DIGESTION AND ABSORPTION

Nutrition:

Food is one of basic requirements of all living organisms. The major components of our food are carbohydrate, proteins and fats. Vitamins and minerals are also required in small quantities.

Food provides energy and organic materials for growth and repair of tissues. The water plays an important role in metabolic processes and also prevents dehydration of the body.

The sum total of the processes by which living organisms obtain substances which are necessary for growth, maintenance and meeting energy needs is called nutrition.

Chemical substances present in the food are **nutrients.**

Types of nutrients

Macronutrients (proximate principles)	Micronutrients (protective principles)
These nutrients provide energy e. g. carbohydrates, lipids and proteins	These do not provide energy but their deficiencies cause specific diseases. e. g. minerals, vitamins & water.

Steps of holozoic nutrition

Ingestion →Digestion→ Absorption→ Assimilation →Egestion

I. **Ingestion**: It is intake of food in the buccal cavity.

II. **Digestion**: Biomacromolecules in food cannot be utilised by our body in their original form. They have to be broken down and converted into simple substances in the digestive system. This 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.**

III. **Absorption**: Digested food material is transported into blood or lymph from gut.

IV. **Assimilation**: Absorbed food material is used by the cell to enhance protoplasm.

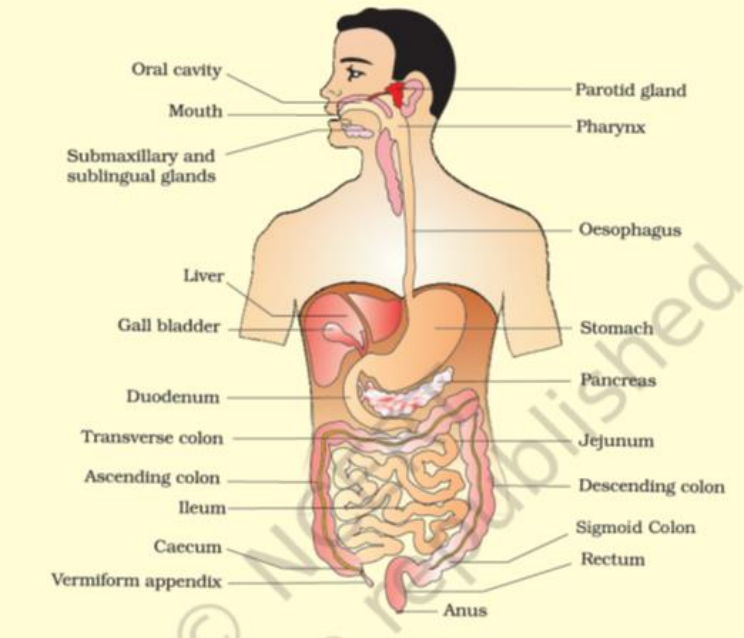
V. **Egestion**: It is elimination of undigested and unabsorbed food through anus.

Types of digestion

Extracellular digestion	**Intracellular digestion**
Digestion occurs outside the cell	**Digestion occurs within the cell**
It is more efficient	**It is less efficient**
Regional differentiation is present	**Regional differentiation is absent**

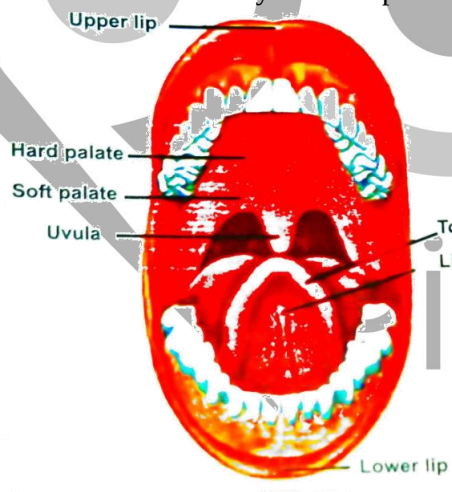
Digestive System of Man:

The human digestive system consists of alimentary canal (GIT) & Accessory Digestive organ. General Organisation of the human digestive system is shown below.



Digestive Tract

1. **Mouth:** It is transverse slit bounded by 2 movable lips (**labia)**. Alimentary canal begins with an anterior opening mouth, and it opens out posteriorly through anus. Mouth leads to buccal cavity or oral cavity.
2. **Buccal cavity/oral cavity:** It includes
   i. **Palate**: The roof of buccal cavity is called palate which is divisible into:

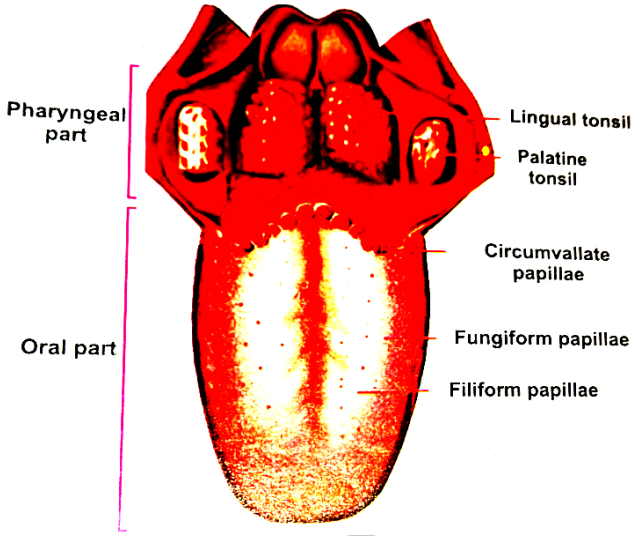


Hard palate: It is anterior, bony area and has transverse ridges called **palatine rugae.** It holds food during mastication.

Soft palate: It is posterior soft part, made up of connective tissue and muscles. Uvula is posterior most part of soft palate hanging in pharynx and closes the internal nostrils during deglutition.

ii. **Tongue:**

It is freely movable, single, pinkish, oval, elongated highly muscular and protrusible.



It is attached to the floor of buccal cavity with the help of **lingual frenulum**.

Upper surface of tongue has numerous small projections called papillae, some of which bear taste buds.

Circumvallate: These are circular, 8-12 in number largest, present in the posterior part of the tongue extending from one side to another.

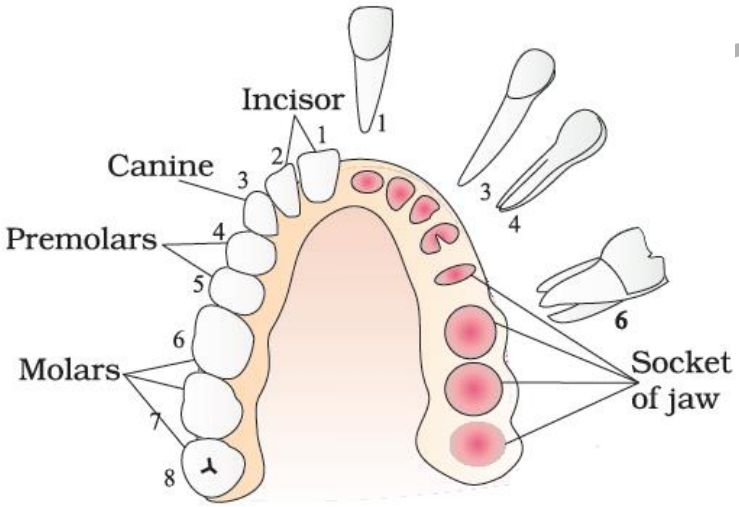
Fungiform: These are mushroom shaped, numerous present at anterior margins and tip of the tongue.

Filiform: These are conical shaped, smallest and most numerous, distributed throughout the tongue. They lack taste buds.

Foliate: These are not developed in human tongue.

iii. Teeth

Homodont: When the teeth are different in structure and functions. Incisors(I) adapted for cutting and biting; canines © meant for piercing & tearing; premolars (PM) meant for crushing, grinding & chewing; Molars (M) meant for grinding..



On the basis of succession

i. Polyphyodont: In lower vertebrates, teeth can be replaced an indefinite number of times during life.

ii. Diphyodont: In most mammals teeth develop during life in two successive sets. A set of temporary milk or deciduous teeth replaced by a set of permanent or adult teeth.

iii. Monophydont: In some mammals only one set of teeth develops.

An adult human has 32 permanent teeth. Arrangement of teeth in each half of the upper and lower jaw in the order I, C, PM, M is represented by a dental formula which in human is given below.

Man (adult)	$\frac{2.1.2.3}{2.1.2.3} \times 2 = 32$
Human (milk set)	$\frac{2.1.0.2}{2.1.0.2} \times 2 = 20$

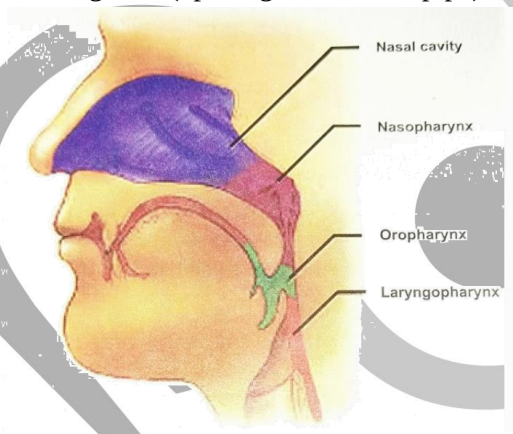
Thecodont: Tooth is embedded in a socket of jaw bone. This type of attachment is called **thecodont**.
Human teeth are thecodont, diphyodont and heterodont.
Last molars are also called wisdom teeth. These are four in number & appear after 18 years of age. Man has 12 Monophydont teeth and 20 diphyodont teeth.
The hard chewing surface of the teeth, made up of enamel, helps in the mastication of food.

3. **Pharynx (Throat):** The oral cavity leads into a short pharynx which serves as a common passage for food and air. It is divisible into

i. **Nasopharynx:** Situated behind nasal chambers, it serves as passage for air only. It bears openings of **eustachian tube**

ii. **Oropharynx –** It is a common passage for food and air, situated behind buccal cavity.

iii. **Larynogopharynx –** It is the most inferior part of pharynx, leads into larynx in front and oesophagus behind. The oesophagus and the trachea (wind pipe) open into the pharynx. A cartilaginous flap called **epiglottis** prevents the entry of food into the glottis (opening of the wind pipe) during swallowing.

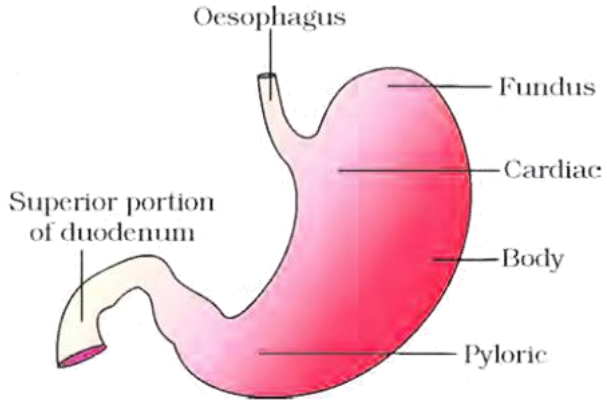


Tonsils

The lymphatic tissues of pharynx and oral cavity are called tonsils. Inflammation of tonsils is called Tonsilitis.

4. **Oesophagus**: It is about 25 cm long and lies behind trachea and the heart. It is thin long tube which extend posteriorly passing through neck, thorax, diaphragm and opens into the stomach at a sharp angle. Its outermost covering is tunica adventitia.
A muscular sphincter (gastro-oesophageal/cardiac sphincter) regulates the opening of oesophagus into the stomach.

5. **Stomach**: It is J-shaped, bag like and the widest part of the alimentary canal located in upper left part of abdominal cavity. The stomach stores the food for 4-5 hours. Empty stomach contains numerous **gastric rugae**. Stomach contains three major regions**.**



i. **Cardiac:** It is the broader part where oesophagus joins the stomach.
ii. **Fundic:** It is a dome like part of the stomach and is filled with gas.
iii. **Pyloric:** It is distal lower part of stomach on the right side. It has a pyloric sphincter around an opening (pyloric aperture) which opens into duodenum.

6. Small intestine

It is longest part of alimentary canal present in the abdominal cavity. Small intestine is distinguishable into three regions, a duodenum, a middle portion jejunum and ileum. The opening of the stomach into the duodenum is guarded by the pyloric sphincter. Its distal end leads into the large intestine by ileo-caecal valve in men.

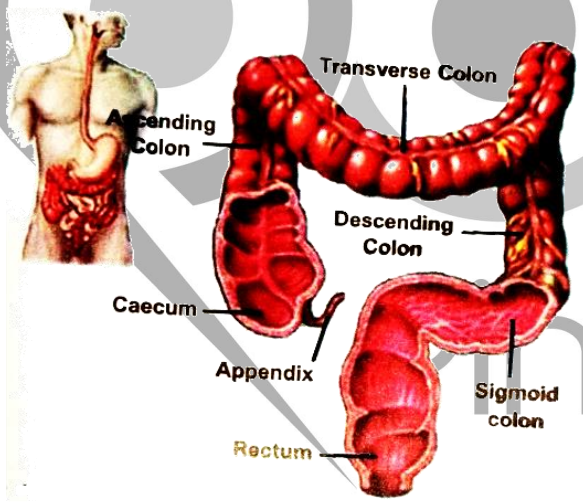
Parts of small intestine

Duodenum (proximal part)	Jejunum (middle part)	Ileum (distal part)
u- shaped	coiled	Highly coiled
Less vascular	Most vascular	Moderate vascular
Minimum absorption	Maximum absorption	Moderate absorption

Luminal surface area is increased many fold by presence of **villi** of intestinal wall and **microvilli** of epithelial cells. Villi are present in intestine and not in the stomach because the main site of absorption is intestine and not stomach. Absorption can occur only after the completion of digestion

Peyer's Patches: These are lymph nodules clustered in groups in ileum as small white patches on mucous membrane. These produce WFC's.

7. **Large intestine**: It has a wider diameter as compared to small intestine. It consist of caecum, colon and rectum.



i. Caecum

It is a small dilated bind sac which hosts some symbiotic organisms. The ileocaecal junction is continued internally into an **ileocaecal** valve which prevent the back flow of faecal matter.

Attached to caecum is a narrow finger like tubular projection called **vermiform appendix** which is mostly filled with lymphoid tissue and its injection is called **appendicitis.**

ii. Colon

It is the longest part of large intestine which lies between caecum and rectum. The colon is divided into three parts –an ascending, a transverse and a descending part.

iii. Rectum

The descending part opens into the rectum which opens out through the anus. Anus has two sphincters:

a. Internal anal sphincter: It is made of smooth muscles.
b. External and sphincter: It is made of striated muscles.

Sometimes, the rectal veins undergo painful dilation. This condition is called **haemorrhoids/piles.**

No significant digestive activity occurs in the large intestine. The functions of large intestine are

i. Absorption of some water minerals and certain drugs

ii. Secretion of mucus which helps in adhering waste (undigested) particles together and lubricating it for an easy passage

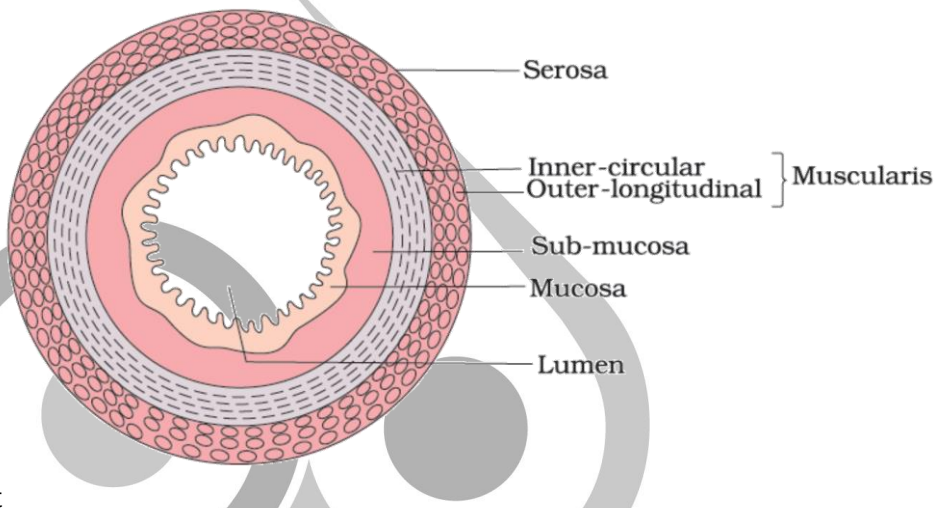
The gut is longer in herbivores.

Histology of human gut (Alimentary canal)

The wall of alimentary canal from oesophagus to rectum possesses four layers namely serosa, muscularis, sub-mucosa and mucosa. All the four layers show modifications in different parts of the alimentary canal.

1. **Visceral peritoneum** (serous membrane or serosa):

It is the outer most layer made up of mesothelium (epithelium of visceral organs) and some connective tissue. It is continuous with the mesentery. Since the oesophagus lies outside the coelom, its outer wall is not covered by peritoneum.



2. Muscular coat

It is composed of outer longitudinal and inner circular smooth muscle fibres. In the stomach an additional layer of oblique muscle fibres is present inner to the circular muscle fibres.

In between the longitudinal and circular muscle fibres, a network of nerve cells and autonomic nerve fibres is present called the **Auerbach's plexus** which control peristalsis.

3. **Submucosa:**

It consists of loose connective tissue richly supplied with blood, lymphatic vessels and nerves. Brunner gland cells are present in duodenum in submucosa which secrete mucus.

Another network of nerve cells and autonomic nerve fibres, called **Meissner' plexus** is present between the muscular coat and the submucosa. This plexus controls the secretion of digestive juice.

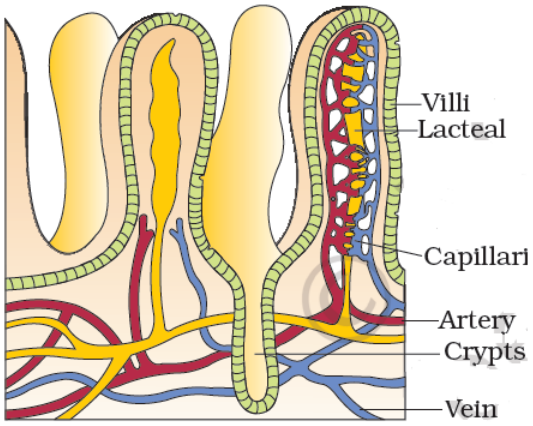
4. **Mucosa:** It consists of three sub layers.

i. **Muscularis mucosa**: It is thin layer that lies next to the submucosa. It has outer longitudinal and inner smooth circular muscle fibres.

ii. **Lamina propria:** It is middle layer of mucosa consisting of loose connective tissue, blood vessels, glands and lymphoidal tissue.

iii. **Epithelium**: It is inner most layer having goblet cells which secrete mucus that help in lubrication.

Mucosa layer forms irregular folds (rugae) in the stomach and small finger-like foldings called **villi** in the small intestine. The cells lining the villi produce numerous microscopic projections called **microvilli** giving a brush border appearance. These modifications increase surface area enormously. Villi are supplied with a network of capillaries and a large lymph vessel called the **lacteal**.

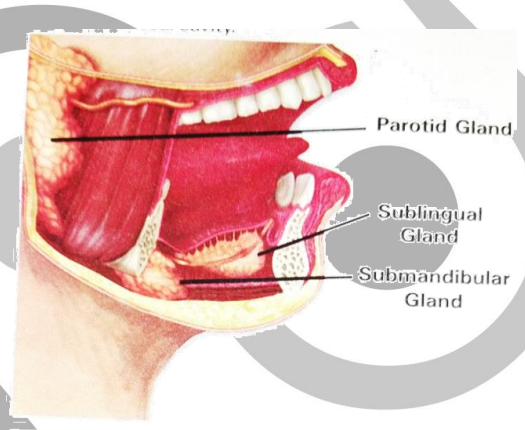


- Mucous goblet cells are present throughout alimentary canal.

Digestive glands:

The accessory digestive glands include the salivary glands, the liver (with gall bladder) and the pancreas. These secrete digestive juices.

1. Salivary glands: These pairs of salivary glands are located outside buccal cavity and secrete saliva into the buccal



Parotid	Sub-mandibular (sub maxillary)	Sub-lingual
Present below pinna or cheek region.	Present at junction of upper and lower jaw.	Present in the floor of buccophary-ngeal cavity.
Largest in size.	Large	smallest
It has stenson's duct.	It has Whartons' duct.	It has 6-8 Rivinus ducts
Secrete maximum salivary amylase	Produce maximum saliva	Moderate secretion

Saliva

Daily secretion of saliva is 1.0-1.5. Its pH is 6.8. Saliva contains 99% water, some salts (e. g. Na^+, K^+, CI^-, HCO_3^-) mucin, antimicrobial substances (lysozyme) & enzyme ptyalin/salivary amylase.

Food mixed with saliva is called **bolus.**

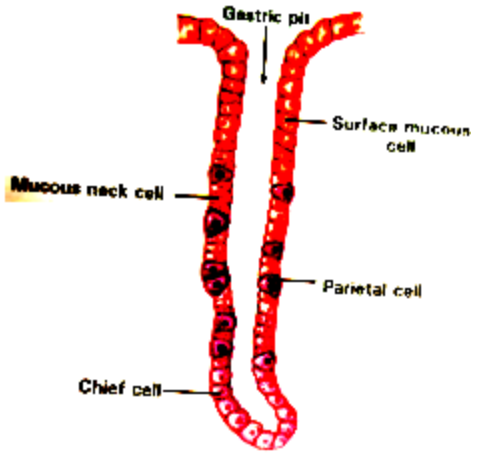
Viral infection of parotid glands causes **"Mumps."**

2. Gastric glands: They are tubular glands present in the mucosal lining of the stomach. These include three major types of cells namely

i. Peptic cells (Chief or Zymogen cells): They produce two proenzymes or zymogens (pepsinogen and prerennin) and gastric lipase in small amount.

ii. Oxyntic cells (Parietal cells): The cells secrete hydrochloric acid (HCI) and Castle 's intrinsic factor essential for absorption of vitamin B_{12}.

iii. Mucous neck cell/Goblet Cells: The cells secrete mucous.



Pyloric stomach has- **G cells** that secrete gastrin which stimulate the release of gastric juice.
Mucus and bicarbonates present in gastric juice play an important role in lubrication and protection of mucosal epithelium from exocoriation by highly concentrated HCI.
Stomach produces 2-3 L of gastric juice per day.
HCI provides acidic pH 1.8. HCL activates pepsinogen & prorennin, denature protein, disinfect food and converts Fe^{+++} into Fe^{++} for iron absorption.
In stomach mainly protein digestion takes place

If HCL is not secreted in the stomach

Pepsinogen would not be activated and protein digestion would be impaired.
HCL is also required for bio availability of iron so its absence can also lead to anaemia.
Microbes will grow in stomach and cause fermentation causing flatulence.
Milk will not be curdled.
Semi-solid food mixed with gastric juice by churning movement of its muscular wall in stomach is called chime.

3. **Pancreas:** It is carrot shaped heterocrine gland or compound gland (both exocrine and endocrine) present between the ascending and descending limbs of U-shaped duodenum.

i. Exocrine part

It is the major part (about 99%) of pancreas consisting of rounded **lobules (**acini). The juice is carried by the main pancreatic duct, (**duct of Wirsung**) into the duodenum through the hepatopancreatic ampulla (**ampulla of vater**).
The pancreatic juice contains inactive enzymes like trypsinogen, chymotrypsinogen and procarboxpeptidase. It also contains amylase, lipases, nucleases.
Pancreatic juice is considered a **complete digestive juice** as it contains enzymes to break all types of nutrients.
Chymotrypsin is protein digesting enzyme. Two other enzymes of the same category secreted by its sourcegland are trypsin and carboxypeptidase

ii. Endocrine:

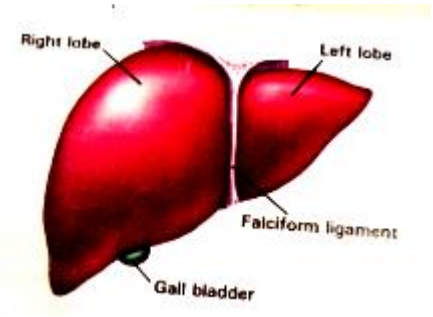
Minor part (1 to 2% only) also called as **islets** of **Langerhans** 1 to 2 million). It lies scattered in the exocrine part. It secretes two major hormones insulin and glucagon.

4. Liver:

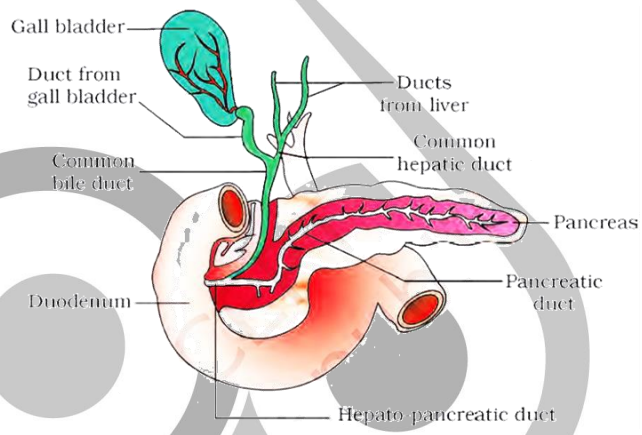
It is the largest and heaviest gland in the body weighing about **1.2 to 1.5 kg** in an adult human. It is situated in abdominal cavity just below the diaphragm.
Liver consists of two lobes in man: **right** and **left** separated by the **falciform ligament.**

Gall Bladder

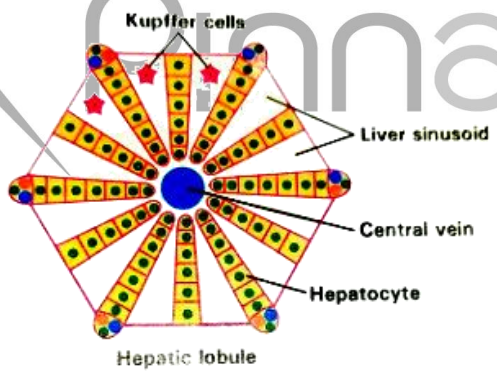
Thin muscular sac associated with liver
Gall bladder stores and concentrate bile juice
If gall bladder stops functioning or is removed digestion of fats will be impaired.



The right and left hepatic ducts join to form the **common hepatic duct**. The latter joins the cystic duct, which arises from the gall bladder. The cystic duct and common hepatic duct join to form common bile duct. Bile duct passes downwards to join the main pancreatic duct which opens over **ampulla of vater** into the duodenum. The opening is guarded by the **sphincter of Oddi**. A **sphincter of Boyden** surrounds the opening of the bile duct before it is joined with the pancreatic duct.



Hepatic lobule is basic structural and functional unit of the liver containing hepatic cells arranged in the form of cords. Each lobule is covered by a thin connective tissue sheath called the Glisson's capsule. Liver contains glycogen-rich **hepatocytes,** arranged radially around central vein.
The sinusoids present between hepatic cords are lined by incomplete endothelium with scattered phagocytic **Kupffer cells.**



Liver secretes bile which is a complex watery fluid containing bile salts **(sodium taurochlolate, sodium glycocholate and sodium carbonate),** bile pigments (**billiverdin** and **bilirubin**), **cholesterol**, mucin, **lecithin** and phospholipids etc. It contains no digestive enzyme.
Hepato pancreatic complex plays a very important role in digestion of carbohydrates, fats and proteins because pancreatic juice contains carbohydrate, fat and protein digesting enzymes. Bile salts present in bile juice help in emulsification of fats.

Functions of liver

i. Liver is a site for various metabolic events.

ii. Haemoglobin of worn out RBC's changes into bilirubin and biliverdin and then stercobilinogen (provide colour to the faeces).
iii. Transamination and deamination of amino acids is also carried out by liver.
iv. Kupffer cells in the liver phagocytose and remove bacteria, worn-out blood cells and foreign particles.
v. Liver also carries out following processes:

- Glycogenesis: It is the conversion of excess of glucose into glycogen.
- Glycogenolysis: It is the breakdown of glycogen to glucose.
- Gluconeogenesis: It is the formation of carbohydrates (glucose) from non carbohydrates (proteins, fats).
- Lipogenesis: It is the formation of fats from excess of glucose.

Functions of bile juice:

i. Bile salts help in breaking large fat droplets into small fat droplets. This is called emulsification of fat.
ii. It causes neutralization of HCI.
iii. Bile activates lipase enzyme.
iv. It helps in absorption of fat and fat soluble vitamins.
v. It prevents decomposition of food in intestine.
vi. Bile increases peristalsis in intestine.

5. **Intestinal glands**

These are **crypts of Lieberkuhn** and **Brunner's glands.**

Brunner's glands are present in sub mucosa of duodenum and open into crypts of Lieberkuhn. Crypts of Lieberkuhn are simple tubular glands found throughout small intestine located between villi. These possess

i. **Paneth cells:** These secrete lysozyme and other anti microbial agents.
ii. **Enteroendocrine or Argentaffin Cells:** These produce hormones (secretin).
iii. **Goblet cells:** These secrete mucus.
iv. **Enzyme Secreting Cells:** secrete different types of enzymes of the intestinal juice.

The secretions of the brush border cells of the mucosa alongwith the secretions of the goblet cells constitute the intestinal juice or **succus entericus.** This juice contains a variety of enzymes like disaccharidases (e.g., maltase), dipeptidases, lipases, nucleosidases, etc.

Intestinal mucosa protects itself from the acidic food entering from the stomach by producing mucus and stimulating the release of sodium bicarbonate from pancreas which makes medium alkaline (pH7.8) for enzymatic activities.

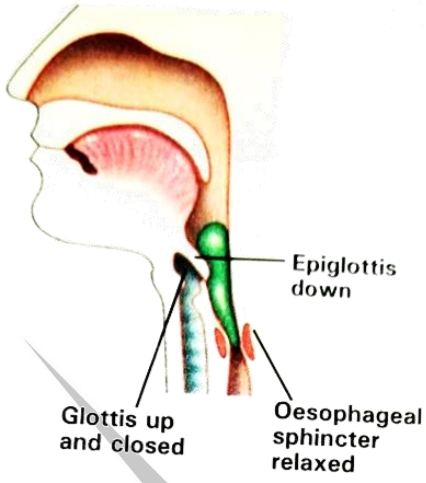
- The bile juice, pancreatic juice and intestinal juice are secretions released into small intestine.

Digestive juice	pH	Daily Secreation	composition
saliva	6.8	1.5 L	Salivary amylase (Ptyalin), water, Na^+, K^2, CI^-, HCO_3^- and Lysozyme
Gastric juice	1.8	2.5-3L	Pepsinogen, Prorennin, Gastric lipase, HCI, CIF
Pancreatic juice	7.8-8.4	1200-1500 ml	Pancreatic α-amylase (amylospsin), Trypsinogen, Chymotrypsingen, procarbo-xypeptidases, Elastase, Pancreatic Pancreatic lipase (steapsin), DNAase, RNAase.
Bile juice	7.6-8.6	500-1000 ml	No digestive enzymes. Bile salts, bile pigments, cholesterol, lecithin and phospholipids.
Intestinal juice	7.8	3 L	Enterokinase, Aminopeptidases, Dipeptidases, Disaccharidases (maltase, Isomaltase, sucrose) Intestinal Lipase, Nucleotidases, Nucleotidases, Nucleosidases

Mobility of Human Gut

This is ability of tract to undergo local movements and it includes.

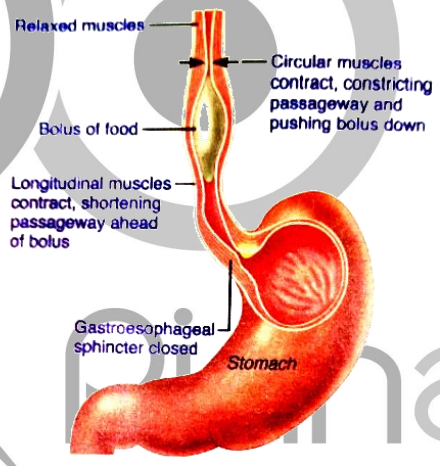
i. Swallowing (Deglutition)



The buccal cavity performs two major functions, mastication of food and facilitation of swallowing. The teeth and the tongue with the help of saliva masticate and mix up the food thoroughly.
Mucus in saliva helps in lubricating and adhering the masticated food particles into a **bolus.** Bolus is pushed through the pharynx into oesophagus. This is called swallowing or deglutition.

ii. Peristalsis

Peristalsis is produced by involuntary contraction of circular muscles in oesophagus lying just above and around top of the bolus and simultaneous contraction of longitudinal muscles just below bolus.



Various types of movements are generated by muscular layer of the small intestine. These movements help in a thorough mixing up of the food with various secretions in the intestine and thereby facilitate digestion.

Digestion:

The process of digestion is accomplished by mechanical and chemical process.

Digestion of carbohydrates

1. Digestion of Carbohydrates in the Oral Cavity:

About 30 percent of starch is hydrolysed here.

Starch $\xrightarrow[Cl^-, pH\ 6.8]{salivery\ amylase}$ **Maltose + lsomaltose + α-dextrins**

The gastric juice does not contain carbohydrase.

2. **Digestion of carbohydrates in the small intestine:**

a. Action of pancreatic juice: The pancreatic juice contains pancreatic α-amylase (amylopsin).

Starch $\xrightarrow[Cl^-]{Amylopsin}$ **Maltose +Isomaltose + α-dextrins**

Pancreatic amylase is the most important carbohydrate digesting enzyme. Nearly 70% digestion of starch occurs here.

b. Action of Intestinal Juice: Intestinal juice contains maltase, isomaltase, sucrase (invertase), lactase and α-dextrinase which act as shown below

Maltose $\xrightarrow{Maltase}$ Glucose + Glucose

Isomaltose $\xrightarrow{isomaltase}$ Glucose + Glucose

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

Lactose $\xrightarrow{lactase}$ Glucose + Galactose

Dextrins $\xrightarrow{Dextrinase}$ Glucose

Digestion of proteins:

Many of protein digesting enzymes are secreted in their inactive forms called **proenzyme** otherwise they would digest the cellular proteins.

Saliva can denature the uncooked germinating seeds, but does not have any protease.

1. Digestion of Proteins in the Stomach

Hydrochloric acid maintains a strongly acidic pH of about 1.8 HCI converts **pepsinogen** and **prorennin** into **pepsin** and **rennin** respectively. Pepsin shows **autocatalytic action**. Squeezing of chyme into oesophagus causes **heart burn.**

Pepsinogen $\xrightarrow{\text{HCI}}$ **Pepsin**

Pepsinogen $\xrightarrow{\text{Pepsin}}$ **Pepsin**

Proteins $\xrightarrow{\text{Pepsin}}$ **Proteoses + peptones**

Prorennin $\xrightarrow{\text{HCI}}$ **Rennin**

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

Paracasein + Ca^{++} → Calcium paracaseinate

Calcium paracaseinate $\xrightarrow{\text{Pepsin}}$ **Peptones + Proteoses**

Rennin is present only in the infants which helps in digestion of milk protein casein and its action is taken over by pepsin in adults.

2. Digestion of proteins in the small intestine

Pancreatic juice contains protease proenzymes-trypsinogen, chymotrypsinogen and procarboxy-peptidase and enzymes- elastase. Proteins, proteoses and peptones (partially hydrolysed proteins) in the chime reaching the intestine are acted upon by the proteolytic enzymes of pancreatic juice as given below:

Trypsinogen $\xrightarrow{\text{Enterokinase}}$ **Trypsin**

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

Procarboxypeptidase $\xrightarrow{\text{Trypsin}}$ **carboxypeptidase**

Proteins

Peptones $\xrightarrow[\textbf{carboxypeptidase}]{\textbf{Trypsin/Chymotrypsin}}$ **Dipeptides**

Proteoses

Intestinal **juice** contains enterokinase, aminopeptidases dipeptidases. Enterokinase converts trypsinogen of pancreatic juice into trypsin.

Dipeptide $\xrightarrow{\textbf{Dipeptidase}}$ Amino Acids

Digestion of Fats:

Saliva does not contain lipase. Gastric juice contains weak lipase which changes some fats into monoglycerides and fatty acids.

Bile salts break down fat droplets into smaller ones (emulsification).

Pancreatic lipase/Steapsin is the principal enzyme for the digestion of fat. Intestinal lipase is also helpful in the digestion of fat.

Fat $\xrightarrow{\text{Bile}}$ Emulsified Fat

Emulsified Fat $\xrightarrow{\text{Pancreatic lipase}}$ Fatty acid + Diglyceride

Diglyceride $\xrightarrow{\text{Pancreatic Lipase}}$ Fatty acid + Monoglyceride

Monoglyceride $\xrightarrow{Pancreatic\ Lipase}$ Fatty acid + Glycerol

Butter in our diet is digested with the help of bile salts and lipase

Digestion of Nucleic Acid

Nucleic acids are digestive in the small intestine by enzymes present in the pancreatic juice and intestinal juice.

Pancreatic juice: It contains deoxyribonuclease (DNAase and ribonuclease (RNAase)

DNA $\xrightarrow{\text{DNAase}}$ **Deoxyribonucleotides**

RNA $\xrightarrow{\text{RNAase}}$ **Ribonucleotides**

Intestinal juice contains nucleotidases & nucleosidases

Nucleotides $\xrightarrow{\text{Nucleotidase}}$ **Nucleosides +Pi**

Nucleosides $\xrightarrow{\text{Nucleosidase}}$ **Nitrogenous bases + Pentose**

Enzymes in succus entericus act on end products of reactions catalysed by other digestive enzymes to form simple absorbable forms. These reactions occur very close to mucosal epithelium of intestine.

The breakdown of biomacromolecules mentioned above occurs in the duodenum region of the small intestine. The simple substances thus formed are absorbed in the jejunum and ileum regions of the small intestine.The undigested and unabsorbed substances are passed to the large intestine.

A person has Roti and dal for his lunch. Changes with occur during its passage through the gut are given below

i. **Starch will be digested in the buccal cavity & intestine**
ii. **Protein digestion occur in stomach and intestine**
iii. **Fats will be digested in intestine.**

Absorption:

Absorption is the process by which the end products of digestion pass through the intestinal mucosa into the blood or lymph. It is carried out by passive, active or facilitated transport mechanisms.

Small amounts of monosacharides like glucose, amino acids and some of electrolytes like chloride ions are generally absorbed by **simple diffusion.** The passage of these substances into the blood depends upon the concentration gradients.

Some of the substances like fructose and some amino acids are absorbed with the help of the carrier ions like Na^+. This mechanism is called the **facilitated transport.**

Transport of water depends upon the **osmotic gradient.**

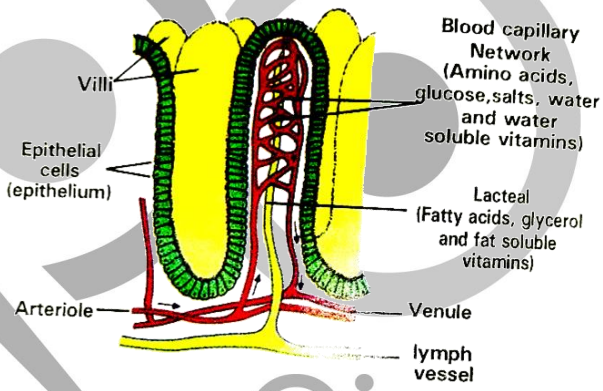
Active transport occurs against the concentration gradient and hence requires energy. Various nutrients like amino acids, monosacharides like glucose, electrolytes like Na^2 are absorbed into the blood by this mechanism.

Fatty acids and glycerol being insoluble, cannot be absorbed into the blood. They are first incorporated into small droplets called **micelles** which move into the intestinal mucosa.

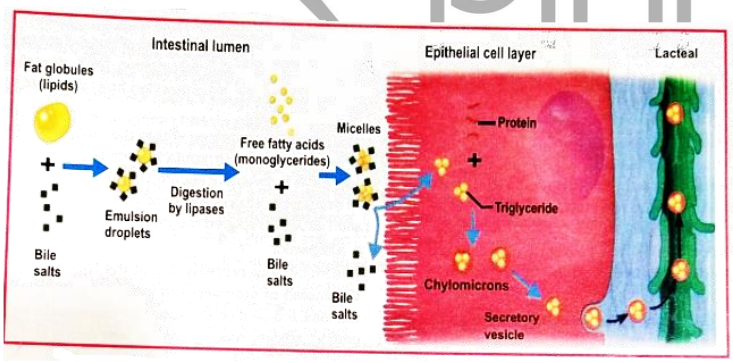
Micelles are reformed into very small protein coated fat globules called the **chylomicrons** which are transported into the lymph vessels (lacteals) in the villi. These lymph vessels ultimately release the absorbed substances into the blood stream.

Absorption of substances takes place in different parts of the alimentary canal, like mouth, stomach, small intestine and large intestine. However, maximum absorption occurs in the small intestine.

Enormous length of small intestine, numerous villi and presence of microvilli in the epithelial cells help in increasing the surface area for absorption.

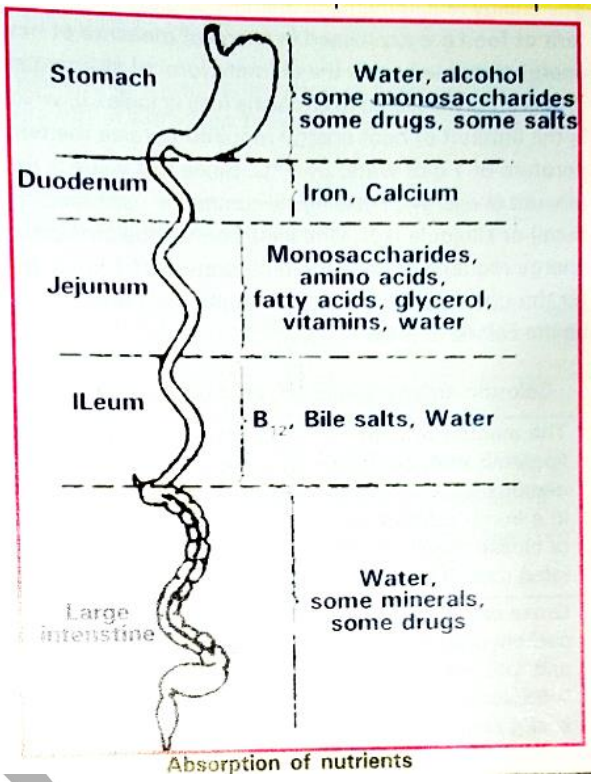


Villus & absorption of digestd nutrients in it



Mouth	Stomach	Small intestine	Large intestine
Certain drugs coming in contact with the mucosa of mouth and lower side of the tongue are absorbed into the blood capillaries	Absorption of water, simple sugars, and alcohol etc. takes place.	Principal organ for absorption of nutrients. The digestion is completed here and the final products of	Absorption of water, some minerals and drugs takes place.

lining them.		digestion such as glucose, fructose, fatty acids, glycerol and amino acids are absorbed through the mucosa into blood stream and lymph.	



Assimilation:

The absorbed substances finally reach the tissues which utilise them for their activities. This process is called assimilation. The absorbed food materials are transported by blood and lymph. Lymph is finally transferred to the blood circulation.

The absorbed food is transported to cells where they are used for energy, growth and repair.

Amino acids

These are taken up by the cells for synthesis of proteins. Excess amino acids can be converted into glucose and then to fat. Amino acids can also be converted to glucose and used as fuel for the cell after deamination. In liver ammonia is soon converted into urea, which is filtered from the blood in the kidney.

Monosaccharides

The excess of the monosaccharides are usually stored in the liver and muscle cells in the form of glycogen. A considerable amount of glycogen. A considerable amount of glucose is converted into fat and stored as such.

Fats: The fat is stored in the fat deposits of the body, such as subcutaneous layers, mesenteries, etc. In the liver cells the fats are converted into amino acids and carbohydrates.

Egestion: The undigested, unabsorbed substances called faeces enters into the caecum of the large intestine through ileo-caecal valve, which prevents the back flow of the faecal matter. Colon absorbs the water and concentrates the undigested food into faeces. It is temporarily stored in the rectum till defaecation.

The egestion of faeces to the outside through the anal opening (defaecation) is a voluntary process and is carried out by a **mass peristaltic movement.** This involves the coordinated contraction of muscles of large intestine, abdominal muscles and diaphragm and relaxation of muscles of anal sphincters.

Regulation of activities of gastro-intestinal tract

The activities of the gastro-intestinal tract are under neural and hormonal control for proper coordination of different parts. The sight, smell and/or the presence of food in the oral cavity can stimulate the secretion of saliva. Gastric and intestinal secretions are also, similarly, stimulated by neural signals. The muscular activities of different parts of the alimentary canal can also be moderated by neural mechanisms, both local and through CNS.
In general, parasympathetic nervous system stimulates release of digestive juices while sympathetic nervous system inhibits the same.
Hormonal control of the secretion of digestive juices is carried out by the local hormones produced by the gastric and intestine mucosa.

Disorders of digestive system:

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

i. Jaundice

The liver is affected, skin and eyes turn yellow due to the deposition of bile pigments. The urine of the patient appears yellow, white stool may appear pale.

i. **Vomiting**

It is ejection of the contents of stomach through the mouth. Feeling of nausea precedes vomiting. Vomiting is controlled by vomiting centre of medulla oblongata.

ii. Diarrhoea

The abnormal frequency of bowel movement and increased liquidity of the faecal discharge is known as diarrhoea. It reduces the absorption of food. Excessive loss of body fluid may result in dehydration. ORS or oral rehydration solution provides protection from dehydration.

iii. **Constipation**

The faeces are retained within the rectum as the bowel movements occur irregularly. Passage of dry hardened faeces. It is generally accompanied by headache, feeling of depression, sluggishness and pain in abdomen. The common cause is reduced roughage content.

iv. **Indigestion**

It is inability to properly digest the food. There is often distension of stomach and intestine giving a feeling of fullness. Indigestion is caused by inadequate enzyme secretion, anxiety, food poisoning, over eating and consumption of spicy food.

Energy value of food contents:

We all recognize the vital importance of food for life. A certain part of the nutrients that we take is used for building cell structures, synthesize functional molecules or replace worn-out parts. However most of the foods are used as source of metabolic fuels. Carbohydrates, proteins and fats serve as the chief sources of energy in humans. These are oxidized and transformed into ATP, the chemical energy form used by cells to drive their multitudes of activities.

The energy requirements of animals, and the energy content of food are expressed in terms of measure of heat energy because heat is the ultimate form of all energies. This is often measured to as calorie (cal) or joule (J), which is the amount of heat energy required to raise the temperature of 1 g of water by 1^0 C. Since this value is tiny amount of energy, physiologists commonly use kilocalorie (kcal) or kilojoule (kJ). One kilocalorie is the amount of energy required to raise the temperature of 1 kg of water through 1^0C. Nutritionists, traditionally refer to kcal as the calorie or joule.

Calorific energy value	**Physiologic energy value**
The amount of heat liberated from complete combustion of 1 g food in a bomb calorimeter (a closed metal chamber filled with O_2)	**The actual amount of energy combustion of 1 g of food in the body.**
Gross calorific value of carbohydrates, protein and	**Physiological value of carbohydrates, protein and fats are 4 kcal/g, 4 kcal/g and 9**

fats are 4.1 kcal/g, 5.65 and 9.45 kcal/g respectively.	**kcal/g.**

Nutritional deficiencies and disorders:

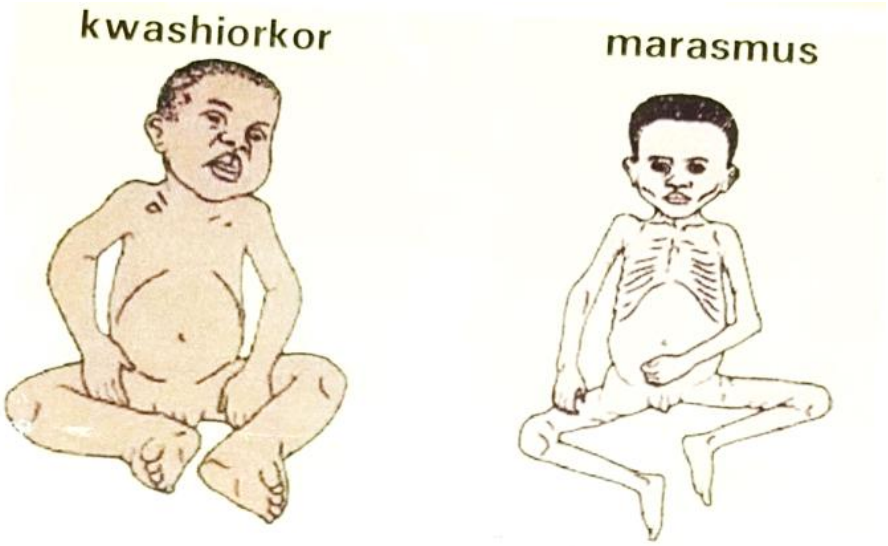
Human require a wide range of nutrients to perform various functions in the body and to lead a healthy life. Inadequate nutrients in the diet cause various deficiency disorders, particularly among the children and the poor. The important deficiency disorders include protein energy malnutrition (PEM) and disorders due to deficiencies of vitamin A, iron and iodine. Deficiency of protein and energy or both, called PEM, has been identified as major health and nutritional problems in India. Protein and energy intake are difficult to separate because diets adequate in energy are adequate in protein. Young children (0-6years) require more protein for each kilogram of body weight than adults. So they are more vulnerable to malnutrition. Malnutrition is not only an important cause of childhood mortality and morbidity, but it also leads to permanent impairment of physical and mental growth of those who survive.

Protein energy malnutrition (PEM): 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 population 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.
It is an important nutritional problem among pre-school children. It leads to various degrees of growth retardation. This is due to lack of adequate quantity of protein or carbohydrate or both.

Differences between kwashiorkor and Marasmus

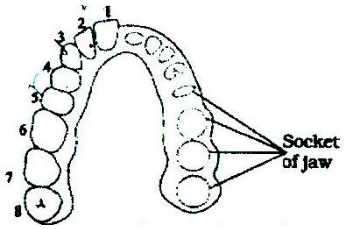
kwashiorkor	Marasmus
It develops in children whose diets are deficient of protein.	It is due to deficiency of proteins and calories.
It occurs in children in age group of 1 to 5 years.	It is common in infants under 1 year of age.
It occurs from the replacement of mother's milk by high calorie-low protein diet in child more than one year in age.	It occurs if mother's milk is replaced too early by other foods which are poor in both proteins and caloric value. This often happen if mother has second pregnancy or childbirth when the older infant is still too young.
Wasting of muscles, thinning of limbs, retarded growth of body and brain, pot belly, diarrhoea.	Extreme emaciation of the body and thinning of limbs. Even growth and development of brain and mental faculties are impaired, growth rate & body weight declines considerably.
Subcutaneous fat is preserved.	Subcutaneous fat is not preserved. Ribs become prominent. Impaired growth & replacement of tissue proteins.
There is oedema. (swelling of legs due to retention of water	Oedema is absent.
Skin and hair (reddish) change colour.	Skin becomes dry, thin and wrinkled

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. The child suffering from PEM can recover if adequate quantities of protein and carbohydrate rich food are given.



EXERCISE - 1

1. The uvula is
   (a) A structure that guards larynx
   (b) A structure that extends into lumen of small intestine
   (c) A fleshy extension of soft palate
   (d) A tonsil in the buccal cavity
2. The strucutre which helps to hold food during mastication is
   (a) Uvula
   (b) Labia
   (c) Palatine rugae
   (d) Vestibule
3. Type of attachment when each tooth is embedded in a socket of jaw bone is
   (a) Acrodont
   (b) Pleurodont
   (c) Thecodont
   (d) Homodont
4. The number of monophyodont and diphyodont teeth in man are respectively
   (a) 12 & 20
   (b) 20 & 12
   (c) 20 & 32
   (d) 32 & 20
5. Note the following
   a. Dentition is heterodont
   b. Canines are poorly developed
   c. Dentition is thecodont
   d. Four wisdom teeth are present
   Which of these is true for human beings?
   (a) a, b & c only
   (b) a, b, c & d
   (c) b, c & d only
   (d) a, c & d only
6. Wisdom teeth in man are
   (a) Incisors
   (b) Last molars
   (c) First molars
   (d) First pre molars
7. Proximate principles of food are
   (a) Proteins, carbohydrates and minerals
   (b) Proteins, carbohydrates and fats
   (c) Minerals, vitamins and carbohydrates
   (d) Minerals, vitamins and water
8. Which of the following correctly represents the type of teeth 2, 4, and 6



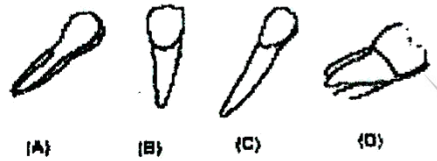
   (a) Incisors, cannines and premolars
   (b) Incisors, premolars and molars
   (c) Cannines, premolars and molars
   (d) Cannines, molars and premolars
9. Which of the following is correct match?

Column – I	Column – II
i. Filiform papillae	a. Leaf like
ii. Foliate papillae	b. Largest papillae
iii. Circumvallate papillae	c. Mushroom like
iv. Fungiform papillae	d. Conical like

   (a) (i-a), (ii-d), (iii-b), (iv-c)
   (b) (i-d), (ii-b), (iii-a), (iv-c)
   (c) (i-d), (ii-a), (iii-b), (iv-c)
   (d) (i-d), (ii-a), (iii-c), (iv-b)
10. Number of premolar in upper half of jaw in adult is
   (a) 0
   (b) 2
   (c) 3
   (d) 1
11. The principles of food which do not provide energy but provide protection from deficiency diseases are
   (a) Provide vitamins & minerals
   (b) Carbohydrates, vitamins & minerals
   (c) Fats, proteins & vitamins
   (d) Vitamins, minerals and water
12. Taste buds of bitter taste are located in our tongue
   (a) On upper surface towards posterior part
   (b) On lower surface towards posterior part
   (c) On lower surface in posterior part
   (d) At tip
13. If dental formula of a man is $\frac{1123}{1123}$, it indicates
   a. 28 teeth instead of 32
   b. 2 less incisors in each jaw
   c. 2 less canines in each jaw

d. That his age is less than 25 years
(a) a & c
(b) a & d
(c) a & b
(d) c & d

14. Examine the figure A, B, C and D. In which one of the four options, all the items A, B, C & D are correct?



	A	B	C	D
(a)	Incisors	Canines	Premolars	Molars
(b)	Premolars	Incisors	Canines	Molars
(c)	Molar	Canines	Incisors	Premolars
(d)	Molar	Incisors	Canines	Premolars

15. Name the lymphatic tissue present in the pharyngeal part of tongue
(a) Thyroid
(b) Tonsils
(c) Epiglottis
(d) Adenoids

16. Gastro – oesophageal sphincter controls the passage of food from
(a) Oesophagus to stomach
(b) Pharynx to stomach
(c) Stomach to duodenum
(d) None of the above

17. The stomach takes part in
(a) Breaking food mechanically
(b) Partially digesting the food
(c) Disinfecting the food
(d) All the above

18. The part of pharynx which contains only air is
(a) Nasopharnx
(b) Oropharynx
(c) laryngopharynx
(d) linguapharynx

19. The part of pharynx which contains only air is
(a) Oral cavity
(b) Pharynx
(c) Stomach
(d) Small intestine

20. Oesophagus is present
(a) In front of trachea
(b) Behind the trachea
(c) In abdominal region only
(d) At the end of oral cavity

21. Failure of gastro – oesophageal sphincter to relax causes
(a) Adenoid
(b) Achalasia cardia
(c) Tonsillitis
(d) Appendicitis

22. Part of stomach connected to duodenum is called
(a) Cardiac
(b) Fundus
(c) Pharynx
(d) Pylorus

23. Rugae are present in
(a) Palate
(b) Stomach
(c) Intestine
(d) Both 1 and 2

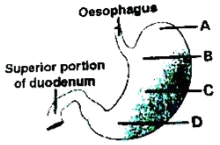
24. What would be the consequence of removal of stomach?
a. Non absorption of vitamin B_{12}
b. Non absorption of iron
c. Anaemia
d. Acidity in the small intestine
(a) a, b & c
(b) a, b & d
(c) b, c & d
(d) a, c & d

25. Which is not a function of HCL?
(a) Killing bacteria
(b) Conversion of pepsinogen into pepsin
(c) Conversion of proteins into peptones
(d) Sterilization of food

26. Gases are mostly collected in which part of stomach?
(a) Cardiac stomach
(b) Fundus
(c) Pyloric stomach
(d) All of these

27. The epiglottis is
(a) A structure that guards larynx
(b) A structure that extends into lumen of vestibule
(c) A fleshy extension of soft palate
(d) Both (b) and (c)

28. Distal part of stomach in the given diagram is



(a) D, which is pyloric stomach
(b) A, which is fundic stomach
(c) B, which is cardiac stomach
(d) D, which is cardiac stomach

29. The common passage in swallowing food and breathing is
(a) Gullet
(b) Glottis
(c) Larynx
(d) Pharynx

30. Cardiac sphincter prevents the back flow of
(a) Blood into heart
(b) Bile into liver
(c) Blood to aortae
(d) food

31. Aggregates of lymphoid tissue present in the distal portion of small intestine are known as
(a) Rugae
(b) Villi
(c) Plexus
(d) Peyer's patches

32. The layer containing glands in small intestine is/are
(a) Submucosa
(b) Serosa
(c) Mucosa
(d) Both (a) and (c)

33. The part of small intestine which bears gland in submucosa region is
(a) Duodenum
(b) Jejunum
(c) Ileum
(d) All of these

34. The type of cells present in mucosal epithelium which secrete mucus to help in lubrication are
(a) Goblet cell
(b) Lacteal
(c) Mesothelium
(d) Rugal cell

35. The jejunum is the part of the alimentary canal which is situated between
(a) Stomach and duodenum
(b) Oesophagus and stomach
(c) Duodenum and ileum
(d) Ileum and rectum

36. Which of the following statement is incorrect about alimentary canal?
(a) Serosa is outer most layer of gut
(b) Muscularis is arranged into an inner circular and outer longitudinal layer
(c) An oblique muscle layer may be present in some regions
(d) Circular folds are best developed in duodenum.

37. Small intestine has
(a) Narrow diameter and longer length than large intestine
(b) Narrow diameter and shorter length than large intestine
(c) Wider diameter and longer length than large intestine
(d) Wider diameter and shorter length than large intestine

38. External anal sphincter is
(a) Voluntary and made up of smooth muscles
(b) Involuntary and made up of striated muscles
(c) Involuntary and made up of smooth muscles
(d) Voluntary and made up of small intestine in order

39. Arrange the three parts of small intestine in order of their increasing length
(a) Duodenum – jejunum – ileum
(b) Ileum – jejunum – duodenum
(c) Jejunum – ileum – duodenum
(d) Jejunum – duodenum – ileum

40. Ileum opens into
(a) Caecum
(b) Colon
(c) Appendix
(d) Rectum

41. The antibacterial agent that prevents infections and is present in saliva is
(a) CI^-
(b) Lysozyme
(c) Na^+
(d) All of these

42. The gland which secrete maximum amount of salivary amylase is
(a) Parotid
(b) Submandibular
(c) Sub – lingual
(d) Gastric

43. Succus entericus is the name given to
(a) Junction between ileum and large intestine
(b) Intestinal juice
(c) Swelling in the gut
(d) Appendix

44. Duct of stenson belongs to
(a) Parotid
(b) Submandibular
(c) Sub – lingual
(d) Gastric

45. Major contribution to saliva is by _____gland through _____duct
(a) Sub maxillary, Wharton's
(b) Sub maxillary, Stenson's
(c) Parotid, Stenson's
(d) Sublingual, Wharton's

46. What would happen if Stenson's duct gets blocked?
(a) Gastric juice will be without HCI
(b) Saliva would be with considerable less salivary amylase
(c) Secretion of saliva would be cut to 60%
(d) Food will accumulate in oesophagus

47. Location of different salivary glands is given be low.
Match the column – I with column – II and find the correct answer

Column – I	**Column – II**
a. Parotids	i. Lower jaw
b. Sub maxillary	ii. Cheek
c. Sub linguals	iii. Below the tongue

(a) a – ii, b – i, c – iii
(b) a – i, b – ii, c – iii
(c) a – iii, b – ii, c – i
(d) a – ii, b – iii, c – i

48. Which organ of alimentary canal have mucus glands?
(a) Oesophagus
(b) Stomach
(c) Small intestine
(d) All of these

49. Chief cells or peptic cells of stomach secrete
(a) Pepsinogen, lipase, HCI
(b) Pepsinogen, Prorennin, lipase
(c) Castle's factor, prorennin, HCI
(d) Castle's factor, prorennin, HCI

50. Which of the following is incorrect about type of cell and its secretion?
(a) Chief cell – Pepsinogen, Prorennin
(b) Oxyntic cell – Castle intrinsic factor, HCI
(c) Neck cell – Lipase, amylase
(d) Argentaffin cell – Somatostatin, Serotonin

51. Enterokinase/Enteropeptidase takes part in conversion of
(a) Pepsinogen to pepsin
(b) Trypsinogen to trypsin
(c) Protein into polypeptides
(d) Caseinogen into casein

52. Match the entities under column – I with those under column – II

Column – I	Column – II
a. Saliva	p. Enterokinase
b. Gastric juice	q. Trypsin
c. Pancreatic juice	r. Ptyalin
d. Intestinal juice	s. Pepsin

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

53. Glisson's capsule is associated with
(a) Liver
(b) pancreases
(c) Lung
(d) Kidney

54. The phagocytic cells present in liver are
(a) Goblet cells
(b) Brunner gland cell
(c) Paneth cell
(d) Kupffer cell

55. Glycogen is
(a) Synthesised in liver, source of energy, forming bile and lipase
(b) Disaccharide stored in liver reacts with ammonia to form protein
(c) Synthesised in blood, stored in liver and muscles to provide glucose
(d) Polysaccharide synthesised and stored in liver

56. Stool of infant entirely fed on whitish mother's milk is yellowish due to
(a) Pancreatic juice
(b) Undigested milk casein
(c) Intestinal juice
(d) Bile pigments

57. Angiotensinogen is secreted by
(a) Gastric cell
(b) Intestinal cell
(c) Liver cell
(d) Colon cell

58. Swallowing of food is called
(a) Deglutition
(b) Reglutition
(c) Ingestion
(d) Digestion

59. Peristalsis is produced by
(a) Voluntary contraction of circular and longitudinal muscle
(b) Voluntary contraction of circular muscle only
(c) Involuntary contraction of circular and longitudinal muscle
(d) Involuntary contraction of plexus

60. What is peristalsis?
(a) Circular skeletal muscles contract at the top and longitudinal skeletal muscles contract at the base of the bolus
(b) Loss of appetite, fatigue, dehydration and nervous disorders
(c) Smooth muscles contractions that move food through the alimentary canal
(d) The transport of nutrients to the liver through the hepatic portal vein

61. The bile duct and pancreatic duct open together in duodenum as hepatopancreatic ampulla which is guarded by sphincter called
(a) Sphincter of Boyden
(b) Sphincter of oddi
(c) Pyloric sphincter
(d) Gastroesophageal sphincter

62. Select the odd one
(a) Trypsin – pancreatic juice
(b) Elastase – Pancreatic juice
(c) Nuclease – pancreatic juice
(d) Nucleosidase – pancreatic juice

63. Bile activates
(a) Proteases
(b) Nucleases
(c) Lipases
(d) Carbohydrases

64. Liver the largest gland of body is situated in the
(a) Thoracic cavity above the diaphragm
(b) Abdominal cavity below the diaphragm
(c) Abdominal cavity above the diaphragm
(d) Thoracic cavity below the diaphragm

65. Hepatic cells in liver are arranged in the form of
(a) Groups
(b) Bundles
(c) Cords
(d) Like bunch of grapes

66. Which of the following statement is correct?
a. Pancreas is both endocrine and exocrine gland
b. Pancreas is located between the limbs of the U – shaped duodenum
c. Exocrine part of pancreas secrete alkaline, enzyme containing pancreatic juice
d. Endocrine part of pancreas secrete hormones, Insulin and glucagon
(a) a, b are correct
(b) a, c are correct
(c) a, b, c and d are correct
(d) a, d are wrong

67. What is common among amylase, rennin and trypsin?
(a) All proteins
(b) Proteolytic enzymes
(c) Produced in stomach
(d) Act at pH lower than 7

68. Choose the correct option to complete the table

Digestive Secretion	Nature of Secretion	Digestive enzymes present
Saliva	Acidic	Enzymes present
Bile	Alkaline	None
Succus entericus	Alkaline	Disaccharides
_____	Acidic	_____

(a) Lysozyme, bile, disaccharides, pancreatic juice, rennin
(b) Ptyalin, bile, disaccharides, gastric juice, pepsin
(c) Ptyalin gastric juice, dipeptidase, bile, none
(d) Salivary amylase, bile, enterokinase, gastric juice, trypsin

69. Which 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) Stomach : fats $\xrightarrow{\text{lipase}}$ micelles
(b) Duodenum : triglycerides $\xrightarrow{\text{trypsin}}$
(c) Small intestine : starch $\xrightarrow{\text{Pancreatic Anylase}}$ disaccharide (Maltose)
(d) Small intestine: proteins $\xrightarrow{\text{pep sin}}$ amino acids

70. Emulsification of fats into very small droplets is brought about by
(a) Bile salts
(b) Bile salts & lipase
(c) Mucus & lipase
(d) Bile salts & fat soluble vitamins

71. If you take butter in your diet, at which its maximum digestion takes place
(a) Stomach
(b) Liver
(c) Duodenum
(d) Ileum

72. If the chyme of a person who had orally consumed only starch as food is analysed before it enters the duodenum it will show the presence of
(a) Glucose
(b) Dextrin and sucrose
(c) Starch, dextrin and glucose
(d) Starch, dextrin and maltose

73. Identify A, B and C in following reaction
a. Sucrose $\xrightarrow{A}$ glucose + fructose
b. Lactose $\xrightarrow{\text{lactase}}$ glucose + B
c. Maltose $\xrightarrow{\textit{maltase}}$ glucose + C
(a) Sucrase, glucose, galactose
(b) Sucrose, galactose, glucose
(c) Sucrose, fructose, glucose
(d) Dextrinase, fructose, glucose

74. Partial digestion of nucleic acid results in formation of
(a) Nitrogenous base, sugar, phosphate
(b) Nucleotides
(c) Nucleosides
(d) Both (b) and (c)

75. Fats are broken down into di – and monoglyceride with the help of
(a) Amylase
(b) Lipases
(c) Proteases
(d) Nucleases
(e)

76. In case of taking food rich in lime juice, the action of ptyalin on starch is
(a) Enhanced
(b) Reduced
(c) Unaffected
(d) Stopped

77. Human digestive juice lack
(a) Lactase
(b) Cellulase
(c) Amylase
(d) Sucrose

78. During vomiting the vomit passes sequentially from
(a) Stomach – oesophagus – pharynx – buccal cavity to the outside
(b) Stomach – oesophagus – gullet – buccal cavity to the outside
(c) Oesophagus – stomach – buccal cavity – glottis to the outside
(d) Small intestine – stomach – gullet – trachea to outside

79. Abnormal frequency of bowel movement reducing absorption of food occurs in
(a) Constipation
(b) Diarrhoea
(c) Indigestion
(d) Jaundice

80. Which among the following is correct for vomiting?
(a) It is ejection of stomach contents through mouth
(b) It is controlled by medulla oblongata
(c) Feeling of nausea precedes vomiting
(d) All of above

81. Infections of the intestinal tract are caused by
(a) Bactria and viruses
(b) Pararites like tapeworm and round worm
(c) Pararites like hookworm and pin worm
(d) All of these

EXERCISE - 2

1. The major components of the food include carbohydrates along with
   (a) Proteins & vitamins
   (b) Vitamins & minerals
   (c) Fats and vitamins
   (d) Proteins and fats
2. Digestion involves mechanical and biochemical breakdown of food into
   (a) Simple non – diffusible forms
   (b) Complex absorbable forms
   (c) Simple absorbable food
   (d) Simple non absorbable forms
3. The alimentary canal lies between
   (a) Mouth and anus
   (b) Mouth and rectum
   (c) Bucal cavity and rectum
   (d) Pharynx and anus
4. Digestion is defined as
   (a) Breakdown of simple food into complex food
   (b) Breakdown of non – diffusible macromolecules into diffusible molecules
   (c) Ingestion and absorption of food
   (d) Crushing and gridnding of food
5. Hard surface of teeth is
   (a) Enamel that helps in mastication
   (b) Enamel that helps in chewing
   (c) Enamel that helps in absorption
   (d) Both (a) and (b)
6. The codont dentition is that tooth is
   (a) Embedded in socket of jaw bone
   (b) Embedded in the side of jaw bone
   (c) Projection of the jaw bone
   (d) None of the above
7. Dental formula is arrangement of teeth in
   (a) Each half of upper and lower jaw
   (b) Upper jaw
   (c) Lower jaw
   (d) Full upper and full lower jaw
8. In the dental formula arrangement of different teeth in the jaw is represented in the order
   (a) I, C, PM, M
   (b) C, I, PM, M
   (c) I, C, M, PM
   (d) C, I, M, PM
9. The chewing surface of teeth is made up of
   (a) Enamel
   (b) Dentine
   (c) Cement
   (d) Bone
10. Which is the incorrect statement?
   (a) Tongue is attached to the floor of oral cavity by frenulum
   (b) All papillae present on tongue contain taste buds
   (c) During swallowing epiglottis prevents the entry of food in to glottis
   (d) Pharynx is common passage for food and air
11. Oesophagus opens into ……..part of stomach guarded by……..sphincter.
   (a) Cardiac ; pyloric
   (b) Cardiac ; gastro oesophageal
   (c) Fundic ; gastro oesophageal
   (d) Fundic ; pyloric
12. The stomach is ….. shaped and located in …….part of abdominal cavity.
   (a) J ; upper left
   (b) C ; upper left
   (c) C ; lower
   (d) J ; lower left
13. Which of the following is not correct match
   (a) Duodenum – C – shaped
   (b) Jejunum – long coiled middle part of small intestine
   (c) Ileum – highly coiled part of small intestine
   (d) Caecum – narrow tubular projection
14. Which is the correct sequence in which food passes?
   (a) Stomach – oesophagus – jejunum – duodenum – ileum
   (b) Stomach – jejunum – oesophagus – ileum – duodenum
   (c) Oesophagus – stomach – jejunum – duodenum ileum
   (d) Oesophagus – stomach – duodenum – jejunum – ileum
15. A – Serosa, B – Mucosa, C – Submucosa D – Muscular layer
   Arrangement of above different layers of gut from inner to outer is
   (a) ABCD
   (b) BCDA
   (c) ABDC
   (d) BDCA

16. Villi are
(a) Innermost layer with irregular folds in stomach
(b) Microscopic projections in the cells lining small intestine
(c) Small finger like folding in the mucosa of small intestine
(d) Irregular folding in the sub – mucosa of small intestine

17. Surface area in gut is highly increased by
(a) Submucosa, villi and microvilli
(b) Rugae, villi and microvilli
(c) Lacteals, rugae and microvilli
(d) Lacteals, crypts and rugae

18. Crypts of liberkuhn are present in the
a. Crypts between the bases of microvilli
b. Crypts between the bases of villi
c. Mucosa of alimentary canal
d. Small intestine in its inner most layer
(a) a, b, c & d
(b) a, b & c
(c) a, b & d
(d) b, c & d

19. Gastric glands and Brunner's glands are present in
(a) Mucosa and submucosa of stomach
(b) Mucosa and submucosa of alimentary canal
(c) Mucosa and muscularis of alimentary canal
(d) Both (a) & (b)

20. Castle intrinsic factor is secreted by
(a) Mucus neck cells
(b) Peptic cell
(c) Oxyntic cells
(d) Crypts of liberkuhn

21. Which of the following will not be affected if parietal cell secretion is blocked?
(a) Protein digestion
(b) Vitamin B_{12} absorption
(c) RBCs maturation
(d) Lubrication of mucosal epithelium

22. What would happen if all oxyntic cells are removed from the gastric epithelium?
(a) Deficiency of vitamin B_{12}
(b) High amount of gastric juice
(c) Non – secretion of gastric juice
(d) Lack of enzymes in gastric juice

23. Intestinal juice is the secretions of goblet cell and
(a) Intestinal mucosal cells
(b) Crypts of liberkhun
(c) Cardiac glands
(d) Both (a) and (b)

24. Acidity in duodenum is neutralised by
(a) Mucous, HCI and bicarbonate ions
(b) Secretion of bile and peptic cells
(c) Mucous, bicarbonate ions and secretions from brunner's glands
(d) Mucous from crypts of liberkuhn & oxyntic cells

25. The digestive glands associated with alimentary canal include
(a) Salivary glands, liver and pancreas
(b) Salivary glands, liver and crypts of liberkuhn
(c) Pancrease and gall bladder
(d) Pancrease, gall bladder and crypts of liberkuhn

26. Match the following

a. Salivary glands	i. Inside the buccal cavity
b. Liver	ii. Outside the buccal cavity
c. Pancreas	iii. Below the diaphragm
	iv. Between limbs of duodenum
	v. Compound gland
	vi. Largest gland
	vii. Formation of food bolus

(a) (a-i, vii), (b-iii, v) (c-iv, v)
(b) (a-ii, vii), (b-iii, vi), (c-iv, v)
(c) (a-i, vii) (b-v, vi), (c-iii, iv)
(d) (a-ii, vii), (b-iii, vi), (c-v, vii)

27. The first enzyme that food comes in contact with is
(a) Amylase
(b) Rennin
(c) Pepsin
(d) Lipase

28. Which of the following statement is NOT true?
(a) 30% hydrolysis of starch occur in buccal cavity?
(b) lysozyme in saliva have antibacterial action
(c) Food is converted into bolus in buccal cavity
(d) Peristaltic waves helps in swallowing

29. Which groups describe functions of buccal cavity?
(a) Chewing of food, mixing of food, facilitation of swallowing
(b) Chewing of food, storage of food, facilitation of swallowing
(c) Cellulose digestion, storage of food, facilitation of swallowing
(d) Tasting of food, storage of food, facilitation of swallowing

30. Peristalsis occur due to ……layers and helps in ……. Digestion
(a) Muscularis ; chemical
(b) Muscularis ; mechanical
(c) Mucosa ; Chemical
(d) Mucosa ; chemical

31. Bile contain
(a) Phospholipids and cholesterol
(b) Bile salts and pigments
(c) Enzymes
(d) Both (a) and (b)

32. Which reaction is correct regarding the digestion?
(a) Starch $\xrightarrow[\text{pH.5}]{\text{Salivary amylase}}$ Maltose
(b) Fats $\xrightarrow[\text{alkaline pH.}]{\text{Lipase}}$ Diglycerides
(c) Starch $\xrightarrow[\text{alkaline pH.}]{\text{Lipase}}$ Diglycerides /Monoglycerides
(d) Polysaccharides $\xrightarrow[\text{pH - 7}]{\text{Pancreatic amylase}}$ Disaccharides

33. End products of nucleic acid digestion are
(a) Nitrogenous base, sugar, phosphate
(b) Nucleotides
(c) Nucleosides
(d) Amino acids

34. During digestion end products are acted upon by enzymes from
(a) Pancreas
(b) Bile
(c) Stomach
(d) Succus entericus

35. Breakdown of Biomacromolecules mainly occur in …….and simple substances are absorbed in ……
(a) Stomach ; duodenum
(b) Mouth ; stomach
(c) Stomach ; ileum
(d) Duodenum ; jejunum & ileum

36. Which one is function of large intestine?
(a) Absorption of carbohydrates
(b) Adherence and lubrication of waste particles
(c) Breakdown of drugs
(d) Significant digestive of macromolecules

37. Secretions of digestion juices is carried under the
(a) Effect of local hormones from gastric and intestinal mucosa
(b) Effect of hormones from pituitary
(c) Effect of neural signal from sight of food
(d) Both (a) & (c)

38. Absorption is the process of
(a) Passing end products of digestion to intestinal mucosa
(b) Intake of simple substances in intestinal mucosa
(c) Intake of simple substances through intestinal mucosa into the blood
(d) Carrying of digested substances to body cells

39. Most of the amino acids and glucose are absorbed by
(a) Simple diffusion
(b) Active transport
(c) Facilitated diffusion
(d) Both by (a) & (b)

40. Fatty acids and glycerol enter into intestinal mucosal cells with the help of
(a) Micelles
(b) Chylomicrons
(c) Fat globules
(d) Triglycerides

41. Chylomicrons are
(a) Undigested proteins
(b) Undigested carbohydrates
(c) Fat droplets coated with proteins
(d) Protein droplets coated with fats

42. Match the following

a. Mouth	i. Absorption of minerals
b. Stomach	ii. Absorption of fatty acids
c. Small intestine	iii. Absorption of drugs
d. Large intestine	iv. Absorption of alcohol

(a) a – iii, b – iv, c – ii, d – i
(b) a – iii, b – ii, c – iv, d – i
(c) a – ii, b – iii, c –i, d – iv,
(d) a – iv, b – iii, c – i, d – ii

43. Water absorption occur in
(a) Stomach, small intestine and oesophagus only
(b) Buccal cavity, stomach and small intestine only
(c) Stomach, small intestine and large intestine
(d) Buccal cavity, small intestine and large intestine only

44. The process of assimilation involves
(a) Utilization of absorbed substances by tissues
(b) Breakdown of complex macromolecules
(c) Transport of simple substances into blood
(d) All of these

45. Defecation reflex is initiated by entry of food in
(a) Ascending colon
(b) Transverse colon
(c) Descending colon
(d) Rectum

46. Mass peristaltic movements are required for
(a) Solidification of faeces
(b) Initiating neural reflexes for excretion
(c) Egestion of faeces
(d) Closing of internal anal sphincter

47. A persons shows yellow tinge of skin & eyes and his digestion is hampered. He is likely showing the symptoms of
(a) Intestinal inflammation
(b) Indigestion
(c) Jaundice
(d) Diarrhoea

48. Which of the following is NOT a correct match?
(a) Vomiting – Ejection of stomach contents through mouth
(b) Diarrhoea – Abnormal frequency of bowel
(c) Constipition – Reduced absorption
(d) Indigestion – Feeling of fullness

49. 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

50. A gland not associated with the alimentary canal is
(a) Pancreas
(b) Adrenal
(c) Liver
(d) Salivary glands

51. Match entries in column – I with entries in column – II.

Column I	Column II
a. Biomacromolecules	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 sub – stances
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

52. Match entries in column – I with entries in column – II.

Column – I	Column – II
a. Duodenum	i. A cartilaginous flap
b. Epiglottis	ii. Small blind sac
c. Glottis	iii. 'C' shaped from stomach
d. Caecum	iv. Opening of wind pipe

(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

53. Goblet cells are located in the intestinal mucosal epithelium and secrete
(a) Chymotrypsin
(b) Mucus
(c) Trypsin
(d) Pepsin

54. Gastric glands of stomach mucosa have oxyntic cell which secrete
(a) Mucus
(b) Lipase
(c) HCI
(d) Pepsin

55. Initial step in digestion of milk in humans is carried out by
(a) Lipase
(b) Trypsin
(c) Rennin
(d) Pepsin

56. Three major parts of stomach are
(a) Cardiac, fundic, pyloric
(b) Pyloric, cardiac, cardiac sphincter
(c) Pyloric, oesophageal, cardiac
(d) Duodenal, cardiac, pyloric

57. Which statement is true w.r.t. pancreas?
(a) Correct shaped soft gland situated below the stomach
(b) Pancreatic juice is released by its Islets of Langerhans
(c) Secretes enzymes like pancreatic amylase, nucleases, trypsinogen
(d) Both a and c are true

58. Match the organ with its function
(a) Small intestines – major site of absorption of food
(b) Stomach – digestion of proteins & nucleic acids
(c) Mouth cavity – absorption of monosaccharides
(d) Large intestine – digestion & absorption of food

59. Hepato – pancreatic duct opens into the duodenum and carries
(a) Bile
(b) Pancreatic juice
(c) Both a & b
(d) Saliva

60. Which one of the following is not a common disorder associated with digestive system?
(a) Tetanus
(b) Diarrhoea
(c) Jaundice
(d) Dysentery

61. 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

(a) a – ii, b – iii, c – I, d – iv
(b) a – iii, b – iv, c – ii, d – I
(c) a – iii, b – I, c – iv, d – ii
(d) a – ii, b – iii, c – iv, d – I

62. 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

63. Liver is the largest gland and is associated with various functions, choose one which is not correct
(a) Metabolism of carbohydrate
(b) Emulsification of fat
(c) Formation of bile
(d) Secretion of hormone called gastrin

64. Fats are broken down into di – and monoglycerides with the help of
(a) Amylase
(b) Lipases
(c) Proteases
(d) nucleases

65. Select the incorrect statement
(a) Absorption of amino acids and glycerol takes place in the small intestine
(b) The faeces in the rectum initiate a neural reflex causing an urge for its removal
(c) Skin and eyes turn yellow in stomach infection
(d) Rennin is a proteolytic enzyme found in gastric juice in infants

66. Saliva contains enzymes that digest
(a) Starch
(b) Protein
(c) Fat
(d) Nucleic acid

67. Which of the following statement is right?
(a) Semi digested food in stomach produced by its churning movement and acidic juice is known as chyme
(b) Semi digested food produced in stomach is known as bolus
(c) Semi digested food produced by churning movement of stomach is known as chyle.
(d) All are right

68. What is the source of Enterokinase which activities trypsinogen into ____
(a) Intestinal glands, chymotrypsin
(b) Intestinal mucosa, trypsin
(c) Gastric cells, pepsin
(d) Pancreatic cells, trypsin

69. Choose the correct option w.r.t. enzymes involved in breakdown of nucleotides into sugar and base and sugar into phosp
(a) Nucleosidases, nucleotides
(b) Nucleotidase, nucleosidases
(c) Nucleases, nucleosidases
(d) Nucleosidases, glycosidases

70. Which one of the following is/are difference between constipation and indigestion?
(a) Constipation may cause injury to digestive tract while indigestion produces distension of stomach and intestines
(b) Constipation is inability to properly digest the food while indigestion is frequent and irregular passage of hardened faeces
(c) Constipation makes a bowl movement 2 – 3 times a day while indigestion makes bowl movement after 2 – 3 days
(d) All of these

71. Which one is wrong?
(a) Gall bladder produces bile
(b) Bile is the juice of pancreasatic cells
(c) Hepato pancreatic duct carries only bile
(d) All are wrong

72. Match entries in column – I with entries in column – II

Column – I	Column – II
a. Goblet cells	i. HCI
b. Fat metabolism	ii. Mucous
c. Oxyntic cells	iii. Lipases

(a) a – ii, b – iii, c – I
(b) a – I, b – ii, c – iii
(c) a – ii, b – I, c – iii
(d) a – iii, b – I, c – ii

73. If gall bladder stops functioning or is removed, the
(a) Emulsification of fat is reduced
(b) Fat digestion is reduced
(c) Digestion of fats is enhanced
(d) Both a and b

74. The faces in rectum that initiate a reflex causing urge for its removal is/are
(a) Only neural
(b) Only hormonal
(c) Both a & b
(d) Neither a nor b

75. Skin and eyes turn yellow in infection – What think it is due to?
(a) Liver infection/Jaundice
(b) Pancreas inflammation
(c) Stomach ulcer
(d) Yellow pigments released by gastric cells

76. What are the end products of dipeptides, disaccharides and triglycerides respectively?
(a) Amino acids, monosaccharides, fatty acids and glycerol
(b) Monosaccharides, glycerol, amino acids
(c) Fatty acids, amino acids, glycerol
(d) Simple proteins, simple sugars and fatty acids

77. Which of the following nutrients provide energy?
(a) Protective principles of food
(b) Minerals and vitamins
(c) Proximate principles of food
(d) Both a and c

78. Protective principles of food are
(a) Proteins, carbohydrates and minerals
(b) Proteins, carbohydrates and fats
(c) Minerals, vitamins and carbohydrates
(d) Minerals, vitamins and water

79. Human tongue
(a) Bears taste buds
(b) Is concerned with chewing and swallowing
(c) Facilitates speech
(d) All of the above

80. Structure that divides tongue into oral and pharyngeal part is called
(a) Foramen caecum
(b) Sulcus terminalis
(c) Lingual frenulum
(d) Labial frenulum

81. Foramen present in the tongue is
(a) Foramen caecum
(b) Apical foramen
(c) Foramen of monro
(d) Foramen ovale

82. Pharynx is divisible into 3 parts:
a. Nasopharynx
b. Oropharynx
c. Laryngopharynx
Which of these parts serve as passage for both air and food?
(a) a and b only
(b) b and c only
(c) a and c only
(d) a, b and c

83. Different types of teeth in humans are
(a) Incisors
(b) Canines
(c) Premolars and molars
(d) All of these

84. Wisdom teeth in human are
(a) 3^{rd} molars and 4 in number
(b) 3^{rd} molars and 2 in number
(c) 2^{nd} molars and 4 in number
(d) 2^{nd} molars and 2 in number

85. Dental formula of adult man is
(a) $\frac{2123}{2123}$
(b) $\frac{2122}{2122}$
(c) $\frac{2123}{2124}$
(d) $\frac{2132}{2132}$

86. Dental formula for a teenager is
(a) $\frac{2123}{2123}$
(b) $\frac{2122}{2122}$
(c) $\frac{2123}{2124}$
(d) $\frac{2132}{2132}$

87. Which of the following is correct regarding proteases?
(a) HCI activates pepsinogen and Enterokinase activates trypsinogen
(b) Pepsin and rennin digest milk sugar
(c) Trypsinogen is release by pancreas
(d) Both a and c

88. Find the correct statement.
(a) The hard chewing surface of teeth made up of dentine helps in mastication of food
(b) Tongue is attached to the floor and sides of oral cavity by frenulum
(c) The upper and lower surface of tongue has small projections called papillae, some of which bear taste buds
(d) Man has 12 Monophydont teeth and 20 diphyodont teeth

89. In humans each tooth is embedded in a socket of jaw bone. Such type of dentition is called
(a) Monophyodont
(b) Thecodont
(c) Diphyodont
(d) Polyphyodont

90. Majority of mammals have two set of teeth during their life, a set of temporary deciduous teeth replaced by a set of permanent teeth. This type of dentition is called
(a) Monophyodont
(b) Diphyodont
(c) Polyphyodont
(d) None of these

91. The dentition in which teeth are of different types is called
(a) Homodont
(b) Heterodont
(c) Thecodont
(d) Acrodont

92. Hard chewing surface of the teeth, that helps in the mastication of food is known as
(a) Pharynx
(b) Enamel
(c) Tonsils
(d) Pulp

93. Choose the correct match.
(a) Foliate papillae – Well developed in human
(b) Fungiform papillae – No taste buds
(c) Circumvallate papillae – Posterior part of tongue
(d) Filiform papillae -= Taste buds present

94. A cartilaginous flap called epiglottis prevents the entry of food in _____ during swallowing.
(a) Gullet
(b) Glottis
(c) Opening of the wind pipe
(d) Both b and c

95. Human teeth are
(a) Heterodont, diphyodont, thecodont
(b) Heterodont, Acrodont, Monophydont
(c) Homodont, Acrodont, diphyodont
(d) Homodont, thecodont, Polyphyodont

96. Lymphatic mass of pharynx is called
(a) Tonsils
(b) Glottis
(c) Epiglottis
(d) Uvula

97. The sphincter which regulates the opening of stomach into duodenum is called
(a) Cardiac sphincter
(b) Gastro – oesophageal sphincter
(c) Pyloric sphincter
(d) Epiglottis

98. As the larva of a certain animal underwent metamorphosis, the length of its intestine shortened. The most probable reason for this is that
(a) Intestine is vestigial in adult
(b) Larva is herbivorous while adult is a carnivorous
(c) Larva is carnivorous while adult is herbivorous
(d) Larva being immature takes longer to digest food so requires longer intestine

99. Match the parts of GIT under column – I with their feature under column – II.

Column – I	Column – II
a. Oesophagus	p. Highly coiled
b. Stomach	q. 'C' shaped
c. Duodenum	r. Thin and long
d. Ileum	s. 'J' shaped

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

100. Comparison of two races A and B of humans showed longer small intestine in people of race B. It is most probably due to
(a) Lesser food consumption by race A
(b) Greater food consumption by race A
(c) More average height of race B
(d) Less average height of race B

101. Peyer's patches are found in
(a) Serosa of jejunum
(b) Mucosa of ileum
(c) Submucosa of duodenum
(d) Muscularis of stomach

102. Read the following statements
A. Palatine rugae are transverse ridges on the soft palate which hold food during mastication.
B. Uvula is the posterior most part of soft palate.
Mark the correct option.
(a) Only A is correct
(b) Only B is correct
(c) Both A and B are correct
(d) Both A and B are incorrect

103. Which of the following parts of alimentary canal is the shortest?
(a) Duodenum
(b) Jejunum
(c) Ileum
(d) Large intestine

104. If the inner surface of the ileum in the human small intestine were smooth, rather than being folded into villi, which statement would be true?
(a) Vitamins would not be synthesized due to lack of E. coli
(b) Absorption would not be very effective
(c) Human would not be able to survive, because the digestive tract would be more susceptible to damage
(d) The rate of absorption of digested food would be higher

105. Which anal muscle is striped or voluntary?
(a) Internal anal sphincter muscle
(b) External longitudinal muscle
(c) Internal circular muscle
(d) External anal sphincter muscle

106. Consider the statements given below and answer the question that follows
a. Stomach is located in the upper left portion of abdominal cavity
b. Small intestine is distinguishable into three regions
c. Large intestine hosts some symbiotic microbes

d. Epiglottis prevents the entry of food into the gullet

Which of the above statements are true?

(a) a, b, c
(b) b, c, d
(c) a, b, d
(d) All are true

107. Function of large intestine is
(a) Absorption of water, mineral and bile salts
(b) Harbours symbiotic microbes
(c) Adhering of waste particles together and lubrication
(d) Both b and c

108. How are vermiform appendix and tonsils similar?
(a) Both are vestigial
(b) Both are lymphoidal
(c) Both are associated with intestine
(d) Both act to digest cellulose in herbivores

109. Opening of oesophagus into stomach is guarded by
(a) Pyloric sphincter
(b) Muscular sphincter
(c) Gastro – oesophageal sphincter
(d) Both b & c

110. Out of the three parts of small intestine, (i) the least vascular, (ii) is moderately coiled and (iii) is the most proximal part.
(a) (i) – ileum, (iii) – duodenum
(b) (ii) – Jejunum, (iii) – ileum
(c) (i) – Duodenum, (ii) – ileum
(d) (ii) – Jejunum, (iii) – Duodenum

111. Which of the following parts of alimentary canal contains a finger like narrow tubular projection?
(a) Caecum
(b) Colon
(c) Stomach
(d) Duodenum

112. Plexus in the submucosa is a network of
(a) Blood vessels and provides nourishment
(b) Nerve cells and nerve fibres and controls secretions of intestinal glands
(c) Nerve cells and nerve fibres and controls motility of intestine
(d) Blood vessels to help in absorption of nutrients

113. Myenteric plexus
(a) Controls motility of gut
(b) Is also called Auerbach's plexus
(c) Is located between circular and longitudinal muscles of muscularis externa
(d) All of these

114. Select the correct statement (s).
(a) Inner most layer of gut is mucosa
(b) Outermost layer of gut is called serosa
(c) Auerbach plexus is present in the mucosa region
(d) Both a and b

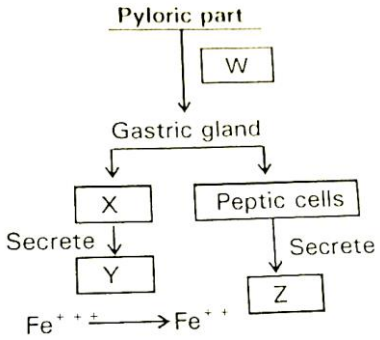
115. Which of the following is present in the saliva of all mammals?
(a) Mucin
(b) Salivary amylase
(c) Diastase
(d) Amylopsin

116. Mark the incorrect match.
(a) Parotid glands – below ears
(b) Sub – maxillary glands – lower jaw
(c) Sub – lingual glands – below tongue
(d) Sub – mandibular glands – upper jaw

117. Prorennin and pepsinogen are secreted by _____cells of stomach
(a) Peptic
(b) Neck
(c) Oxyntic
(d) Parietal

118. Epithelial cells lining the stomach are protected from damage by HCI because
(a) HCI is very dilute
(b) Stomach secretions neutralise HCI
(c) Epithelial cells are covered by a mucus secretion
(d) HCI gets broken down by enzymes

119. Which of the following is true?
(a) Stomach stores the food for 1 hr. only
(b) Food mixes with gastric juice by churning movements of its muscular layer
(c) Pepsinogen gets converted to pepsin on exposure to renin
(d) All of these

120. 

In the above diagram identify W, X, Y and Z – respectively with the sequence of number of appropriate terms given below

(i) Gastrin
(ii) Parietal cells
(iii) HCI
(iv) Pepsinogen

(a) I, II, III, IV
(b) I, II, IV, III
(c) III, II, IV, I
(d) IV, III, II, I

121. The effect of secretion of a less than normal amount of the hormone gastrin would be
(a) Decrease in stomach pH
(b) Decrease in protein digestion in stomach
(c) Increase in carbohydrate digestion in stomach
(d) All of these

122. The sequence of layers of the wall of alimentary canal from outside to inside is
(a) Serosa, muscularis, sub – mucosa, mucosa
(b) Serosa, sub – mucosa, mucosa, muscularis
(c) Serosa, mucosa, submucosa, Muscularis
(d) All are incorrect

123. Serosa (the outer most layer of stomach) is made up of a thin
(a) Mesothelium
(b) Epithelium of visceral organs
(c) Endothelium
(d) Both a & b

124. Smooth muscles of muscularis in wall of alimentary canal are arranged as
(a) Inner circular and outer longitudinal layer
(b) Inner longitudinal and outer circular layer
(c) Only circular layer
(d) Circular layer on both sides of longitudinal layer

125. Which of the following statements is incorrect?
(a) Salivary glands are situated just outside the buccal cavity
(b) Salivary glands are situated inside the buccal cavity
(c) Salivary glands secrete juice into the buccal cavity
(d) Saliva is mainly produced by three pairs of salivary glands

126. The saliva secreted into the oral cavity contains
(a) Electrolytes (Na^+, K^+, CI^-, HCO_3^-)
(b) Salivary amylase
(c) Lysozyme
(d) All the above

127. Gastric glands have following three types of cells. Match these cells with their secretions and find the correct answer

Gastric glands cells	Name of secretion
a. Neck cells	i. Pepsinogen
b. Peptic/chief cells	ii. Mucus
c. Parietal/oxyntic cells	iii. Intrinsic factor

(a) a – ii, b – I, c – iii
(b) a – I, b – ii, c – iii
(c) a – iii, b – ii, c – i
(d) a – ii, b – iii, c – I

128. Intrinsic factor is
(a) Secreted by oxyntic cells
(b) Secreted by cells of gastric glands
(c) Essential for absorption of vitamin B_{12}
(d) All the above

129. Find the correct answer.
a. HCI is gastric juice provides the acidic pH (pH 1.8) optimal for pepsin.
b. Rennin is a lipolytic enzyme found in gastric juice of infants
c. Small amounts of lipases are also secreted by gastric glands

(a) a and b are correct, c is wrong
(b) a and c are correct, b is wrong
(c) a is correct b and c are wrong
(d) all are correct

130. Which of the following statements are correct?
a. Pancreas is a compound gland
b. Pancreas is located between the limbs of the C – shaped duodenum
c. Exocrine part of pancreas secretes alkaline enzyme containing pancreatic juice
d. Endocrine part of pancreas secretes hormones, insulin and glucagon

(a) a, b
(b) a, c
(c) a, b, c and d

(d) a, d

131. If there is blockage in main bile duct which of the following is affected?
(a) Digestion of proteins
(b) Digestion of lipids
(c) Blood glucose level
(d) Digestion of nucleic acids

132. Which of the following secretions are released into the small intestine?
(a) Bile juice
(b) Pancreatic juice
(c) Intestinal juice
(d) All the above

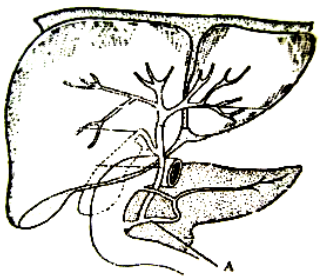
133. Inactive enzyme trypsinogen and lipases in duodenum are activated respectively by
(a) Enterokinase and bile
(b) Enterokinase and HCI
(c) HCI and bile
(d) None of the above

134. Which of the following represents enzymes presents in Succus entericus?
(a) Sucrase, maltase, lactase
(b) α – amylase, trypsin, lactase
(c) nuclease, trypsin, lactase
(d) Sucrase, carboxypeptidase, lactase

135. Mark the incorrect statement w.r.t. liver
(a) Kupffer cells are phagocytic and are present in liver
(b) Liver secretes bile which is stored in gall bladder
(c) Bile helps in digestion of fats as it contains lipase
(d) Constriction of sphincter of Boyden stimulates

136. When gall bladder of a man is removed
(a) Effect of concentrated bile juice upon food is impaired
(b) Fat digestion is affected
(c) Protein digestion is affected
(d) Both a and b

137. Which of the following is correct w.r.t. A?



(a) Wirsung duct, opens directly into duodenum
(b) Wrisung duct, opens directly in duodenum and contains pancreatic juice
(c) Wirsung duct, opens in duodenum through ampulla of Vater and passes pancreatic juice which contains somatostatin and pancreatic enzymes
(d) Wirsung duct, opens in duodenum through ampulla of Vater and passes pancreatic juice which contains pancreatic enzymes

138. Sphincter of oddi is present in
(a) Pancreatic duct
(b) Duct of Wirsung
(c) Ampulla of vater
(d) Bile duct

139. Identify the two incorrect statement w.r.t. jejunum and ileum
a. Wall of jejunum is more absorptive
b. No absorption of water in ileum
c. Main breakdown of macromolecules takes place in ileum
d. Site of glucose and amino acid absorption is jejunum
(a) a & b
(b) b & c
(c) a & d
(d) c & d

140. If the following structures are arranged in order of the correct sequence as food passes through them, which would be the first organ through which food will pass?
(a) Rectum
(b) Caecum
(c) Descending colon
(d) Ascending colon

141. Liver, the largest gland of body is situated in the
(a) Thoracic cavity, above the diaphragm
(b) Abdominal cavity, above the diaphragm
(c) Abdominal cavity, above the diaphragm
(d) Thoracic cavity, below the diaphragm

142. Pancreatic juice and bile are poured through
(a) A common duct into duodenum
(b) Two distinct ducts into duodenum
(c) A common duct into ileum
(d) Two distinct ducts into ileum

143. The swallowing of bolus of food from the buccal cavity into oesophagus is called
(a) Deglutition
(b) Regurgitation
(c) Phagocytosis
(d) Peristalsis

144. Which of the following is true regarding bile salts?
(a) They help in formation of micelles
(b) They help in absorption of all vitamins
(c) Sodium glycocholate and sodium taurocholate are excretory products
(d) Both a and b

145. Liver is the largest gland of the body. In adult human, it weights about
(a) 1.2 – 1.5 gm
(b) 1.2 – 1.5 gm
(c) 2.2 – 3.5 kg
(d) 2.2 – 3.5 gm

146. About ____% of starch is hydrolysed in the buccal cavity by the action of salivary amylase.
(a) 50
(b) 70
(c) 30
(d) 45

147. The optimum pH of saliva in humans is
(a) 7.8
(b) 7.4
(c) 6.8
(d) 6.4

148. Each hepatic lobule is covered by a thin connective tissue sheath called
(a) Peritoneal layer
(b) Mesothelial layer
(c) Glisson's capsule
(d) Hepatic capsule

149. Identify the proenzyme which is converted into active enzyme by HCI.
(a) Trypsin
(b) Chymotrypsinogen
(c) Pepsin
(d) Prorennin

150. The activator enzyme of intestinal juice is
(a) Succus entericus
(b) Secretin
(c) Enterokinase
(d) Enterozymase

151. Proteins → Peptides
Polysaccharides → Disaccharides
Fats → Diglycerides
Nucleic acids → Nucleotides
In the above reactions, the enzymes used are
(a) Trypsin, amylase, lipase and nuclease
(b) Trypsin, amylase, lipase and nucleosidase
(c) Chymotrypsin, amylase, & nucleosidase
(d) None of these

152. Which of the following sugars is absorbed from the small intestine by facilitated diffusion?
(a) Fructose
(b) Maltose
(c) Lactose
(d) Sucrose

153. Fats absorbed from gut are transported in form of
(a) Liposome
(b) Lacteals
(c) Chylomicrons
(d) Micelles

154. Fats soluble vitamins are absorbed by
(a) Active method
(b) Osmosis
(c) Passive method
(d) Facilitated transport

155. Some of the substances are absorbed with the help of the carriers like sodium ions. This mechanism is called
(a) Facilitated transport
(b) Osmosis
(c) Active transport
(d) Diffusion

156. Match the substance under column – I with its mode of absorption in intestine under Column – II

Column – I	Column – II
a. Glucose	i. Osmosis
b. Fructose	ii. Facilitated transport
c. Water	iii. Simple diffusion
d. Chloride ions	iv. Active transport

(a) a – iv, b – iii, c – I, d – ii
(b) a – iv, b – ii, c – I, d – iii
(c) a – iii, b – ii, c – iv, d – I
(d) a – iii, b – iv, c – ii, d – I

157. Brunner's glands
(a) Are present in submucosal layer
(b) Secrete mucus
(c) Secrete proteolytic enzymes
(d) Both a and b

158. Which of the following statements is false?
(a) Pepsin is an enzyme that acts on peptide bonds to digest proteins
(b) Salivary amylase starts the process of protein digestion in the mouth
(c) The bile helps in digestion by breaking fat into tiny droplets
(d) The pancreas produces both enzymes and hormones

159. Correct sequence of action of proteases on food is
(a) Trypsin – aminopeptidase – Dipeptidases
(b) Trypsin – Dipeptidases – aminopeptidase
(c) Trypsin – Rennin – aminopeptidase
(d) Chymotrypsin – trypsin – pepsin

160. What is peristalsis?
(a) Circular skeletal muscles contract at the top and longitudinal skeletal muscles contract at the base of the bolus
(b) Loss of appetite, fatigue, dehydration and nervous disorders
(c) Smooth muscle contractions that move food through the alimentary canal
(d) The transport of nutrients to the liver through the hepatic portal vein

161. Which of the following is the correct matching of the site of action of the given substrate, the enzyme acting upon of the given substrate, the enzyme acting upon it and the end product?
(a) Stomach : fats $\xrightarrow{\text{amylase}}$ micelles
(b) Duodenum : triglycerides $\xrightarrow{\text{Steapsin}}$ monoglycerides
(c) Small intestine : starch $\xrightarrow{\text{Pepsin}}$ disaccharide (maltose)
(d) Large intestine : proteins $\xrightarrow{\text{rennin}}$ amino acids

162. Water insoluble nutrients are absorbed into
(a) Aorta
(b) Hepatic artery
(c) Inferior vena cava
(d) Lymph capillaries

163. The absorption of glucose, amino acids and minerals takes place in the
(a) Colon
(b) Wall of the stomach
(c) Capillaries within the villi
(d) Lymph vessels within the villi

164. Final steps in digestion occur very close to
(a) Mucosal epithelial cells very close to
(b) Mucosal lamina propia
(c) Muscularis mucosa
(d) All of these

165. Correct set which shows the name of enzyme, source of secretion and the substrate upon which it acts is
(a) Rennin – stomach wall – casein
(b) Ptyalin – intestine – maltose
(c) Chymotrypsin – pancreas – casein
(d) Both a and c

166. What is the correct path followed from digestion to absorption of fats?
(a) Micelles → chylomicron → fatty acid → emulsified fat
(b) Fatty acid → emulsified fat → Micelles → chylomicron
(c) Emulsified fat → Fatty acid → Micelles → chylomicron
(d) Chylomicron → Micelles → Fatty acid

167. Which of the following is incorrectly matched?
(a) Chymotrypsin – milk coagulation in stomach
(b) Elastase - Digest the elastin protein
(c) Enteropeptidase – Activation of enzyme
(d) Pancreatic lipase – Action in intestine

168. The wall of alimentary canal possesses four layers serosa, muscularis, sub – mucosa and mucosa. The layer that is made up of connective tissue, nerves, lymph and epithelium is
(a) Serosa
(b) Muscularis
(c) Submucosa
(d) Mucosa

169. Release of gastro – intestinal secretions and movement after ingestion of food is brought about by
(a) Sympathetic nervous system
(b) Parasympathetic nervous system
(c) Pituitary gland
(d) Thyroid gland

170. Which of the following statements is correct?
(a) Digestive wastes are solidified into coherent faeces in rectum
(b) Faeces in rectum initiate a neural reflex causing an urge for its removal

(c) Causes of indigestion are inadequate enzyme secretion, anxiety, food poisoning, over eating etc.
(d) All of these

171. Initation of peristalsis in the last part of colon and rectum is due to
(a) Excretion
(b) Defecation reflex
(c) Filling of anus
(d) All of these

172. If a person takes less roughage, he is likely to suffer from
(a) Diarrhoea
(b) Constipation
(c) Dysentery
(d) Indigestion

173. The vomiting centre is located in
(a) Cerebrum
(b) Cerebellum
(c) Medulla
(d) Hypothalamus

174. Which is true for Kwashiorkor and Marasmus?
(a) Kwashiorkor is common in infants under 1 year of age where as marasmus occurs in children between 1 – 5 years of age
(b) Kwashiorkor results from deficiency of proteins & calories whereas marasmus develops in children who are on a high calorie, low protein diet
(c) Subcutaneous fat is preserved in children suffering from Kwashiorkor whereas ribs are non prominent
(d) Kwashiorkor is characterized by change in colour of skin and hair whereas marasmus is characterized by oedema

175. Which of the following statement is not correct?
(a) Goblet cells are present in the mucosa of intestine and secretion mucus
(b) Oxyntic cells are present in the mucosa of stomach and secrete HCI
(c) Acini are present in the pancreas and secrete carboxypeptidase
(d) Brunner's glands are present in the submucosa of stomach and secrete pepsinogen

176. Gastric juice of infants contains
(a) Nuclease, Pepsinogen, Lipase
(b) Pepsinogen, Lipase, Rennin
(c) Amylase, Rennin, Pepsinogen
(d) Maltase, Pepsinogen, Rennin

177. The primary dentition in human differs from permanent dentition in not having one of the following type of teeth?
(a) Premolars
(b) Molars
(c) Incisors
(d) Canines

178. The enzyme that is not present in Succus entericus is
(a) Nucleases
(b) Nucleosidases
(c) Lipase
(d) Maltase

179. Which hormones do stimulate the production of pancreatic juice and bicarbonate?
(a) Angiotensin and epinephrine
(b) Gastrin and Insulin
(c) Cholecystokinin and secretin
(d) Insulin and glucagon

180. Which of the following guards the opening of hepatopancreatic duct into the duodenum?
(a) Sphincter of Oddi
(b) Semilunar valve
(c) Ileocaecal valve
(d) Pyloric sphincter

181. Presence of HCI in stomach in very crucial as it helps in all except one
(a) Digestion of protein
(b) Preventing anaemia
(c) Killing microbes
(d) Formation of alkaline chyme

182. Which of the following enzymes show autocatalytic behaviour?
(a) Pepsin and trypsin
(b) Trypsin and rennin
(c) Trypsin and chymotrypsin
(d) Pepsin, trypsin and carboxypeptidase

183. Pancreatic juice contains
(a) Nuclease, pepsinogen, amylase
(b) Nucleosidase, maltase, lipase
(c) Trypsinogen, Nucleosidase, Enterokinase
(d) Nuclease, Procarboxypeptidase, amylase

184. Which of the following statement is/are correct about caecum?
   (a) Undigested, unabsorbed substance called faeces enter caecum
   (b) Small blind sac that shows symbiotic association
   (c) A vestigial organ arises from it
   (d) All are correct

185. A protease in pancreatic secretion which activates other protease is itself activated by
   (a) Succus entericus
   (b) Enterokinase
   (c) Enterogastrone
   (d) Enterocrinin

186. All of the following factors stimulate the release of saliva except
   (a) Sight and smell of food
   (b) Presence of food in Buccal cavity
   (c) Sympathetic nerve stimulation
   (d) Parasympathetic nerve stimulation

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

   (A) Both Assertion (A) and Reason (R) are true & reason is correct explanation of assertion.
   (B) Both Assertion and Reason are true but reason in not correct explanation of assertion.
   (C) Assertion is true but Reason is false.
   (D) Assertion is false.

187. A: Digestion is a biochemical process.
   R: The breakdown of complex food into simple forms occurs by enzymes present in digestive juices

188. A: Glands in duodenum are present only in submucosa.
   R: Brunner's glands secrete mucus and are called submucosal glands

189. A: Rennin is a proteolytic enzyme present in infants for digestion of casein.
   R: Casein is a milk protein which is hydrolysed by pepsin in adults

190. A: Associated glands of digestive system includes salivary glands, liver and pancreas.
   R: The secretion of the associated glands help to absorb the food.

ANSWER KEY

EXERCISE – 1

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

EXERCISE – 2

Ques.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Ans.	d	c	a	b	d	a	a	a	a	b
Ques.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Ans.	b	a	d	d	b	c	b	d	b	c
Ques.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
Ans.	d	a	d	c	a	b	a	d	a	b
Ques.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
Ans.	d	b	a	d	d	b	d	c	b	a
Ques.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.
Ans.	c	a	c	a	d	c	c	c	d	b
Ques.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.
Ans.	b	c	b	c	c	a	d	a	c	a
Ques.	61.	62.	63.	64.	65.	66.	67.	68.	69.	70.
Ans.	d	a	d	b	c	a	a	b	b	a
Ques.	71.	72.	73.	74.	75.	76.	77.	78.	79.	80.
Ans.	d	a	d	a	a	a	c	d	d	b
Ques.	81.	82.	83.	84.	85.	86.	87.	88.	89.	90.
Ans.	a	b	d	a	a	b	d	d	b	b
Ques.	91.	92.	93.	94.	95.	96.	97.	98.	99.	100.
Ans.	b	b	c	d	a	a	c	b	d	c
Ques.	101.	102.	103.	104.	105.	106.	107.	108.	109.	110.
Ans.	b	b	a	b	d	a	d	b	d	d
Ques.	111.	112.	113.	114.	115.	116.	117.	118.	119.	120.
Ans.	a	b	d	d	a	d	a	c	b	a
Ques.	121.	122.	123.	124.	125.	126.	127.	128.	129.	130.
Ans.	b	a	d	a	b	d	a	d	b	c
Ques.	131.	132.	133.	134.	135.	136.	137.	138.	139.	140.
Ans.	b	d	a	a	c	d	d	c	b	b
Ques.	141.	142.	143.	144.	145.	146.	147.	148.	149.	150.
Ans.	b	a	a	a	b	c	c	c	d	c
Ques.	151.	152.	153.	154.	155.	156.	157.	158.	159.	160.
Ans.	a	a	c	c	a	b	d	b	a	c
Ques.	161.	162.	163.	164.	165.	166.	167.	168.	169.	170.
Ans.	b	d	c	a	d	c	a	d	b	d
Ques.	171.	172.	173.	174.	175.	176.	177.	178.	179.	180.
Ans.	b	b	c	c	d	b	a	a	c	a

Ques.	181.	182.	183.	184.	185.	186.	187.	188.	189.	190.
Ans.	d	a	d	d	b	c	a	d	b	c