BIOLOGY

CLASS-XI NEET

MODULE-01

Digestion and Absorption

| Structural Organization in Animal | Cell Unit of Life | Cell cycle | Transports in Plants

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16 CHAPTER

Digestion and Absorption

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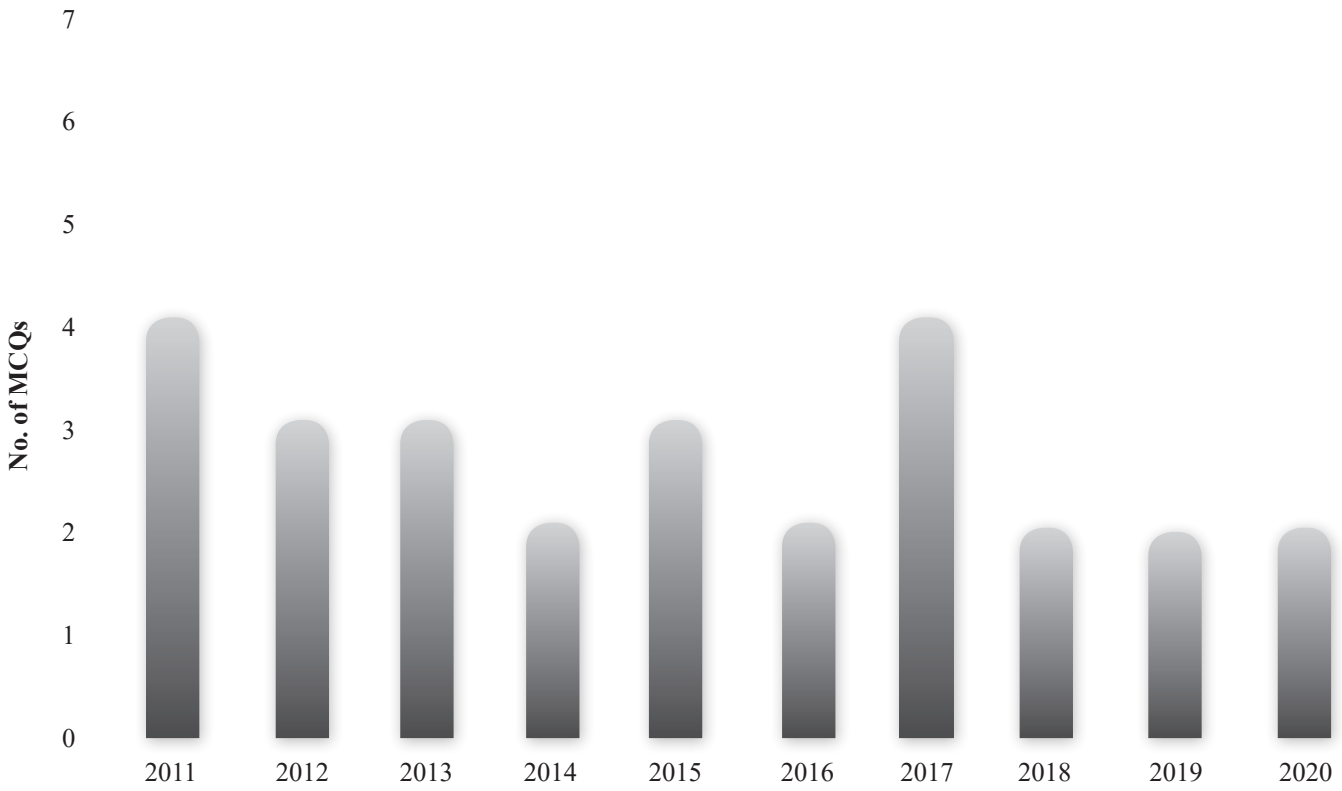
Past Year NEET Trend



Investigation Report

TARGET EXAM	PREDICTED NO. OF MCQs	CRITICAL CONCEPTS
NEET	1-2	• System • Digestion and absorption of food • Disorders of digestive system

Perfect Practice Plan

TOPIC-WISE MCQs	NCERT BASED MCQs	MULTI-CONCEPT MCQs	NEET PAST 10 YEAR QUESTIONS	TOTAL MCQs
116	42	30	26	214

Introduction

- Food is one of the basic requirements of all living organisms.
- Animals are not able to synthesise their own food, therefore they depend on ready-made food for their nutritional requirements.
- **Nutrition** is the process by which an organism derives energy to work and other materials, required for growth and maintenance of the various activities of life.
- The major components of our food are carbohydrates, proteins and fats. They are also known as biomacromolecules
- Vitamins and minerals are required in small quantities. Food provides energy and organic materials for growth and repair of tissues. They are also known as biomicromolecules.
- The water plays an important role in metabolic processes and also prevents dehydration of the body.
- 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.

Types of Digestion

1. **Intracellular:** When the process of digestion occurs within the cell in the food vacuole. Examples include Protozoa, Porifera, Coelenterata and free living platyhelminthes.
2. **Extracellular:** When the process of digestion occurs outside the cell. Examples include Coelenterates and phylum platyhelminthes to phylum chordata.

Digestive System

- Digestion in vertebrates occurs in the digestive tract or alimentary canal.
- The various parts involved in digestion can be broadly grouped in two groups :
  1. Digestive tract or alimentary canal
  2. Digestive glands

Alimentary canal

- The alimentary canal is tubular structure which extends from mouth (anterior opening) to anus (posterior opening).
- The alimentary canal is divided into following parts:
  - (i) Mouth and Buccopharyngeal cavity
  - (ii) Oesophagus
  - (iii) Stomach
  - (iv) Intestine

Parts of alimentary canal

(i) Mouth

- The mouth is a transverse slit like aperture bounded by two movable lips or labia, upper lip and lower lip.
- Mouth opens into buccopharyngeal cavity, this cavity is divided into two parts namely buccal vestibule and oral cavity.

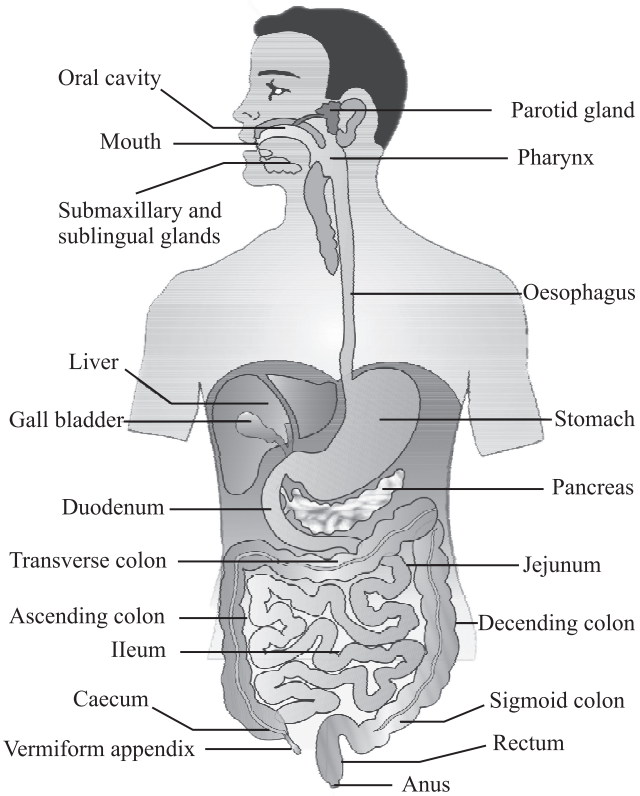


Fig.: The human digestive system

Buccopharyngeal cavity

- It includes anterior buccal cavity is lined by stratified squamous epithelial cells
- Pharynx is a vertical canal beyond the soft palate.
- Oral cavity leads into a short pharynx which serves as a common passage for food and air. A cartilaginous flap called **epiglotis** prevents the entry of food into glottis (opening of wind pipe) during swallowing.
- Pharynx may be divided into three parts; nasopharynx, oropharynx and laryngopharynx.
- Oral cavity is inner and central part which is surrounded by upper and lower jaw. It is lined by stratified squamous epithelium. Upper Jaw is fixed and lower Jaw is movable.

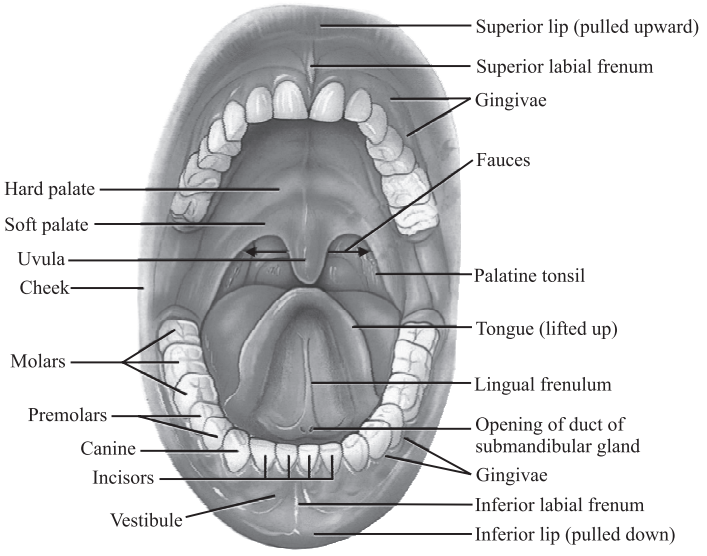


Fig.: Buccal cavity instead

(iv) Tongue

☺ Freely movable muscular (mesodermal) organ and protrusible present on the floor of buccopharyngeal cavity

☺ Stratified squamous epithelial cells are present.

☺ The upper surface of the tongue has small projects called papillae. Some of which bears taste buds.

☺ Tongue is attached to the floor of the oral cavity by **frenulum**.

Functions of tongue

(i) Acts as universal toothbrush, as it helps in tooth cleaning.

(ii) Helps in speaking.

(iii) Helps in degglutition.

(iv) Helps in mixing saliva with food.

(v) Helps in taste detection.

Need to know:

Hard palate have transverse ridges called palatine rugae.

(v) Teeth

Structure of teeth

☺ Teeth divided into three parts:

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

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

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

☺ The hard chewing surface of the teeth, made up of enamel, helps in the mastication of food.

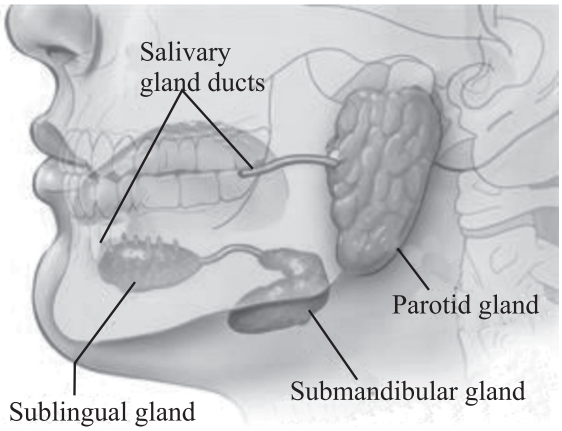


Fig.: Teeth

◆ **Thecodont:** Each tooth is embedded in a socket of jaw bone. This type of attachment is called thecodont.

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

Need to know:

The odontoblast cells are mesodermal in embryonic origin forming immediate covering of the pulp cavity. The cells secrete dentine.

Differentiation of teeth

◆ Dentition is differentiated into two types:

(i) Homodont: When all the teeth are structurally and functionally similar.

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

Types of teeth

(i) Incisor: These are long, chisel-like teeth for cutting and chopping the food. They have one root

(ii) Canines: These are sharp pointed teeth meant for tearing and shearing the food. Canines are most developed in carnivorous animals and are absent in herbivorous animals. They have one root

(iii) Premolars: These teeth are meant for chewing and crushing of food. They are triangular in shape. The premolars of upper jaw have two roots and lower jaw have one root

(iv) Molars (Cheek teeth)**:** These also meant for chewing and crushing of food. They are rectangular in shape. The molar of upper jaw have 3 roots and lower jaw have 2 roots

— *KEY NOTE* —

◆ Premolar and molar help in the mastication of food.

◆ In mammals, except premolar and last molar, all type of teeth appear twice in life.

Need to know:

◆ Enamel, secreted by ameloblast or Enameloblast cells, forms the outermost covering. It is ectodermal and made up of 92% of inorganic substances, hence considered as **hardest part of the body.**

◆ The inorganic substances present are calcium phosphate (85%), calcium hydroxide and calcium carbonate.

◆ Ossein is a protein of bones.

☺ **Dental formula:** Each mammalian species is characterized by its own specific dentition with a definite number and arrangement of 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 $\frac{2123}{2123}$.

Child $= I\frac{2}{2}C\frac{1}{1}PM\frac{0}{0}M\frac{2}{2} = \frac{5}{5} \times 2 = \frac{10}{10} = 20$

17 Yr. old $= I\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{2}{2}=\frac{7}{7}\times2=28$

Adult $= I\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{3}{3}=\frac{8}{8}\times2=\frac{16}{16}=32$

(ii) Oesophagus (food tube)

Morphology

☺ A thin, long tube which extends posteriorly passing through the neck, thorax and diaphragm and leads to a 'J' shaped bag like structure called stomach.

☺ Upper 1/3 of oesophagus is made up of skeletal muscles and lower 2/3 is made up of smooth muscles.

☺ A muscular sphincter (gastro-oesophageal) regulates the opening of oesophagus into the stomach.

Function: Conduction of food.

(iii) Stomach

Structure:

☺ Single oval, elongated, unilobed and J shaped bag like structure and present in the upper left portion of the abdominal cavity below diaphragm.

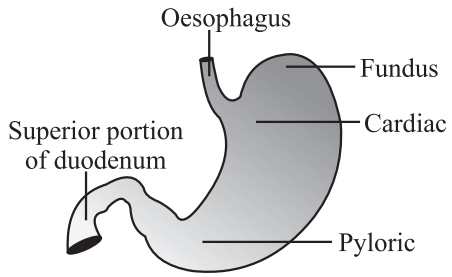


Fig.: Stomach

☺ It consists of **four parts:**

(i) Cardiac portion into which oesophagus opens

(ii) Fundic region

(iii) Pyloric portion which opens into the first part of small intestine.

(iv) Body-Main central region.

☺ Two types of valves are present in the stomach *viz*. **cardiac sphincter** valve between oesophagus and stomach and **pyloric sphincter** valve between stomach and duodenum.

Need to know:

Inner surface of stomach is raised into numeros longitudinal folds called gastric rugae.

Parts of stomach

Gastric glands in human has four distinct types of cells:

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

(b) Oxyntic or parietal cells : Secretes HCl and castle's intrinsic factor required for the absorption of vitamin B_{12}. Hyperacidity is abnormally high degree of acidity due to the secretion of large quantity of HCl, i.e., gastric juice.

(c) Mucous neck cells: Secretes alkaline mucous.

(d) Argentaffin cells : Responsible for the secretion of vasoconstrictor serotonin. It plays a role regulation of muscular movements.

(e) "G" cells, secrete a hormone, named gastrin, which increases the motility of gastric wall and stimulates gastric glands for active secretion.

Functions:

☺ Storage of food.

☺ Churning of food to mix with gastric juice.

(iv) Small intestine

Structure: It is distinguishable into three regions:

(i) a 'C' shaped duodenum,

(ii) a long coiled middle portion jejunum

(iii) a highly coiled ileum.

☺ Also numerous finger-like projection called villi project from the wall of lumen, increasing internal surface area about ten time.

☺ The distal end of ileum leads into the large intestine by ileo-caecal valve in man.

Function: Digestion and absorption of food.

(v) Large intestine

Structure: Endodermal, approximately 1.5-1.75 metre long.

It consists of following parts:

(i) Caecum: It is small blind sac which hosts some symbiotic microorganism. Its posterior end is present as a blind sac in abdominal cavity called vermiform appendix. Vermiform appendix is narrow finger-like tubular projection and is a vestigial organ.

(ii) Colon: In human, it is distinguished into four parts as ascending, transverse, descending part and sigmoid colon. Colon is concerned with absorption of water from undigested food, 5% salts, vitamins, etc., hence concerned with faeces formation.

(iii) Rectum: The descending part opens into the rectum which opens out through the anus. Single small dilated sac-like in human. It is concerned with storage of faeces. Rectum has strong sphincter muscle in its wall. The **sphincter** keeps the canal as well as anus, closed when not used for defecation.

Function: Absorption of water from undigested food.

(vi) Anal canal and anus: Anal canal connects rectum with anus and it is about 3 cm long. Anus is the terminal inferior opening of alimentary canal.

Histology of alimentary canal

☺ The wall of alimentary canal from oesophagus to rectum possesses four layers namely serosa, muscularis, sub-mucosa and mucosa.

(i) **Serosa** is the outermost layer and is made up of a thin mesothelium (epithelium of visceral organs) with some connective tissues.

(ii) **Muscularis** is formed by smooth muscles usually arranged into an inner circular and an outer longitudinal layer. An oblique muscle layer may be present in some regions.

(iii) The **sub-mucosal layer** is formed of loose connective tissues containing nerves, blood and lymph vessels. In duodenum, glands are also present in sub-mucosa.

(iv) **Mucosa** is the innermost layer lining the lumen of the alimentary canal. This 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 the surface area enormously.

☺ Villi are supplied with a network of capillaries and a large lymph vessel called the **lacteal**.

☺ Mucosal epithelium has **goblet cells** which secrete mucus that help in lubrication.

☺ Mucosa also forms glands in the stomach (gastric glands) and crypts in between the bases of villi in the intestine (crypts of Lieberkuhn). All the four layers show modifications in different parts of the alimentary canal.

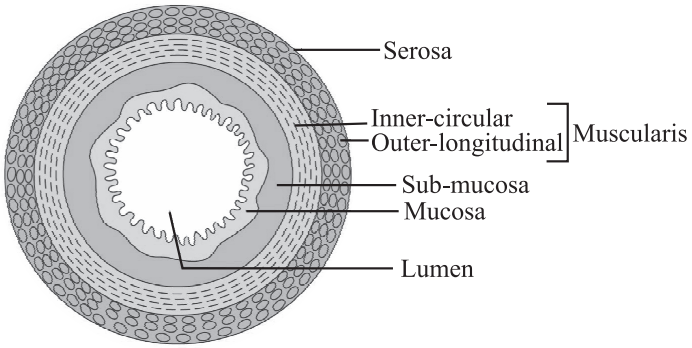


Fig.: Diagrammatic representation of transverse section of gut

Brunner's Gland	Payer's Patches	Crypts of Leiberkuhn
◆ Found in submucosa of duodenum only. ◆ Alkaline mucus secreting gland so known as mucus gland.	◆ These are lymph nodules. ◆ They produce lymphocytes. Lymphocytes are phagocytic in nature which destroy harmful bacteria.	◆ Known as intestinal gland. ◆ Secrete antibacterial substances hence it provides immunity.

Digestive Glands

☺ The various types of digestive glands present in mammals are salivary glands, gastric glands, intestinal glands, pancreas and liver.

☺ The digestive glands secrete digestive juices.

☺ Parasympathetic nervous system increases the secretion of digestive juice whereas sympathetic nervous system decreases it.

Salivary glands

☺ Three pairs of salivary glands present in humans are as follows:

1. **Parotid (cheek):** One-pair, largest salivary gland present.
2. **Sub-mandibular / sub-maxillary (lower jaw):** One-pair, present at the junction of upper and lower jaw in cheek region.
3. **Sub-lingual (below the tongue):** One-pair, present in the floor of buccopharyngeal cavity.

Need to know:

- **Parotids:** Stenson's duct
- **Sub-maxillary or sub-mandibular:** Wharton duct
- **Sublingual's:** Duct of Rivinus

☺ The secretion of salivary glands is called saliva or salivary juice. Some of the characteristics are as follows -

- Amount: 1.0-1.5 litre/day
- Chemical nature: Slightly acidic.
- pH : 6.3 - 6.8
- Control of secretion: Autonomic reflex (parasympathetic nervous system increases salivation while sympathetic nervous system inhibit secretion.)
- Chemical composition: Water (99.5%), mucous (acts as lubricant), salts (NaCI, $NaHCO_3$ etc.), enzymes (ptyalin, lysozyme) etc..

Functions: Salivary juice and its enzymes:

☺ Makes the medium slightly acidic for the action of its enzyme.

☺ Help in taste detection, deglutition, speaking, etc.

☺ Starch $\xrightarrow[\text{(Salivary amylase)}]{\text{Plyalin/Diastase}}$ Maltose + Isomaltose + Limit Dextrin

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

Liver

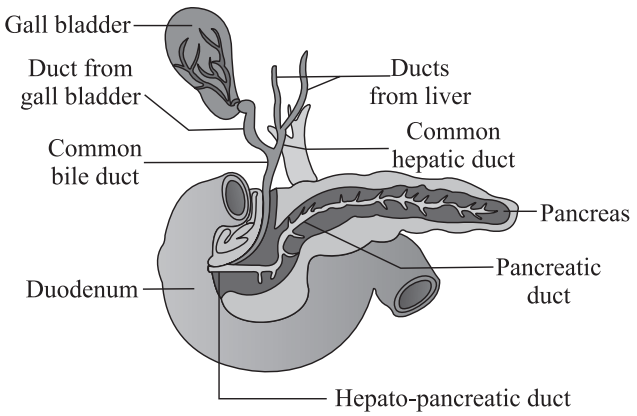


Fig.: Both salivary gland as well as liver

- It is the largest gland of the body weighing about 1.2 to 1.5 kg in an adult human.
- It is situated in the abdominal cavity, just below the diaphragm and has two lobes.
- The hepatic lobules are the structural and functional units of 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**.
- The bile secreted by the hepatic cells passes through the hepatic ducts and is stored and concentrated in a thin muscular sac called the gall bladder.
- The duct of gall bladder (cystic duct) along with the hepatic duct from the liver forms the common bile duct.

— *KEY NOTE* —

The bile duct and the pancreatic duct open together into the duodenum as the common hepato-pancreatic duct which is guarded by a sphincter called the **sphincter of Oddi**.

Pancreas

- The pancreas is a compound (both exocrine and endocrine) elongated organ situated between the limbs of the 'C' shaped duodenum.
- The exocrine portion secretes an alkaline pancreatic juice containing enzymes and the endocrine portion secretes hormones, insulin and glucagon.

Digestion of Food

- Digestion is divided in **two ways:** Mechanical digestion and Chemical digestion. Mechanical digestion takes place in mouth and small intestine.

Digestion in oral cavity

- Food enters through mouth and mixed with saliva, tongue mixes the food with saliva.
- Mucus in saliva helps in lubricating and adhering the masticated food particles into a **bolus**. The bolus is then conveyed into the pharynx and then into the oesophagus by swallowing or **deglutition**.
- The bolus further passes down through the oesophagus by successive waves of muscular contractions called peristalsis.

Mechanical digestion

- In mouth teeth, tongue and lips have important role in mechanical digestion through the process of chewing or mastication. They help in mixing up the food thoroughly.

Chemical digestion

- The saliva secreted into the oral cavity contains electrolytes (Na^+, K^+, CI^-, HCO^-_3) and enzymes, salivary amylase and lysozyme.
- The chemical process of digestion is initiated in the oral cavity by the hydrolytic action of the carbohydrate splitting enzyme, the salivary amylase. About 30 per cent of starch is hydrolysed here by this enzyme (optimum pH 6.8) into a disaccharide – maltose.
- **Mucin:** It is a glycoprotein. It lubricates the food particles and helps in the swallowing of food.
- **Lysozyme:** It is an enzyme which kills the harmful bacteria. It acts as an antibacterial agent that prevent infections.
- **Thiocynate:** It is a special salt which kills the harmful bacteria. So it is called bacteriocidal salt.

$$\text{Starch} \xrightarrow[\text{Salivary amylase}]{\text{Ptyalin, ph 6.8}} \text{Maltose}$$

Need to know:

Ptyalin is found in human saliva because human food is mainly made up of starch.

— *KEY NOTE* —

- Peristalsis is progression of coordinated contraction of involuntary circular muscles, which is preceded by a simultaneous contraction of the longitudinal muscle and relaxation of the circular muscle in the lining of gut.
- Gastroesophageal sphincter or cardiac sphincter normaly remains closed and does not allow food contents of the stomach to move back.

Digestion of food in stomach

- When the food enters into stomach G-cells secrete **gastrin hormones** which stimulate the secretion of gastric juice by gastric glands.
- Secretion of gastric juice is controlled by nerve, hormones and chemical substances.

Need to know:

Some drinking substances also stimulates the secretion of gastric juice such a soup, alcohol, caffeine, histamine. These drinking substance and gastric juice stimulate the desire of appetite. So these substances are called **appetiser juice**.

Composition of Gastric juice

- Amount : 1-1.5 liters/day.
- Chemical nature: Highly acidic
- pH : 1.0 - 3.5 (due to presence of HCl)
- Control of secretion: By gastrin hormone.
- Chemical composition: Water (99%), mucous, inorganic salts, castle's intrinsic factor, HCI (0.5% conc) and enzymes prorennin and pepsinogen and gastric lipase.
- The stomach stores the food for 4-5 hours. The food mixes thoroughly with the acidic gastric juice of the stomach by the churning movements of its muscular wall and is called the **chyme**.

Functions of HCl

- The main function of HCl (activater) is to convert proenzyme pepsinogen into active enzyme pepsin.
- Pepsin converts proteins into proteoses and peptones (peptides).

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

$$\text{Prorennin} \xrightarrow{\text{HCl}} \text{Rennin}$$

- The mucus and bicarbonates present in the gastric juice play an important role in lubrication and protection of the mucosal epithelium from excoriation by the highly concentrated hydrochloric acid.
- HCl provides the acidic pH (pH 1.8) optimal for pepsins.

— *KEY NOTE* —

- Pepsinogen and prorennin are inactive enzymes.
- Pepsin is the proteolytic enzyme of the stomach.

Digestion by Rennin

- Rennin (proteolytic enzyme) is active in the childhood stage of mammals only. It converts milk into curd like substance (clot the milk) and then digests it. In adult stages, it is inactive.
- Rennin acts on milk protein **casein**. Casein is a soluble protein.
- In presence of rennin, casein gets converted into insoluble **Ca-paracaseinate**. This process is termed as **curdling of milk**. After becoming insoluble, milk can remain in the stomach for a longer time. Rennin is absent in adult human (curdling of milk is done by HCl, pepsin and chymotrypsin in human)

Digestion by Gastric Lipase

- It converts fats into fatty-acids and glycerols. It is secreted in a less amount so less digestion of fats takes place here.
- This lipase acts on emulsified fat and convert it into fatty acid and glycerol.

Digestion of Food in small intestine

- In small intestine mechanical and chemical digestion occurs.
- Various types of movements are generated by the muscularis 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.
- The bile, pancreatic juice and the intestinal juice are the secretions released into the small intestine.

Pancreatic juice

- Pancreatic juice and bile are released through the hepato-pancreatic duct.
- The pancreatic juice contains inactive enzymes – trypsinogen, chymotrypsinogen, procarboxypeptidases, amylases, lipases and nucleases.
- Trypsinogen is activated by an enzyme, enterokinase, secreted by the intestinal mucosa into active trypsin, which in turn activates the other enzymes in the pancreatic juice.

Bile juice

- In the proximal-part of the duodenum bile-juice is secreted.
- The hepatocytes of the liver produce bile juice and it is stored in the gall bladder.
- Bile juice does not contain any digestive enzyme. Therefore it is not a true digestive juice (Pseudodigestive juice).

Compostion of Bile-juice

- The bile released into the duodenum contains bile pigments (bilirubin and bili-verdin), bile salts, cholesterol and phospholipids but no enzymes.

Function of bile juice

- **Neutralization of HCl:** Its sodium neutralizes HCl of chyme (semifluid food found in the stomach).
- **Emulsification:** Sodium glycocholate and sodium taurocholate are bile salts which break the large fat droplets into the smaller micelles.
- **Absorption of fat and fat-soluble vitamins:** Bile salts help in the absorption of fats (fatty acids and glycerol) and fat-soluble vitamin (A, D, E and K).
- **Stimulation of peristalsis:** Bile increases peristalsis of the intestine.
- **Activation of Lipase:** Bile also activates the enzyme lipase.

Need to know:

- Bile-pigments, cholesterol and lecithin are the excretory substances found in bile juice.
- **Gall-Stone:** Sometimes the passage inside the bile-duct gets blocked or becomes narrow, so the cholesterol gets deposited or precipitated in the gall-bladder. This is termed as the gall-stone (cholelithiasis).
- **Obstructive Jaundice:** If the passage of bile is blocked then the amount of bilirubin increases in the blood. So the yellowish colouration of body like skin, cornea and nails appear yellow. Urine also becomes yellow.

- Proteins, proteoses and peptones (partially hydrolysed proteins) in the chyme reaching the intestine are acted upon by the proteolytic enzymes of pancreatic juice as given below:

$$\left.\begin{matrix}\text{Proteins}\\ \text{Peptones}\\ \text{Proteoses}\end{matrix}\right\} \xrightarrow[\text{Carboxypeptidase}]{\text{Trypsin/Chymotrypsin}} \text{Dipeptides}$$

- Carbohydrates in the chyme are hydrolysed by pancreatic amylase into disaccharides.

$$\text{Polysaccharides (starch)} \xrightarrow{\text{Amylase}} \text{Disaccharides}$$

- Fats are broken down by lipases with the help of bile into di- and monoglycerides.

$$\text{Fats} \xrightarrow{\text{Lipases}} \text{Diglycerides} \longrightarrow \text{Monoglycerides}$$

☺ Nucleases in the pancreatic juice acts on nucleic acids to form nucleotides and nucleosides

$$\text{Nucleic acids} \xrightarrow{\text{Nucleases}} \text{Nucleotides} \longrightarrow \text{Nucleosides}$$

☺ The enzymes in the succus entericus act on the end products of the above reactions to form the respective simple absorbable forms. These final steps in digestion occur very close to the mucosal epithelial cells of the intestine.

— *KEY NOTE* —

Trypsin and chymotrypsin are **endopeptidase** type of enzymes. They dissociate proteins into peptones and proteoses. Majority of proteins are broken into the stomach and the remaining are broken into the duodenum.

Digestion in duodenum, jejunum and ileum

☺ These hormones stimulate the crypts of Leiberkuhn to secrete **succus entericus** or intestinal juice. This succus entericus mainly contains water (99%) and digestive enzymes (<1%). Intestinal juice act on food.

☺ The intestinal mucosal epithelium has goblet cells which secrete mucus.

☺ 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. The mucus alongwith the bicarbonates from the pancreas protects the intestinal mucosa from acid as well as provide an alkaline medium (pH 7.8) for enzymatic activities.

☺ Sub-mucosal glands (Brunner's glands) also help in this.

Succus-entericus mainly contains the following enzymes:

☺ **Peptidase or Erepsin:** This is a type of exopeptidase. It converts oligopeptides into amino-acids.

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

☺ **Maltase:** It converts maltose sugar into glucose molecules.

☺ **Lactase:** This enzyme is found only in mammals. It converts milk sugar lactose into glucose and galactose.

☺ **Intestinal Lipase:** This fat-digesting enzyme converts fats into fatty-acids and glycerol.

☺ **Nucleotidase and Nucleosidase:** These act on nucleotides and nucleosides and convert them into sugars and bases.

$$\text{Dipeptides} \xrightarrow{\text{Dipeptidases}} \text{Amino acids}$$

$$\text{Maltose} \xrightarrow{\text{Maltase}} \text{Glucose+Glucose}$$

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

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

$$\text{Nucleotides} \xrightarrow{\text{Nucleotidases}} \text{Nucleosides} \xrightarrow{\text{Nucleosidase}} \text{Sugars+Bases}$$

$$\text{Di and Monoglycerides} \xrightarrow{\text{Lipases}} \text{Fatty acids+Glycerol}$$

☺ The breakdown of biomacromolecules 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 on to the large intestine.

Digestion in Large Intestine

☺ 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 the waste (undigested) particles together and lubricating it for an easy passage.

☺ 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. It is temporarily stored in the rectum till defaecation.

☺ 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.

☺ Hormonal control of the secretion of digestive juices is carried out by the local hormones produced by the gastric and intestinal mucosa.

Need to know:

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

— *KEY NOTE* —

- Maximum digestion of food – Duodenum.
- Digestion of food complete in – Jejunum.
- Maximum absorption of food in – Jejunum.

Absorption of Digested Food

☺ 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.

Simple diffusion: It facilitates the absorption of small amounts of monosacharides like glucose, amino acids and some of electrolytes like chloride ions

- The passage of these substances into the blood depends upon the concentration gradients.

Facilitated transport: Some of the substances like fructose and some amino acids are absorbed with the help of the carrier ions like Na^+.

Active 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+ are absorbed into the blood by this mechanism.

Table: Absorption in Different Parts of Digestive System

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

☺ Fatty acids and glycerol being insoluble, cannot be absorbed into the blood.

☺ They are first incorporated into small droplets called micelles which move into the intestinal mucosa.

☺ They are re-formed into very small protein coated fat globules called the chylomicrons which are transported into the lymph vessels (lacteals) in the villi. These lymph vessels ultimately release the absorbed substances into the blood stream.

☺ The absorbed substances finally reach the tissues which utilise them for their activities. This process is called assimilation.

☺ The digestive wastes, solidified into coherent faeces in the rectum initiate a neural reflex causing an urge or desire for its removal. The egestion of faeces to the outside through the anal opening (defaecation) is a voluntary process and is carried out by a mass peristaltic movement.

Need to know:

Calorific value of protein, carbohydrate and fat

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°C. Since this value is tiny amount of energy, physiologists commonly use kilocalorie (kcal) or kilo joule (kJ). One kilo calorie is the amount of energy required to raise the temperature of 1 kg of water by 1°C. Nutritionists, traditionally refer to kcal as the Calorie or Joule (always capitalised). The amount of heat liberated from complete combustion of 1 g food in a bomb calorimeter (a closed metal chamber filled with O_2) is its gross calorific or gross energy value. The actual amount of energy combustion of 1 g of food is the physiologic value of food. Gross calorific values of carbohydrates, proteins and fats are 4.1 kcal/g, 5.65 kcal/g and 9.45 kcal/g, respectively, whereas their physiologic values are 4.0 kcal/g, 4.0 kcal/g and 9.0 kcal/g, respectively.

Disorders of Digestive System

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

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

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

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

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

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

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 Kwashiorkar.

Marasmus

- Marasmus is produced by a **simultaneous deficiency** of proteins and calories.
- It is found in infants less than a year in age, if mother's milk is replaced too early by other foods which are poor in both proteins and caloric value. This often happens if the mother has second pregnancy or childbirth when the older infant is still too young.
- In Marasmus, protein deficiency impairs growth and replacement of tissue proteins; extreme emaciation of the body and thinning of limbs results, the skin becomes dry, thin and wrinkled.
- Growth rate and body weight decline considerably. Even growth and development of brain and mental faculties are impaired.

Kwashiorkar

- Kwashiorkar is produced by protein deficiency **unaccompanied by calorie deficiency**.
- It results from the replacement of mother's milk by a high calorie-low protein diet in a child more than one year in age.

— *KEY NOTE* —

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.

ABOUT PHYSICS WALLAH

Alakh Pandey is one of the most renowned faculty in NEET & JEE domain's Physics. On his YouTube channel, Physics Wallah, he teaches the Science courses of 11th and 12th standard to the students aiming to appear for the engineering and medical entrance exams.

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