Digestive system of human

Group of organs that involve in mastication, swallowing, digestion and absorption of food materials and egestion of undigested food materials formed the digestive system. It includes:

A. **Alimentary canal or Digestive tract or Gut**
B. **Associated digestive glands**
C. **Physiology of digestion**

A. Alimentary canal

It is a about 8 to 9 meters long and coiled tube of varying diameter that extended from mouth to the anus. In between these openings, there is present of following parts; vestibule, buccal cavity, pharynx, oesophagus, stomach, small intestine and large intestine.

1. Mouth

It is a small transverse slit like opening, bounded anteriorly by fleshy and movable upper and lower lips and laterally by cheeks. It helps in ingestion and speaking.

2. Vestibule

Mouth opens into a narrow and vertical space that lined by mucous membrane is called **vestibule** which is bounded outside by cheeks and lips and inside by gum and teeth of jaws.

3. Buccal cavity or Oral buccal cavity

The vestibule opens behind into a spacious chamber called buccal that situated between the upper and lower jaws and lined by mucous membrane. Dorsal surface of buccal cavity is called **palate.** The anterior part of palate is bony known as **hard palate** and ventral surface of it bears the prominent ridges called **palatal rugae**. The posterior part of palate is a flexible, fleshy and smooth, known as **soft palate.** The distal part of it terminated into a small, median flap like free hanging structure, the **uvula** that closes the internal nostrils during swallowing of food.

A large, motile and muscular organ, the tongue, occupies most of the part of floor of buccal cavity. Dorsal surface of it is covered by the epithelium that contains numerous papillae and taste buds. Tongue helps in cleaning the teeth, speaking, swallowing, tasting and proper mixing of foods with saliva and manipulating the food during mastication.

The upper jaw and lower jaw bear thecodont (teeth are firmly embedded in cup like socket of jaw bones), diphyodont (two set of teeth are present i.e., milk or deciduous teeth and permanent teeth) and heterodont (different shape and size of teeth) types of teeth. There four kinds of teeth present in human i.e., incisors, canines, premolar and molar and they help in biting, cutting, tearing and grinding the foods and offence and defense etc.

[NOTE:

i. Types of papillae

Based on shape and size, four types of papillae are found in the tongue

- **Vallate papillae**- They are large size papillae of about 8 to 12 in numbers and arranged in an inverted 'V' shaped manner at the base of tongue.
- **Filiform papillae**- They are smallest sized papillae that found in anterior two third surface in numerous number, conical shaped and white color.
- **Fungiform papillae**- They are larger and less numerous than filiform papillae. They are bright red color, rounded or mushroom shaped and found at tip and edges of tongue.
- **Foliate papillae**- They are leaf like structure. It is situated at the sides of tongue at base and contain the most sensitive taste buds. They are most numerous in young children and decrease with age, become rare in adult.

ii. Tasting area of tongue

Tongue possesses four tasting areas. The taste buds present at tip of tongue taste the sweetness of food. Anterior lateral side of tongue tastes the saltiness, posterior lateral tastes sour and base of tongue tastes bitterness. While central part of tongue tastes mixed.

iii. Structure of tooth of human

Teeth are present in cup shaped socket of maxillae bones of upper jaw and dentaries bones of lower jaw. They are originated from epidermis and dermis. A typical tooth consists of three parts: crown, neck and root. The crown is exposed part of tooth that lies above the gum. The neck is part that surrounded by gum and root is part of tooth that embedded in socket of jawbone. A tooth is made up of hard bone like substance called dentine, which enclosed a cavity called pulp cavity. This cavity is lined by dentine forming cells called odontoblast cells and filled with gelatinous connective tissue, pulp with blood vessels and nerve endings. The odontoblast cells give fine protoplasmic processes to the dentine. A white, shiny and hard substance, the enamel covers the crown part of dentine, which protects the tooth from decaying. At root region, dentine is covered by a hard cement like substance called cementum at root region, which is surrounded externally by strong and vascular connective tissue fibers called periodontal membrane. Cementum and periodontal membrane help to fix tooth into socket of jawbone. Blood vessels and nerves pass to the tooth through a small foramen present at apex of each root. The number of roots vary according to type of teeth. The incisor and canine teeth have only one root, premolar tooth has two roots and molar tooth has more than two roots.

iv. Types and functions of teeth

Type of tooth	**Number of each type of tooth in each half of jaw**	**Structure**	**Number of cusps and roots**	**Functions of teeth**
Incisors	Two front teeth	Flat, chisel shaped with sharp cutting edge	One cusp and one root	Seizing, cutting and biting
Canines	One side tooth	Elongated and pointed	One cusp and root	Piercing and tearing

Premolar	Two cheek teeth	Broad and strong	Two cusps and two roots	Crushing, grinding and chewing
Molar	Three back teeth	Broad and strong	More than two cusps and roots	Crushing, grinding and chewing

v. Dental formula

A type of equation that represent the number and types of teeth in a species of mammal is called dental formula. In this equation, only number and types of teeth of each halve of each jaw are recorded because two halves of each jaw are identical and upper and lower jaws are separated by horizontal line. The types of teeth are denoted by their initial letter like I, C, Pm and M represent incisor, canine, Premolar and Molar respectively. Number of teeth shown in formula multiplied by two gives the total number of teeth of species.

- Dental formula of adult man $(D.F) = \frac{\text{number of teeth in one half of upper jaw}}{\text{number of teeth in one half of lower jaw}}$

$$= \frac{I.C.Pm.M}{I.C.Pm.M}$$
$$= \frac{2.1.2.3}{2.1.2.3}$$
$$= (8+8) * 2$$
$$= 32$$

- Dental formula of human child $(D.F) = \frac{\text{number of teeth in one half of upper jaw}}{\text{number of teeth in one half of lower jaw}}$

$$= \frac{I.C.Pm.M}{I.C.Pm.M}$$
$$= \frac{2.1.0.2}{2.1.0.2}$$
$$= 20$$

4. Pharynx

Buccal cavity posteriorly merges with a short and narrow chamber, the pharynx. It is divided into three incomplete chambers by a soft palate. These are nasopharynx, oropharynx and laryngopharynx. The part of pharynx that lies dorsal to the soft palate, is called nasopharynx. It is connected anteriorly with olfactory chambers through a pair of openings, the internal nostrils while laterally it is connected to a middle ear cavity through a pair of eustachian tube openings. The part of pharynx that lies ventral to soft palate is called oropharynx and it is common passage of both food and gases. On each lateral wall of it bears an oval shaped of mass of lymphatic tissue called **palatine tonsil**. The part of pharynx that lies behind the uvula is called laryngopharynx. It consists of a median longitudinal slit like an opening on the floor called glottis that connects the pharynx with larynx. The glottis is covered, during swallowing of food materials by a thin, bi-lobed and flap like elastic cartilage called epiglottis. A wide opening, the gullet lies just behind the glottis and leads the laryngopharynx to Oesophagus.

5. **Oesophagus**

It is a 25 cm long, narrow (2cm diameters), elastic and muscular tube. It runs straight down through the neck and thoracic cavity, lies just dorsal and parallel to the trachea and penetrates the diaphragm to open into the stomach in abdominal cavity. It acts as passage to transfer the food to the stomach by generating peristaltic movement.

6. **Stomach**

It is a broad, 'J' shaped and hollow muscular sac-like organ that lies at anterior left side of abdominal cavity. It is divided into four parts- cardiac, fundus, body and pyloric. The anterior part of stomach is called cardiac stomach. It consists an opening of Oesophagus that is guarded by a cardiac valve. The superior dome shaped part that lies above the cardiac stomach is called fundus and it is filled with gases. A large part of stomach that lies between fundus and pyloric regions is called body. The smaller, narrower and funnel shaped posterior part is called pyloric stomach. The distal part of pyloric stomach leads into the duodenum of small intestine and an opening between them is guarded by a circular pyloric sphincter. [The sphincters prevent reflux of foods.] The inner wall of stomach bears numerous gastric glands that secrete acidic gastric juice (P^H 2 to 3.7). [**Note:** Its inner small and concave surface is called lesser curvature and its outer larger and convex surface is called greater curvature. It connects with posterior abdominal wall by the peritoneum that extends beyond greater curvature is known as greater Omentum. It store fats]

The main functions of stomach are-

- It generates the **churning movement** by the action of its muscular walls, for proper mixing of foods with gastric juice and mechanical digestion of foods.
- Gastric glands present in its walls secrete **acidic gastric juice** for partial digestion of foods specially proteins.
- Gastric glands also secrete **Castle's intrinsic factors** require for absorption of vit B_{12} and secretion of gastric hormone.
- It also helps in **temporary storage and absorption** of food material like alcohol, drugs, water and some amount of sugar and lipids.

7. **Small intestine**

The small intestine is a long (about 6.25 meters), narrow and much coiled tube that made of three parts: duodenum, jejunum and ileum. The inner mucosa membrane layer of small intestine is folded into finger like processes called villi. They increase the digestive and absorptive surface.

a. **Duodenum**

It is the anterior, smallest (25cm) part of small intestine that forms somewhat 'C' shaped loop in which pancreas is present. It receives the opening of hepato-pancreatic ampulla. The opening of hepato-pancreatic ampulla is guarded by valve called sphincter of Oddi.

b. **Jejunum**

It is a middle part of small intestine about 2.5metes long

c. Ileum

It is a last and longest part of small intestine about 3.5 meters long. Posterior end of it opens into caecum of large intestine and the opening is guarded by an ileo-caecal valve. Jejunum and ileum are highly coiled and hold into the abdominal wall by a fan like folds of mesentery.

Functions of small intestine-

- The villi and micro-villi present in its wall increases the digestive and absorptive areas for complete digestion and absorption of foods.
- The intestinal glands (Crypts of Lieberkuhn) secrete intestinal juice that complete the digestion process. These glands also secrete hormones that regulate the secretion various of digestive juices.

d. Large intestine

It is a wide and thick-walled tube that extended from ileo-caecal junction to anus and lying at periphery of the abdominal cavity. It is about 1.5 meters long and consists of three parts: caecum, colon and rectum.

a. **Caecum**

It is a dilated pouch like structure (of about 6 cm long and 7.5 cm broad). It connects with the ileum through ileo-caecal junction and it continues into the colon. The caecum gives sightly coiled, blind tube-like outgrowth called vermiform appendix. [It is functional in herbivorous animals and helps in digestion of cellulose, but in human, it is vestigial.]

b. Colon

It is (about 130 cm) long, uncoiled and inverted 'U' shaped tube. It consists of four parts: ascending, transvers, descending and sigmoid colon. Its wall has many sacculation called haustra.

c. Rectum

The sigmoid colon opens into slightly dilated part of about 20cm long tube called as rectum. It terminates into 2 cm long anal canal.

Functions- Absorption of water and solutes, formation of feces from undigested food materials and temporary storage of it, bacteria present in colon synthesized certain vitamins like vit K, vit B_3, B_6 etc.

e. Anus

The anal canal opens outside through an opening called anus that present in median posterior end of body. The feces are removed outside through the anus.

B. Associated or Accessory digestive glands

Those glands that present within and around the alimentary canal and their secretion help in digestion of foods are called associated digestive glands. There are three main associated digestive glands in the human body. They are

I. Salivary glands

II. Liver

III. Pancreas

IV. Gastric glands

V. Intestinal glands

I. Salivary glands

Salivary glands are highly branched, tiny and lobulated glands that located in the lining of buccal cavity. Secretion of salivary glands is called saliva. It is slightly acidic in nature (P^H6.8) and composed of water (99%) and remaining 1% includes mineral salts, mucus, lysozyme, proteins, lingual lipase enzymes and ptyalin or amylase enzyme. There are three pairs of salivary glands in man:

(a) **A pair of Parotid salivary glands**- they are the largest salivary glands that present at one on either side of face just below the ear and their ducts open into second molar teeth of upper jaw in buccal cavity

(b) **A pair of Sub- Mandibular salivary glands**- they are median sized salivary glands that present one on either side at the angle of lower jaw and their ducts open near the lower central incisor teeth.

(c) **A pair of Sub Lingual salivary glands**- they are smallest salivary glands present beneath the tongue and their ducts open into the floor of buccal cavity.

Functions:

- It moistens and soften the food materials and increases the sense of taste
- Mucus lubricates the foods for swallowing
- It destroys the micro-organisms present in the food
- Protein molecules and some mineral salts help in maintain the P^H of saliva.
- Lingual lipase enzyme hydrolyses the fats of the food into fatty acid and glycerol
- Ptyalin enzyme hydrolyses the starch and glycogen into maltose and dextrin.

II. Liver

a. External structure of liver

Liver is a largest gland of the body (1.4 to 1.8 kg in male and 1.2 to 1.4 kg in female). It is a reddish brown in color, present at anterior right side of abdominal cavity. It is divided into right lobe and left lobe and the right lobe is much larger than left lobe. A pear-shaped, greenish color sac is attached on the posterior surface of right lobe called gall bladder. It receives several small hepatic ducts from both the lobes of liver to store bile juice. From the gall bladder arises a large duct called cystic duct that joins with common hepatic ducts to form a large common bile duct. It passes downward through the pancreas and joins with pancreatic duct to form a hepatopancreatic ampulla that opens into the duodenum.

b. Internal structure or Histology of liver

Histologically, liver is made up of numerous numbers of minute, hexagonal shaped of hepatic lobules. At the corner of two adjacent hepatic lobules, there is strand of connective tissues that contains the branches of hepatic artery, hepatic poral vein, hepatic vein, lymph vessel, nerve fibers and bile duct. Each hepatic lobule contains blood vessel

at center called central vein that opens into hepatic vein and it receives the blood from sinusoids. The lobule is made of polyhedral shaped of cells called hepatic cells and they are arranged in one or two celled thick radial rows that extended from central vein to periphery. The radial rows of hepatic cells called hepatic cords. Each hepatic cell contains a large centrally placed rounded nucleus with granular cytoplasm and cytoplasm consists of large amount of glycogen, lipids and other nutrients. The hepatic cells are surrounded by an intricate meshwork of fine tubules called bile capillaries. They are united forming bile ductules which in-turn open into hepatic ducts. Between the hepatic cords, there is a narrow and irregular space called lacuna, through it runs blood capillary called sinusoid. The wall of sinusoids is made of endothelial cells with some of large and irregular shaped phagocytic cells called Kupffer's cells. The sinusoid receives the blood from branches of hepatic artery and hepatic portal vein and pours into central vein.

Functions of liver:

i. Hepatic cells secrete the dark green color, alkaline (P^H8.6) bile juice in bile capillaries.
ii. It decomposes excess proteins and nucleic acids of wounded cells into urea and uric acids respectively. This process is called **deamination** and they are removed outside through urine by kidneys.
iii. It synthesizes various substances like plasma proteins, non-essential amino acids, heparin, prothrombin, lymph, enzymes and RBCs in embryonic stage etc.
iv. It stores various substances like glycogen, fats, fat soluble vitamins, certain water- soluble vitamins (B_2, B_6, B_{11} and B_{12}), and mineral salts etc.
v. It neutralizes harmful substances, drugs, alcohol, toxins produced by microorganisms and ammonia etc. into harmless form by biochemical reactions and they are excreted by kidneys.
vi. **Kupffer cells** of liver kill the harmful bacteria and worn-out Red Blood Corpuscles (RBCs) by phagocytosis.
vii. It regulates the blood glucose level by process of **glycogenesis**, **glycogenolysis** and **gluconeogenesi**s.
viii. It converts the excess glucoses and amino acids into fats (**lipogenesis**). Whenever require, store fats are converted into form that body cells can use and provide energy (**desaturation**).

[Note:

1. **Composition and function of Bile juice**:

It is composed of water (97%), bile salts (sodium carbonate, sodium taurocholate and sodium glycocholate), bile pigments (bilirubin and biliverdin), cholesterol, inorganic salts and lecithin etc.

Functions of bile

- Bile salts neutralize the acidity of chyme and help in emulsification of fats. (**Emulsification is process of breakdown of large fat drops into small droplets**)
- Cholesterol present in bile helps in absorption of fats and fat-soluble vitamins
- Alkaline nature of bile also stimulates peristaltic movement and activates different digestive enzymes.
- Bile pigments, inorganic salts and toxins present in bile are excretory waste products which are remove through the feces.
- Lecithin present in bile prevent decaying of food and growth of bacteria in food.

2. **Glycogenesis- process of conversion of excess glucoses into glycogen in presence of insulin hormone.**
3. **Glycogenolysis- process of conversion of excess glycogen into glucose in presence of glucagon hormone.**
4. **Gluconeogenesis- process of formation of glucose from non-carbohydrate groups like fats and protein.]**

III. Pancreas

a. External structure

Pancreas is second largest gland of body. It is soft, greyish-pink color, lobulated leaf like structure that weighting about 60gms and present in 'C'-shaped loop of duodenum. From the pancreas arises a pancreatic duct that fused with common bile duct to form hepato-pancreatic ampulla and opens into duodenum.

b. Internal structure

It acts as both exocrine and endocrine in function. Histologically exocrine part is made of large number of rounded lobes and lobules that are bounded by connective tissue containing blood vessels, lymph vessels, nerves and pancreatic ducts. Each lobule consists of several branching tubules called acini or alveoli. They are embedded in connective tissue. Each acinus is made of pyramid shaped, glandular pancreatic cells around the lumen. Pancreatic cells secrete alkaline pancreatic juice (P^H 8.4) into ductules of acini which join with each other to form large ducts and ultimately form a main pancreatic duct. The pancreatic duct fuses with common bile duct forming hepato-pancreatic ampulla that opened into the duodenum. The alkaline pancreatic juice is composed of water, sodium bicarbonate salt, enzymes like amylase, lipase, deoxyribonuclease (DNase) and ribonuclease (RNase) and three types of inactive enzymes like trypsinogen, chymo-trypsinogen and proto-carboxypeptidase.
The endocrine part of pancreas consists Islets of Langerhans, which are somewhat spherical, compact masses of cells present in connective tissue binding the acini together. Islets of Langerhans made of four types of cells i.e.

i. **Alpha cells or ∝-cells** present towards the periphery and secrete glucagon hormone that increases the blood glucose level by glycogenolysis process.

ii. **Beta cells or β-cells** are present towards center and secrete insulin hormone that decreases the blood glucose level by glycogenesis process.
iii. **Delta cells or δ cells** are present towards the periphery and secrete somatostatin hormone that inhibits the secretion of glucagon and insulin.
iv. **Pancreatic polypeptide cells** secrete pancreatic polypeptide that inhibits the release of pancreatic juice.

Functions of pancreas:

- Exocrine part of pancreas secretes the pancreatic juice which helps in digestion of carbohydrates, proteins and fats.
- Endocrine part of pancreas secretes the hormones like glucagon and insulin that regulate the carbohydrates metabolism or blood glucose level.

IV. Gastric glands:

Mucosa epithelium of mucosa layer of stomach is invaginated at close intervals forming gastric pits, which lead into simple branched tubular gastric glands. The gastric gland is made up of three types of cells- mucous or goblets cells, oxyntic or parietal cells and peptic or chief or zymogen cells. Goblet cells secrete mucus, Oxyntic cells secrete hydrochloric acid and peptic cells are present at base of gland and secrete inactive enzyme pepsinogen and prorenin (in children) and also gastric lipase and gastric amylase enzymes. Beside these three types of cells, gastric gland also contains Argentaffin cells secreting serotonin, somatostatin and histamine and 'G'-cell secreting gastrin hormone.

V. Intestinal glands or Crypt of Lieberkuhn

Mucous membrane or epithelium of small intestinal wall is folded into numerous, **finger like projections** called **villi**. At the bases of villi are found simple tubular pits of intestine glands known as Crypts of Lieberkuhn. They secrete succus entericus. Crypts also have Paneth cells that secrete antibacterial substance and Argentaffin cells secrete hormones that regulate the secretion of digestive juices.

C. Physiology of Digestion

I. Process of Digestion

Process of breakdown of large and complex food materials into small and chemically simple form that can be easily absorbed and assimilated by body's cells is called digestion. In man, digestion is an extracellular type and carried out by both mechanical and chemical methods. Digestion of carbohydrates starts in buccal cavity, complete in small intestine, while protein digestion starts in stomach, and completes in small intestine. Lipid digestion starts in buccal cavity, continue in stomach and completes in small intestine. Mineral salts, vitamins and water are more or less absorbed directly without digestion.

1. **Digestion in buccal cavity:**

Digestion in buccal cavity takes place by both mechanical and chemical methods. Mechanical digestion of food takes place with help of teeth present in upper and lower jawbone's sockets. Teeth help in cutting, tearing and grinding of large food materials into

small pieces. The movement of tongue helps to manipulate the food in between the chewing surface of grinding teeth and in proper mixing of saliva with food materials for salivary digestion. Saliva lubricates and softens the food materials, kills bacteria, salivary amylase or ptyalin enzyme hydrolyses the starch into maltose and lingual lipase enzyme hydrolyses some lipids (fats) into glycerol and fatty acid. After completed mastication and salivary digestion, food changes into slightly semisolid forms called bolus. It is pushed into pharynx by raising the tongue and then swallowed through the gullet into Oesophagus.

Ptyalin or salivary amylase + starch→ maltose

Salivary lipase + fats → fatty acids + glycerol

2. **Digestion in Oesophagus**

The bolus pushes down through the oesophagus by the peristaltic movement and reach to stomach. There is no digestion of food in oesophagus but its wall secretes the mucus that lubricates the passage of food.

3. **Digestion in Stomach**

When bolus reaches to stomach, the gastric glands stimulate to secrete and release the gastric juice and the stomach wall also induces the vigorous contraction to generate the churning movement for mechanical digestion and proper mixing of food with gastric juice. The gastric juice is acidic in nature and it performs following functions;

- The HCl of gastric juice converts the bolus into acidic medium, stop the action of salivary ptyalin enzyme, kill the bacteria to prevent the food from putrefaction and converts the inactive pepsinogen and prorenin enzymes into active pepsin and rennin enzymes.
- Mucus protects the living tissue from action of enzymes and acts as the mechanical buffer between hard food material and living cells.
- Pepsin enzyme hydrolyses the protein present in food into proteoses and peptones and rennin enzyme coagulated the soluble milk protein caseinogen into insoluble caseins.

Pepsinogen $\xrightarrow{\text{Hydrochloric Acid}}$ pepsin + protein → peptones + proteoses

Prorenin $\xrightarrow{\text{Hydrochloric acid}}$ rennin+ caseinogen (soluble milk protein) → insoluble casein

- Gastric lipase hydrolyzed some fats into glycerol and fatty acids.
- Gastric amylase hydrolyzed some starch
- After completed digestion in stomach, bolus convert into acidic fine paste form called chyme. When chyme becomes more acidic, the pyloric sphincter opens time to time to force the chyme into duodenum by the peristaltic contraction of stomach wall.

4. **Digestion in small intestine:**

When acidic chyme enters into duodenum, wall of duodenum stimulates to secrete the different types of hormones like **secretin, pancreozymin, cholecystokinin,**

enterogastrone and enterokinin etc. These hormones reach to different organs through blood circulation and cause different actions. Secretin and pancreozymin reach to pancreas for secretion and release of pancreatic juice, cholecystokinin reaches to gall bladder for its contraction to release the bile juice. Similarly, enterogastrone reaches to stomach to stop the secretion of gastric juice from gastric glands and enterokinin stimulates intestinal glands present in wall of small intestine to secrete and release the intestinal juice. Bile juice and pancreatic juice reach to lumen of duodenum through hepatopancreatic ampulla and intestinal juice or Succus entericus release to lumen of small intestine from intestinal glands.

- The alkaline bile juice (P^H 8.6) has no enzymes but it helps in neutralization of acidic chyme into alkaline form, emulsification of fats, prevent the decaying of food and growth of bacteria and absorption of fat and fat-soluble vitamins.
- The enzymes present in alkaline pancreatic juice help in digestion of all sort of food materials in following way

Inactive trypsinogen $\xrightarrow{\text{enterokinase enzyme of succus entericus}}$ trypsin (active form) + proteins → proteoses+ peptones

Inactive Chymo-trypsinogen $\xrightarrow{\text{enterokinase + trypsin enzymes}}$ Chymo-trypsin (active form)

Chymo-trypsin + proteoses → Polypeptides

Chymo-trypsin + peptones → Polypeptides

Inactive proto-carboxypeptidase $\xrightarrow{\text{Enterokinase + Trypsin enzymes}}$ Carboxypeptidase (active form)

Carboxypeptidase +Polypeptides → Amino acids + simple peptides

Amylase + Starch→ Maltose

Lipase + Emulsified fats → Fatty acids + Glycerol

Deoxyribonuclease + Deoxyribonucleic acid → Nucleotides

Ribonuclease + Ribonucleic acid→ Nucleotides

When food moves ahead from duodenum, it mixes with Succus entericus. Different enzymes present in succus entericus complete the digestion of all the constituents of food and converts chyme into alkaline pale-yellow color fluid or emulsion called **Chyle** that move slowly towards the ileum by peristalsis. The digestion of food in small intestine occurs in following way;

Amino peptidase + Polypeptides → Dipeptides + Amino acids

Dipeptidase + Dipeptides→ Amino acids

Lipase + Emulsified Fats → Fatty acids + Glycerol

Invertase or Sucrase + Sucrose → Glucose + Fructose

Maltase + Maltose → Glucose + Glucose

Lactase + Lactose → Glucose + Galactose

Nucleosidase +Nucleotides→ Nucleosides + Inorganic Phosphates

II. Absorption:

Process of entry of digested food materials through the wall of alimentary canal to blood stream and lymph is called Absorption. Very little amount of absorption of food

materials take place in buccal cavity and stomach. Some amount of water, salts, alcohol and moderate amount of sugar are absorbed in stomach. But, most of absorption of digested food materials take place in the ileum of small intestine. To increase the digestive and absorptive surface, the inner layer of small intestine's wall is folded in finger like projection called villi. The absorption process occurs by two methods; Active and Passive transport methods. In active transport method, glucose, galactose, fructose, amino acid and mineral salts are absorbed into the blood stream and carried them into liver by hepatic portal vein for proper regulation. The fatty acids, glycerol, and fat-soluble vitamins are absorbed into lymph of lacteal vessels in intestinal villi by active method. From the lymph, these absorbed food materials are carried to blood stream later. In passive transport method by osmosis and diffusion processes, nutrients like water and water-soluble vitamins are absorbed.

III. Assimilation

Process of incorporation of absorbed food materials into cellular components is called Assimilation. The glucose, amino acids, fatty acids and glycerol are carried by blood and lymph to various tissues and cells and then they assimilated in different forms. Amino acids are utilized to synthesized the proteins to form protoplasm, enzymes and hormones etc. While glucose is used for energy production and temporarily stored for future use. Fatty acids and glycerol form the fats which are stored for emergency use and other functions.

IV. Egestion

Process of elimination of undigested food residues in the form of feces from the body through anus is called egestion. After completion of absorption in ileum of small intestine, undigested food residue moves to large intestine. In the colon region of large intestine, water is reabsorbed from undigested food materials and in rectum region, feces form from semi-solid undigestible residue which removes through the anus to outside time to time.