

Unit 9: Human Digestive System

Long Questions

DESCRIPTIVE QUESTIONS

ANATOMY AND PHYSIOLOGY OF DIGESTIVE SYSTEM

Q1. Define Digestion. Mention its importance and components of digestive system.

Ans. Definition: Digestion is a process by which the body **breaks down** food into smaller absorbable components.

Components

Human digestive system is composed of **gastrointestinal (GI) tract** and accessory digestive organs. The GI tract is a continuous tube that extends from mouth to anus. Oral cavity is the first part of GI tract. **Accessory digestive organs** of oral cavity are the salivary glands.

Oral Cavity: It is a cavity immediately after the opening of mouth.

Functions of oral cavity

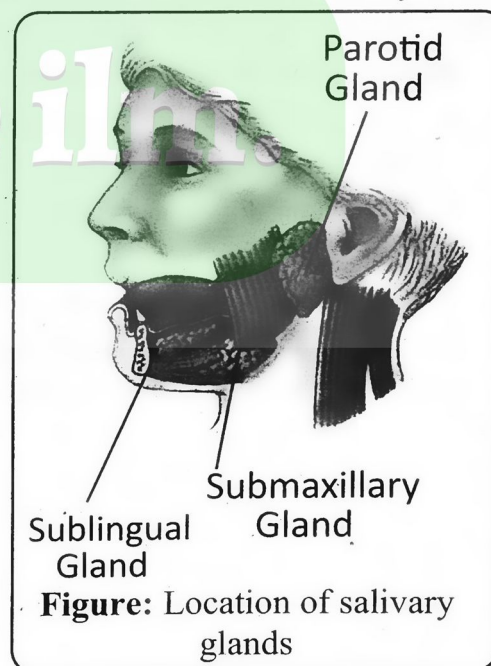
(i) Selection of food: The muscular tongue plays role in selection of food through its taste buds. When food enters the oral cavity, it is **tasted** and **physically felt**. If the taste or smell is unpleasant or if hard objects like bone or dirt are present in the food, it is rejected. The senses of smell and sight also play role in the selection of food.

(ii) Mechanical digestion of food: The ingested food is physically broken down by the teeth through a process called **mastication** (chewing). Chewing converts food into smaller and more manageable pieces. This increases their surface area for enzymatic action.

(iii) Chemical digestion of food: During the process of chewing salivary glands secrete saliva into oral cavity. There are three pairs of salivary glands.

a. Sublingual glands: Situated below the tongue.

b. Submaxillary glands: Located behind the jaws.



★ **Note:** All questions and paragraphs marked with a star ★ are explanations of the Box Information provided in the textbook.

c. Parotid glands: Located in front of ears.

Composition of Saliva

Saliva is composed of:

- (i) **Water and Mucus:** These moisten and lubricate the food.
- (ii) **Bicarbonate ions:** These act as buffer to control pH of the oral cavity.
- (iii) **Thiocyanate ions:** They kill microorganisms.
- **pH of saliva:** Fresh saliva is alkaline with pH 8 but it quickly loses CO_2 and pH becomes 6.
- **Salivary amylase:** Saliva contains amylase which partially digests the polysaccharides (starch and glycogen) to a disaccharide (maltose).

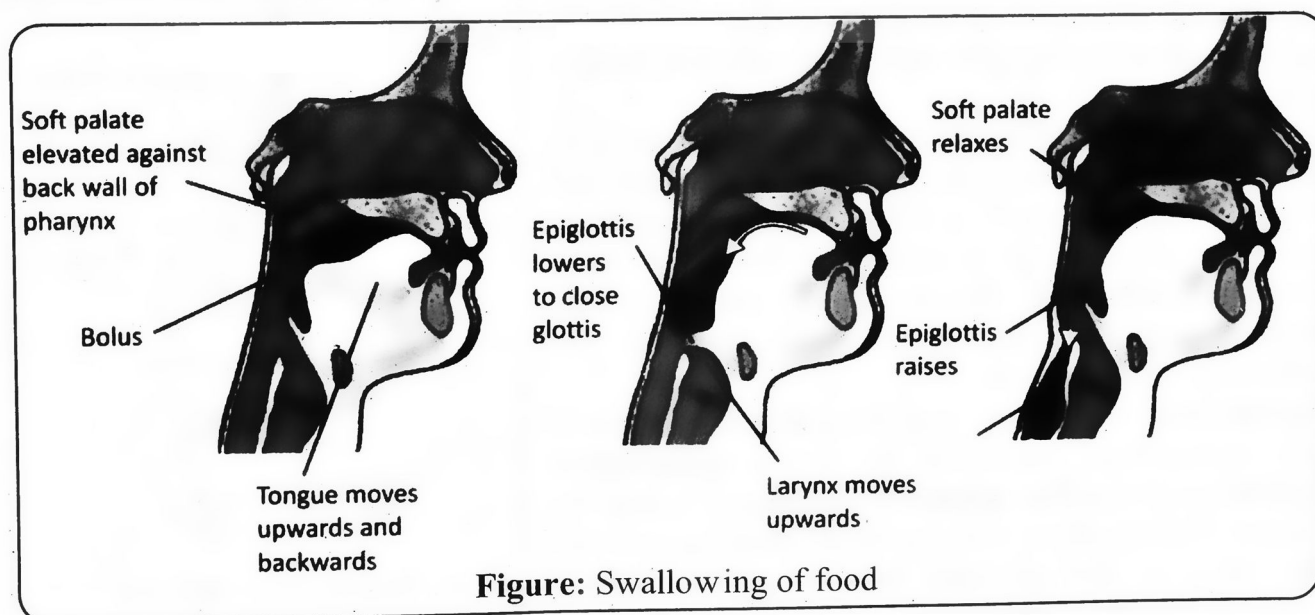
Bolus: After chemical and mechanical digestion in the oral cavity the food in the oral cavity takes the form of a small moist mass called a bolus.

Q2. Explain the process of swallowing of food.

Ans. **Pharynx** is the cavity behind the month (oral cavity). It is the common passageway for both the digestive and respiratory tracts. Bolus is pushed to the back of mouth and is swallowed through the pharynx.

Swallowing of food

- (i) During swallowing the tongue moves upwards and backwards against the roof of the mouth this forces the bolus to the back of oral cavity.
- (ii) Soft palate is raised against the back wall of pharynx, this closes the passage between nasal cavity and pharynx.
- (iii) At the same time larynx moves upwards and epiglottis (a flap of cartilage over glottis) is lowered. This closes the opening of trachea (wind pipe).
- (iv) In this way the bolus passes over the trachea and enters oesophagus.



★ Mechanism of Swallowing

The beginning of the swallowing action is voluntary but once the food reaches the back of the mouth swallowing becomes automatic.

Q3. Explain movement of food through oesophagus.

Ans. 1. After being swallowed, the food enters the tube oesophagus. It connects the pharynx to the stomach. The digestive action of **saliva** continues in oesophagus.

2. Oesophagus is **25cm** long and its lower end opens in stomach.

3. Food passes through oesophagus to stomach by a process called peristalsis.

Motility of Alimentary Canal

Movement in the alimentary canal is of two types i.e. **peristalsis** and **segmentation**.

1. Peristalsis: It is the **rhythmic sequence** of waves of contraction in the smooth muscles of the walls of alimentary canal. Peristalsis squeezes the food down along the oesophagus and other parts of alimentary canal.

Anti-peristalsis: Occasionally the **peristaltic movements** may reverse in a process called antiperistalsis. In this food is pushed from intestine back into stomach and oral cavity. This is also called as **vomiting**.

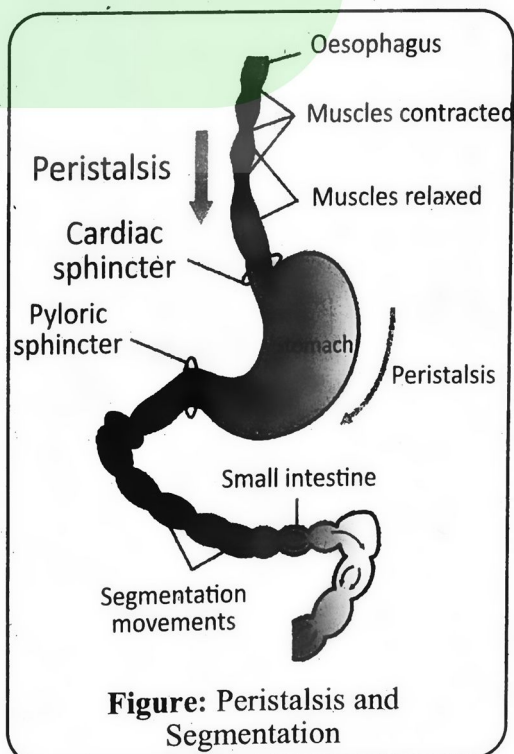
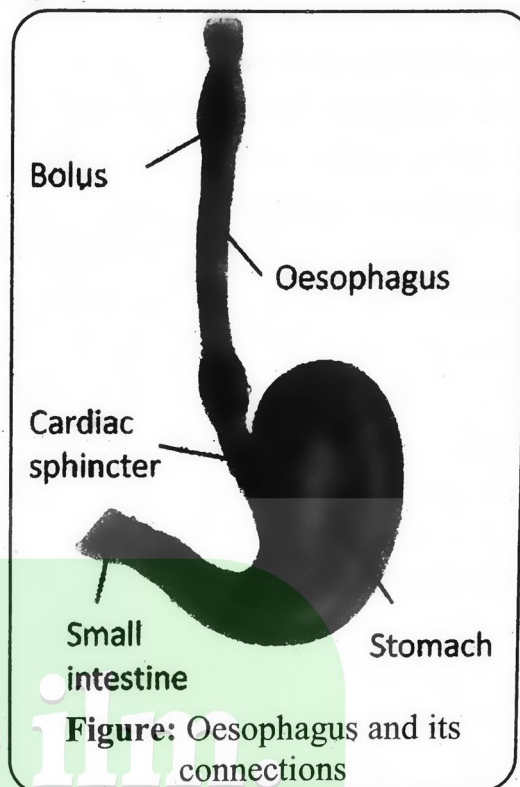
Hunger contractions: These are also peristaltic movements caused by low glucose levels in blood, creating the uncomfortable sensation known as hunger pangs.

2. Segmentation: The small and large intestines also have rings of smooth-muscles which contract and relax repeatedly. These contractions and relaxations create back and forth movement in the same place, called **segmentation**. This movement mixes the food with digestive secretions and thus increases the efficiency of absorption.

Sphincters: The exit of food from the oesophagus to the stomach is controlled by lower **oesophageal sphincter** or **cardiac sphincter** (because it is near the heart). This opens in response to the pressure exerted by food. It also prevents back flow of stomach contents into the oesophagus.

Q4. Explain structure and function of stomach.

Ans. Structure



1. Shape: It is an elastic muscular bag (J-shaped) situated after oesophagus and before duodenum.

2. Location: It is located in the left side in abdominal cavity, below the diaphragm.

3. Portions

Stomach has three portions.

(i) Cardiac portion: It is present immediately after oesophagus.

(ii) Fundus portion: It is present on a side of cardiac portion.

(iii) Pyloric portion: It is located beneath the cardiac portion.

Stomach wall

1. Serosa: It is the outer covering and provides protection.

2. Muscularis Externa: There are three layers of smooth muscles outer longitudinal, middle circular and inner oblique muscles.

3. Mucosa and Submucosa: Mucosa is the inner lining of the stomach. It contains gastric glands that produce digestive juice. Submucosa lies beneath mucosa it contains blood vessels, lymphatic vessel and nerve fibers.

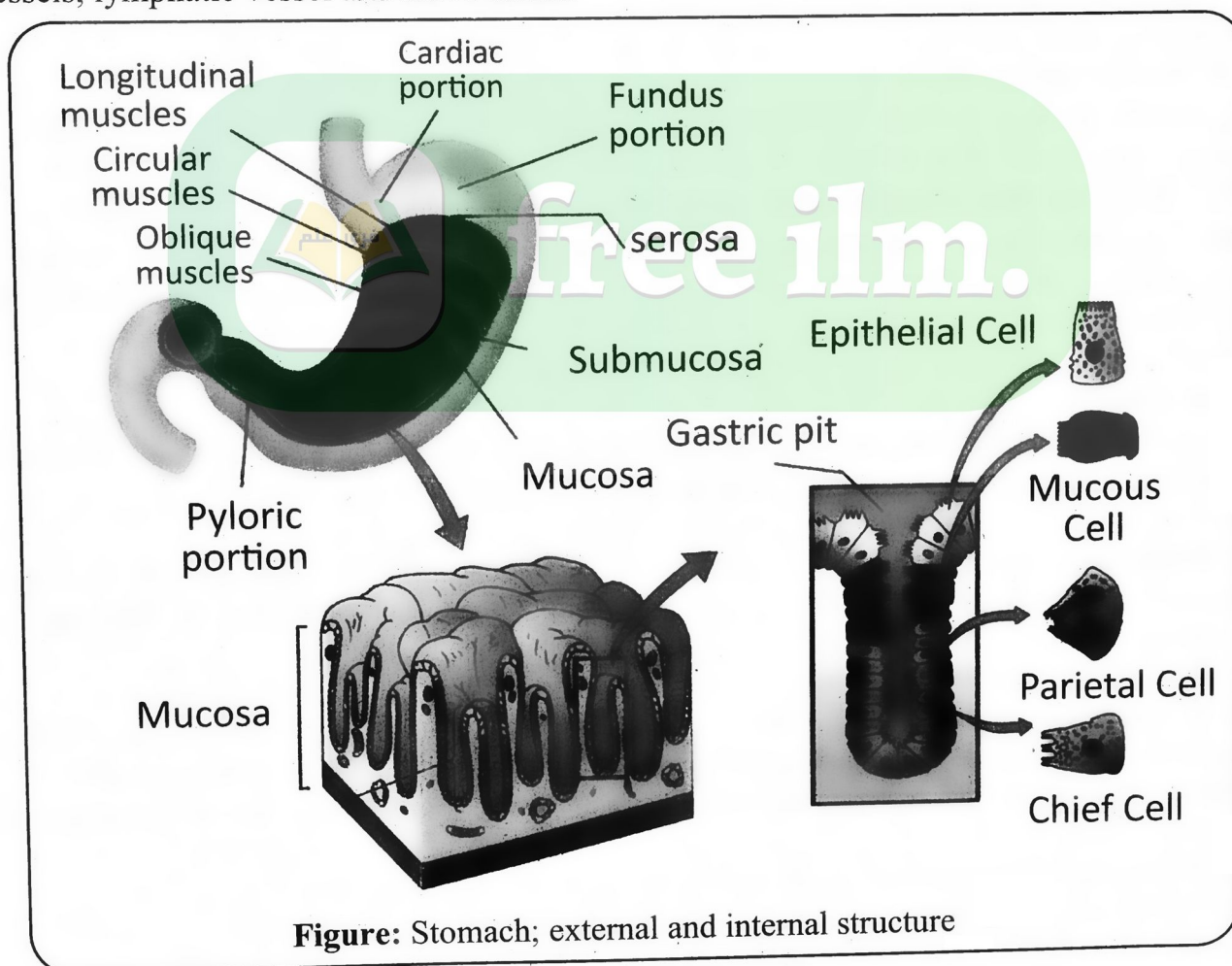


Figure: Stomach; external and internal structure

Functions

1. Mechanical digestion: The muscular walls of stomach contract vigorously and help in **churning** (shaking) and **mixing of food** with stomach secretions. The contractions also generate enough heat to **melt** the solid fats.

2. Chemical digestion: The mucosa of stomach possesses many tubular gastric glands which open through the deep depressions called **gastric pits**. Each gastric gland has epithelial cells and three secretory cells.

(i) **Mucous cells:** These secrete mucous which is **thick secretion** that covers the inside of the stomach and protects it from HCl and digestive enzymes.

(ii) **The parietal (oxyntic) cells:** These secrete **hydrochloric acid**. It adjusts the pH of stomach contents to about 2-3. HCl also softens the food and activates the protein digesting enzyme, pepsinogen to pepsin. It also kills microorganisms.

(iii) **Chief Cells:** These cells secrete enzyme pepsinogen (inactive form of pepsin).

All the secretions of gastric glands are collectively called **gastric juice**. When the bolus enters the stomach the gastric glands secrete gastric juice. H^+ ions of HCl activate pepsinogen into pepsin. Pepsin breaks protein into polypeptides (Contain 10–50 amino acids) and peptides (Contain 2 to 50 amino acids).

Chyme: After about three to four hours after meal, stomach contents are mixed and in the form of semi-liquid acidic mass called chyme. Pyloric sphincter controls the release of chyme into small intestine.

★ **Pyrosis or Heart Burn**

Sometimes there is a **back flush** of acidic chyme from stomach into the oesophagus. It causes a painful burning sensation in the chest and this is called **Pyrosis or Heart burn**.

Q5. Explain digestion in small intestine.

Ans. Small intestine is **largest part** of alimentary canal. It starts from stomach and ends at large intestine. It has diameter of 2-3 cm and 6 metres' length. Food is not only digested but also absorbed in small intestine.

Parts: Small intestine consists of three parts i.e. duodenum, jejunum and ileum.

1. Duodenum

(i) It is first **20-25 cm long part** of small intestine. It is concerned with digestion of food. It contains glands, which produce an alkaline secretion containing bicarbonate.

(ii) Two main secretions are poured into duodenum.

(a) **Pancreatic juice:** It is secreted from pancreas. It is **slightly alkaline (pH 8)** due to presence of bicarbonate. It neutralizes the acidity of chyme. Important enzymes of pancreatic juice are.

(i) **Pancreatic amylase:** It digests polysaccharides into maltose and even glucose.

(ii) **Trypsinogen:** It is an inactive form. Another enzyme enterokinase (secreted by walls of duodenum) activates trypsinogen into trypsin, which digests proteins into polypeptides.

(iii) **Chymotrypsin and carboxypeptidase**, which digest proteins into smaller peptides and then into amino acids.

(iv) **Pancreatic lipase**, which digest lipids into glycerol and fatty acids.

(v) **Pancreatic nucleases**, which digest DNA and RNA into nucleotides.

(b) **Bile:** It is the secretion of liver. Before its release it is stored in gallbladder. It contains salts which emulsify fat and break them into small droplets (emulsion). These droplets provide large surface areas for effective action of lipid digesting enzymes.

2. Jejunum and Ileum: Jejunum is **2.4 meters long**, next to duodenum. Ileum is the last three fifth i.e., about **3.5 metres long** part of small intestine. These parts carry out the rest of

digestion and absorption of food. The walls of jejunum and ileum contain glands which secrete intestinal juice. It contains various enzymes; e.g.,

- **Aminopeptidase** which digests polypeptides into dipeptides.
- **Erypsin** digests dipeptides into amino acids.
- **Lipase** digests fats into fatty acids and glycerol.
- **Maltase** digests maltose into glucose
- **Sucrase** digests sucrose into glucose and fructose
- **Lactase** digests lactose into glucose and galactose.

Chyle: In jejunum chyme after digestion is converted into alkaline emulsion called **chyle**.

Q6. Explain absorption of digested food and water.

Ans. The absorption of digested food, water, and dissolved minerals occurs in jejunum and ileum. Inner wall of jejunum and ileum contains large circular folds. These folds have several finger like projections called **villi**.

Structure of Villus

Each villus is richly supplied with blood capillaries and a vessel of lymphatic system, called **lacteal**. The blood capillaries and lacteal are covered by a single-cell thick epithelium.

The epithelial cells of villi have many cytoplasmic projections, called **microvilli**. The total surface area of absorption becomes extraordinarily increased due to villi and microvilli.

★ **Appearance:** Due to presence of folds and numerous villi the internal surface of jejunum and ileum appears velvety.

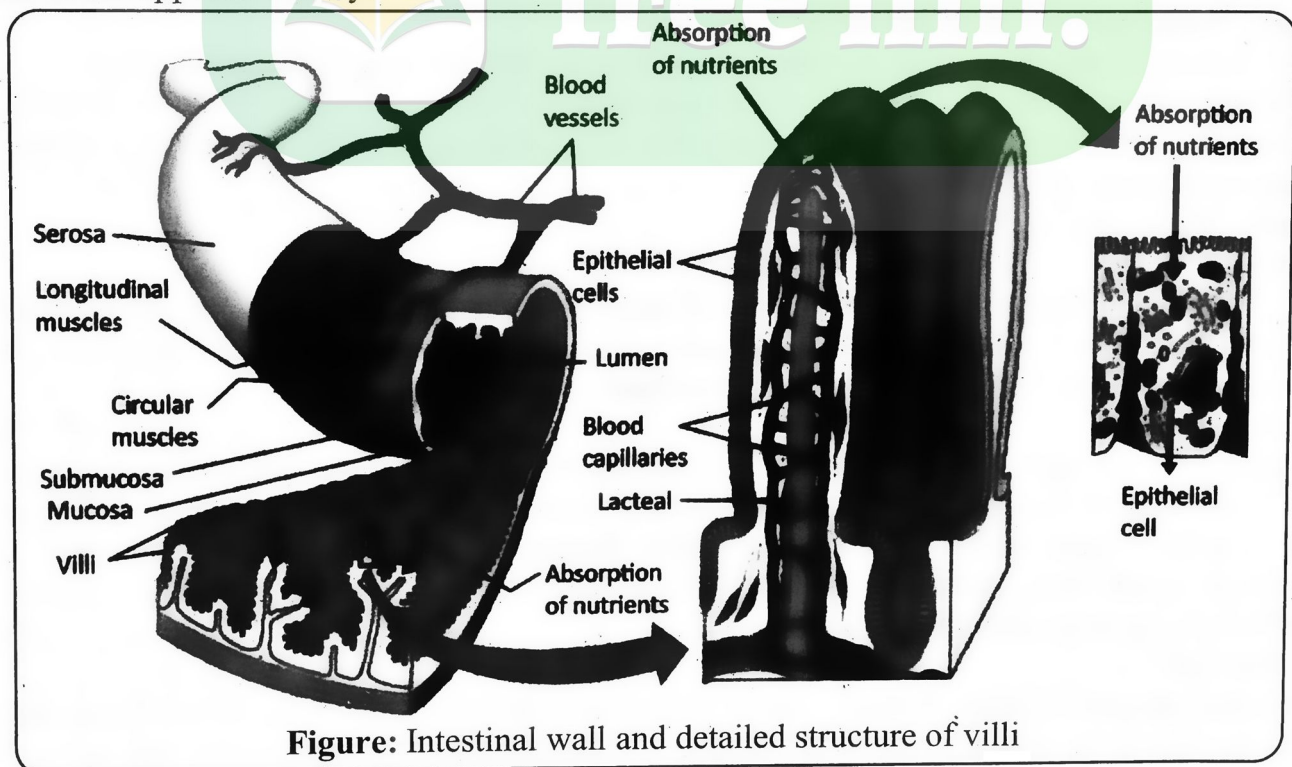


Figure: Intestinal wall and detailed structure of villi

Absorption of simple sugars and amino acids

- Simple sugars (e.g., glucose) and amino acids are absorbed by diffusion or active transport into the epithelial cells of villi.

- From here, these molecules enter the blood capillaries of villi.
- Blood capillaries of villi join to form **hepatic portal vein** which carries sugars and amino acids to liver.
- Liver stores extra glucose and amino acids in the form glycogen and proteins respectively.
- From liver, the required amounts of these products pass to heart via hepatic vein.

Absorption of Fatty acids and glycerol

- The products of fat digestion i.e., fatty acids and glycerol are absorbed by passive transport into the epithelial cells of villi. Here they combine to form triglycerides.
- The triglycerides are coated with proteins and small droplets, called **chylomicrons**.
- The chylomicrons enter the lacteals of villi.
- From the lacteals, the chylomicrons move into thoracic lymphatic duct, and then into the blood stream. Chylomicrons in blood are hydrolysed by the enzymes of blood plasma back into fats and proteins.
- Fats are further hydrolyzed into fatty acids and glycerol and enter the body cells.

★ **Absorption of fats**

Fats are insoluble in water. So, they cannot be attacked readily by lipase enzymes of pancreatic juice. Bile salts act as detergent molecules. They break fats into droplets and keep them separate from one another.

Q7. Describe structure and function of large intestine.

Ans. Structure of Large Intestine

1. It is much shorter than small intestine and makes the last meter of the intestinal tract.
2. It is involved in the absorption of water and salts and vitamin K from the lumen (cavity) of intestine into the blood. The large intestine is not convoluted (coiled) and its inner surface does not possess villi.

Parts: Large intestine has three parts.

a. Caecum

It is a blind sac that projects from the area of large intestine between ileum and colon. From the blind end of caecum, **vermiform** (finger like) process arises called as appendix. In humans **appendix** has no function so it is **vestigial** (non-functional).

b. Colon

Next to caecum is the colon. It has an ascending, a transverse and a descending limb. Its main function is to absorb water. As the water is absorbed, the remaining material becomes more solid. These wastes products are called **faeces**, these consist of large number of bacteria, undigested plant fibres (e.g., cellulose), and other food stuff, sloughed off mucosal cells, bile pigments and water.

c. Rectum

It is the last part of large intestine where faeces are stored for short time. At its distal end, the rectum opens out through anus. Anus is surrounded by two sphincters; the internal sphincter is made of smooth muscles and the outer is made of striated muscles. When the rectum is filled up with faeces, it gives rise to a **defecation reflex**. The defecation reflex can be consciously inhibited in adults but in infants it is controlled involuntarily. Later on the child learns to control this reflex voluntarily.

Vitamin K Production: Many bacteria, e.g. *E.coli*, live and actively divide in the colon. They produce amino acids and vitamin K. Vitamin K is necessary for **blood coagulation**. It is absorbed from the large intestine into the blood.

Q8. Write note on control of Egestion.

Ans. Egestion is removal of the undigested food from the rectum. It is an involuntary act in infants while voluntary in the adults. There are two stages of egestion control i.e. Neurological and muscular development.

1. In infants, egestion is an involuntary reflex mediated by the spinal cord. Here the rectal distension triggers automatic relaxation of the internal anal sphincter and expulsion of waste. This occurs because the higher centres (cerebral cortex) are not yet fully developed.

2. In adults, because cerebral cortex is mature, this allows conscious regulation of external anal sphincter to delay or initiate defecation.

This transition (change) reflects the integration (combination) of reflex pathways with cognitive (conscious) control, adapting to social and environmental demands.

This means that in adults when brain is fully developed, motor neurons from cerebral cortex, change this involuntary action of egestion, controlled by neurons of spinal cord only in infants, to the voluntary action in adults. So adults can control (initiate or inhibit) egestion voluntarily as per situation or requirement.

Q9. Write note on accessory digestive organs.

Ans. 1. Liver and Gallbladder

i. Liver plays a vital role in digestion by producing bile, which is essential for fat digestion. Bile emulsifies fats (during emulsification large fat globules are converted into smaller ones). This makes them easier for enzymes to digest.

ii. Liver also modifies nutrients absorbed from the small intestine.

iii. It detoxifies the harmful substances.

iv. It synthesizes proteins.

v. It stores glycogen for energy.

vi. Gall bladder stores and concentrates bile produced by liver. When food enters the small intestine, bile is released from the gall bladder into duodenum through bile duct.

2. Pancreas

i. It is a large gland situated just ventral to the stomach.

ii. It has exocrine and endocrine portions. The exocrine (with duct) portion secretes pancreatic juice through pancreatic duct, which joins into the common bile duct from the liver and enters the duodenum.

iii. Pancreatic juice contains enzymes for the digestion of all groups of food. The main enzymes are trypsin, chymotrypsin, lipases, amylases, nucleases etc.

iv. The endocrine (ductless) portion of pancreas secretes insulin and glucagon hormones into extracellular fluid from where they diffuse into nearby capillaries.

Q10. Write short note on hormonal control of the secretions of pancreas and liver.

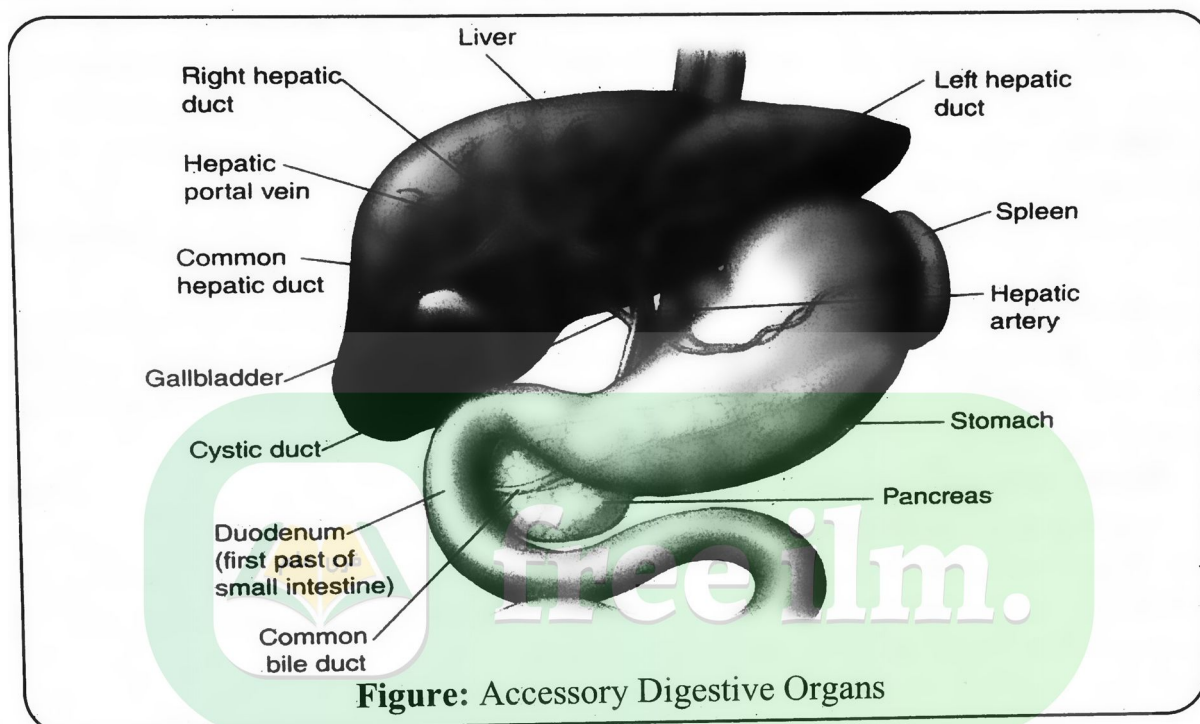
Ans. 1. The release of secretions from pancreas and liver is controlled by hormones.

2. When chyme enters duodenum from stomach, its acidity stimulates duodenal walls to release **secretin**.

3. Similarly, the partially digested proteins and fats present in chyme stimulate the duodenal walls to secrete another hormone, **cholecystokinin (CCK)**. Both these hormones stimulate pancreas to release pancreatic juice, and gallbladder to release bile.

Cholecystokinin

Cholecystokinin is a hormone produced in the small intestine that play a key role in digestion by triggering the gall bladder to release bile into small intestine, stimulating pancreatic enzyme release and regulating appetite.



Q11. Explain storage and metabolic role of liver.

Ans. The liver performs many important functions like storing nutrient and regulating metabolism.

1. Storage

- It stores excess nutrients from the food and releases them when body needs energy or building materials.
- The stored nutrients include glucose (stored as glycogen), vitamins (like A, D, B₁₂, and K), minerals (e.g., iron and copper) and fats along with fat-soluble substances.

2. Metabolic role

- Conversion:** It converts excess glucose into glycogen and back when needed.
- Breakdown:** It breaks down fats to produce energy.

3. Synthesis

- If forms cholesterol and lipoproteins.
- It synthesizes urea by removing ammonia produced from amino acids. Urea is then excreted in urine.

4. Detoxification: It breaks down and removes toxins, drugs, and alcohol from the blood.

5. Hormonal Regulation: Liver also helps in breaking down and regulating hormones.

Q12. Describe the hormonal and nervous regulation of gastric acid secretion.

Ans. The secretion of gastric juice is regulated by both the nervous system and hormonal

mechanisms.

1. In reaction to the smell, sight or thought of food, the medulla of brain sends message to the gastric glands to secrete small amounts of gastric juice.
2. When food arrives in stomach, the distension (expansion) of stomach and decrease in pH of gastric contents stimulate more secretion and powerful contraction.
3. The presence of proteins in food stimulate special endocrine cells present in the mucosa of stomach to release a hormone called **gastrin**. Gastrin is carried by blood to gastric glands where it stimulates them to produce and secrete more gastric juice.
4. When food moves from stomach to small intestine, a hormone called somatostatin stops the release of hydrochloric acid.



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