary canal passes through its mucous membrane into circulatory system is called as [1992]
 (a) Absorption (b) Assimilation
 (c) Hydrolysis (d) Defecation

11. Lipids, which can be found in oil based salad dressings and ice cream, during digestion are splitted into [2009]
 (a) Fatty acids and glycerol
 (b) Glycerol and amino acids
 (c) Glucose and fatty acids
 (d) Glucose and amino acids
12. Excessive stimulation of vagus nerve in humans may lead to [2003]
 (a) Hoarse voice
 (b) Peptic ulcers
 (c) Efficient digestion of proteins
 (d) Irregular contractions of diaphragm
13. The pH of the digestive juices within the human small intestine is between 7.5 and 8.5. This environment is slightly [2009]
 (a) Basic (b) Acidic
 (c) Neutral (d) None of these
14. Milk protein is acted upon by a gastric enzyme [1989, 1991, 2000, 2002, 2005]

Or

Which one of the following enzymes carries on the initial step in the digestion of milk in humans [2011, 2014]

- (a) Casein (b) Rennin
 (c) Pepsin (d) Caseinogens
15. Which of the following statement is correct [1993]
 (a) Though secretin is an enzyme, it is not involved in digestion
 (b) Secretin is an enzyme and so it helps digestion
 (c) Secretin is a hormone but it plays a role in digestion
 (d) Secretin is a hormone and hence it does not play any role in digestion
16. Which one of the following four secretions is correctly matched with its source, target and nature of action [2005]

	Secretion	Source	Target	Action
(a)	Gastric	Stomach lining	Oxyntic cells	Production of HCl
(b)	Inhibin	Sertoli cells	Hypothalamus	Inhibition of secretion of gonadotropin releasing hormone
(c)	Enterokinase	Duodenum	Gall bladder	Release of bile juice
(d)	Atrial Natriuretic Factor (ANF)	Sinu atrial node (SAN) M-cells of Atria	Juxta-glomerular apparatus (JGA)	Inhibition of release of renin

17. Enzymes, vitamins and hormones can be classified into a single category of biological chemicals, because all of them [1992, 2005]
 (a) Are proteins
 (b) Enhance the oxidative metabolism
 (c) Aid the regulating mechanism
 (d) Are synthesized within the body of an organism

18. Pancreatic secretion and gall bladder contraction are stimulated by [1991, 2003, 1993, 2005, 1998, 1999, 2000, 2006, 2010]
 (a) Gastrin
 (b) Enterocrinin
 (c) Enterogastrone
 (d) Cholecystokinin pancreozymin
19. Thiamine (B_1) deficiency results in [2009, 13]
 (a) Wernickes' syndromes (b) Korsakoffs' syndromes
 (c) Osteonecrosis (d) Tunnel vision
20. Vitamin D is synthesized by one of the following with the help of sunlight [1992, 1999, 2010]
 (a) Skin (b) Gall bladder
 (c) Liver (d) Pancreas
21. Which of the following are required in minimum amount by human [2006, 2011]
 (a) Iron, iodine, carbon, manganese, copper, O_2
 (b) Iron, iodine, manganese, copper, zinc, fluorine
 (c) Iron, iodine, manganese, zinc, hydrogen
 (d) Nitrogen, oxygen, zinc, fluorine
22. Infertility is believed to be due to the lack of vitamin [1991, 1993, 1993, 2012]
 (a) A (b) B
 (c) C (d) E
23. Which of the following can be called 'animal starch' [1993]
 (a) Hemicellulose (b) Glucose
 (c) Glycogen (d) Chitin
24. Main difference between brown fat and white fat is that the cells of brown fat [1987]
 (a) Are multicolored
 (b) Have more Mitochondria
 (c) Are polygonal in shape
 (d) All the above
25. Continued consumption of a diet rich in butter, red meat and eggs for a long period may lead to [2007]
 (a) Vitamin A toxicity
 (b) Kidney stones
 (c) Hypercholesterolemia
 (d) Urine laden with ketone bodies
26. The vitamin nicotinamide can be synthesized in our body from [2002]
 (a) Tyrosine (b) Valine
 (c) Tryptophan (d) Phenyl alanine
27. Which one of the following is a matching pair of a certain body feature and its value/count in a normal human adult [2003]
 (a) Urea 5-10 mg/100 ml of blood
 (b) Blood sugar 80-100 mg/100 ml
 (c) Total blood volume 3-4 liters
 (d) ESR in Wintrobe method 9-15 mm per hour in males and 20-34 mm per hour in females

8. Assertion and Reason

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

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

1. Assertion : Arachidic acid is an unsaturated fatty acid.
Reason : There are present one or more double bonds between carbon atoms in unsaturated fatty acids.
2. Assertion : Thick layers of muscles are present in the wall of alimentary canal.
Reason : These muscles help in the mixing of food materials with the enzymes coming from different glands in the alimentary canal.
3. Assertion : Insulin is secreted by α -cells of islets of langerhans of pancreas.
Reason : Insulin promotes conversion of glucose to glycogen.
4. Assertion : The amino acid glycine comes under the category of nonessential amino acids.
Reason : This is due to the fact that it can not be synthesised in the body.
5. Assertion : The main part of carbohydrate digestion takes place in small intestine.
Reason : Here pancreatic amylase converts carbohydrates into lactose.

6. Assertion : Starch is hydrolysed by ptyalin to maltose.
Reason : Sucrase hydrolyses sucrose to lactose.
7. Assertion : Absorption of digested food mainly occurs in the stomach.
Reason : Stomach produces the hormone gastrin and the intrinsic factor and it liquefies ingested food.
8. Assertion : Blood sugar level falls rapidly after hepatectomy.
9. Assertion : Minerals are not biologically active substances.
Reason : Some individuals suffer anaemia due to deficiency of copper.
10. Assertion : In alcoholic fermentation, the hexose molecule is converted into glucose and fructose.
11. Assertion : Scurvy is caused by deficiency of vitamin.
Reason : Deficiency of ascorbic acid causes scurvy.
12. Assertion : In alcoholic drink, the alcohol is converted into glucose in the liver.
Reason : Liver cells are able to produce glucose from alcohol by back fermentation.
13. Assertion : Sea-faring fishermen sometimes eat raw fish.
Reason : They can be deficient of Vitamin B_1 .
14. Assertion : Cold blooded animals have no fat layer.
Reason : Cold blooded animals use their fat for metabolic process during hibernation.