

# Digestive System

## INTRODUCTION

- The digestive system consists of the parts mainly concerned with the ingestion and digestion of the food. It is a primary system of the body responsible for the continuous supply of water, electrolytes, vitamins, and nutrients.
- The length of the digestive tract is about 10 m. Pharyngo-esophageal junction is the narrowest part of the gut.

## Major Functions of Digestive System

*Q. List the major functions of digestive system.*

- The major functions of the digestive system are as follows:
  1. *Ingestion* – taking the food and liquids into mouth.
  2. *Mastication* – chewing food into smaller pieces and mixing it with saliva.
  3. *Salivation* – secretion of saliva.
  4. *Deglutition* – swallowing of food from mouth to stomach.
  5. *Digestion* – breaking down food into smaller pieces and making them suitable for absorption.
  6. *Secretion* of digestive enzymes and chemicals.
  7. *Absorption* of nutrients from intestine into the blood.
  8. *Motility* such as peristalsis (rhythmic contractions of intestine) to move food and mix with digestive juices.
  9. *Defecation* – excretion of waste products (feces) through anus.

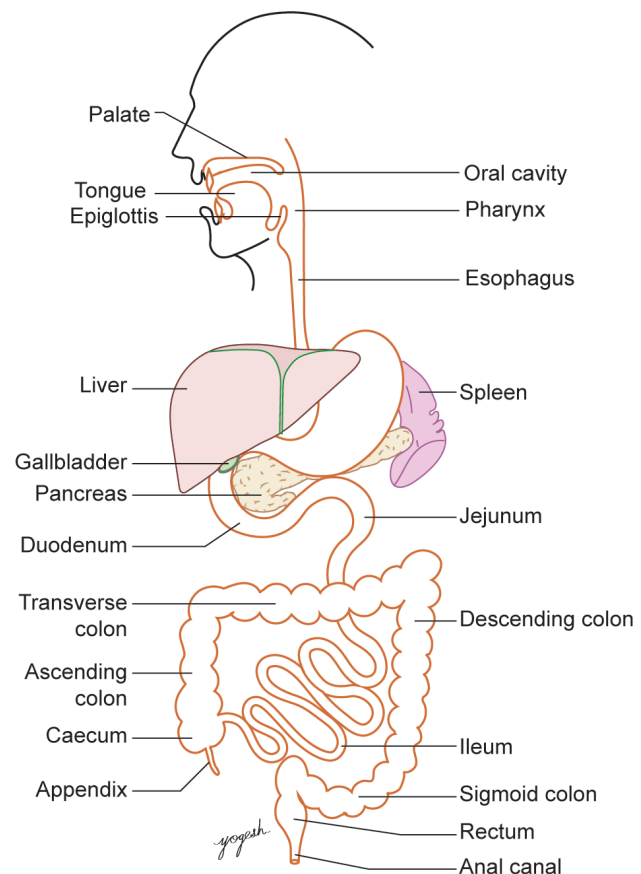
## COMPONENTS/PARTS OF DIGESTIVE SYSTEM

*Q. List the parts of digestive system.*

*Q. Draw a well-labeled diagram of various parts of digestive system.*

- The digestive system is a tubular passage (~10 m or 30 feet long).
- It extends from the oral cavity to the anal opening. It consists of the following parts (Fig. 14.1):
  1. Mouth or oral cavity
  2. Pharynx

3. Esophagus
  4. Stomach
  5. Small intestine – duodenum, jejunum, ileum.
  6. Large intestine – caecum, appendix, ascending colon, transverse colon, descending colon, sigmoid colon, rectum
  7. Anal canal.
- The digestive system is supported by the following glands:
    1. Salivary glands – parotid, submandibular, and sublingual glands
    2. Liver
    3. Pancreas.



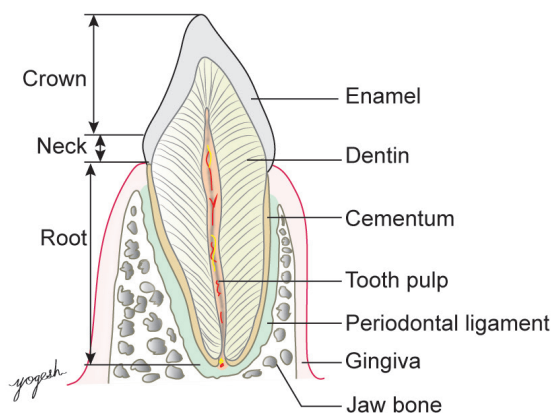
**Fig. 14.1:** Components of digestive system

## MOUTH OR ORAL CAVITY

- The mouth or oral cavity is the beginning of the digestive tract.
- It is bounded by two lips and cheeks. It is separated from the nasal cavity by *palate*.
- *Lips* are muscular structures formed by *orbicularis oris* muscle. The outer surface of lip is covered by skin and inner surface by mucosa. The color of lips is due to a dense network of vessels visible through the thin transport epithelium.
- *Cheek* forms the lateral wall of the oral cavity. It helps in mastication (chewing) and speech.
- *Vestibule* is a house shoe-shaped space outside the gums and teeth and deep to the lips and cheeks.
- *Oral cavity proper* is the space surrounded by teeth and gums.

### Teeth

- There are 32 teeth in jaw in adults, the teeth are embedded in the alveolar sockets of the mandible (lower jawbone) and maxilla (upper jawbone)
- Humans have two sets of teeth (diphyodont), as teeth are replaced only once.
- The teeth are grounded as follows in adults:
  1. Incisors (4 pairs)
  2. Canines (2 pairs)
  3. Premolars (4 pairs)
  4. Molars (6 pairs).
- There are 20 *milk or deciduous teeth* in childhood as follows:
  - 4 pairs of incisors
  - 2 pairs of canines
  - 4 pairs of molar.
- Each tooth consists of *crown* (visible part), *neck*, and *root* (embedded part). The center of tooth has a *pulp cavity* filled with blood vessels (Fig. 14.2).
- The crown of tooth is covered with extremely hard *enamel*. The root of tooth is covered with hard *dentine* and *cementum*. *Periodontal ligaments* fix the teeth with alveolar sockets.



**Fig. 14.2:** Practice figure: Longitudinal section of dry tooth (for practice) *Note:* Draw this figure using HB pencil only

## Tongue

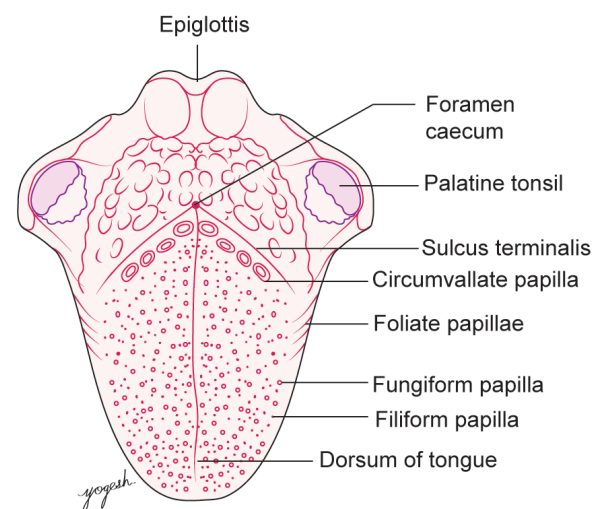
- The tongue is the large muscular organ that occupies most of the oral cavity proper.
- Functions of tongue:
  - Chewing
  - Speech
  - Deglutition
  - Taste sensation.

### Parts

- Tongue consists of the following parts (Fig. 14.3):
  1. *Root* of tongue is fixed by muscles to the bones.
  2. *Tip* is the free anterior end of tongue.
  3. *Body* is the main bulk of the tongue. It has dorsal and ventral surface. The *dorsal surface* is divided into anterior two-thirds and posterior one-third by V-shaped *sulcus terminalis*. The ventral surface is smooth and has *frenulum linguae* (median mucosal fold that connects the tongue with the floor of mouth).

### Papillae of Tongue

- The dorsal surface of tongue shows projections called *lingual papillae*. They are of the following types:
  1. *Filiform papillae* – most numerous, small, pointed projections.
  2. *Fungiform papillae* – mushroom-shaped projections along the side and tip of the tongue.
  3. *Circumvallate papillae* – 8–12 large, dome-shaped papillae located just anterior to the sulcus terminalis.
  4. *Foliate papillae* – parallel rows of ridge near the margin of tongue. These are rudimentary in humans.
- *Note:* Taste buds are present at fungiform and circumvallate papillae.



**Fig. 14.3:** Practice figure: Features of the dorsal surface of the tongue

### Muscles of Tongue

- There are extrinsic and intrinsic muscles.
- *Intrinsic muscles* do not have body attachment, and they can change the shape of the tongue. There are 4 intrinsic muscles in each half of the tongue.
- *Extrinsic muscles* are attached to adjacent bones. There are 4 extrinsic muscles in each half of the tongue, and they can change shape and position of tongue.
- *Genioglossus* muscle is called *safety muscle of tongue* because it prevents back fall of tongue and obstruction of air passage, choking, and death.

### Nerve Supply

- Most of the tongue muscles are supplied by hypoglossal nerve. The taste sensation is carried by facial, glossopharyngeal and vagus nerves.

### Clinical Integration

- *Sublingual route of drug administration* is useful for the administration of drugs such as *nitroglycerin* (vasodilator) to treat angina pectoris. It allows the drug (kept below the tongue) to enter circulation in less than one minute.

### PHARYNX

- Pharynx is a wide funnel-shaped passage situated behind nose, mouth, and larynx. It is about 12–14 cm long and 3–5 cm wide.

### Subdivision

- The pharynx is divided into three parts (Fig. 14.4):
  1. *Nasopharynx* – lies behind the nasal cavity
  2. *Oropharynx* – lies behind the oral cavity
  3. *Laryngopharynx* – lies behind the oral cavity.
- Wall of pharynx is formed by *constrictor muscles* of pharynx which is an example of involuntary skeletal muscles.
- Nasopharynx is separated from the oropharynx by soft palate which prevents the entry of food into nasopharynx from oropharynx.

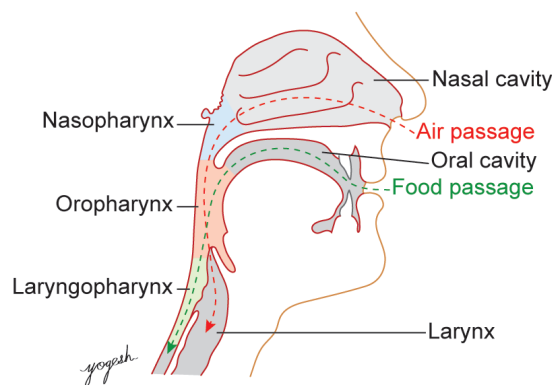


Fig. 14.4: Subdivisions of pharynx

### ESOPHAGUS

- The esophagus is a muscular tube that connects the pharynx with stomach, it is about 25 cm long and 2 cm wide.
- *Function*: Transport of food from pharynx to stomach
- The wall of esophagus has the muscles. At the lower end of esophagus, these muscles form *lower esophagus sphincter* which prevents reflux of food from stomach to esophagus.
- Lumen of esophagus remains collapsed and distended only during the passage of food. It takes 5–9 seconds for food to travel through the esophagus.
- At the junction of pharynx and esophagus, *cricopharyngeal sphincter* prevents air entry into esophagus during respiration.

### STOMACH

- Stomach is J-shaped muscular bag that acts as reservoir of food and convert it into *chyme* with the help of acidic juice (*gaster* = stomach). It connects esophagus with duodenum. It is about 25 cm and has the capacity of 1000–1500 ml. Stomach is the most dilated part of the intestine.
- Stomach has the following parts (Fig. 14.5):
  1. Two orifices:
    - Cardiac orifices (communication with esophagus)
    - Pyloric orifice (communication with duodenum)
  2. Two curvatures: Concave lesser curvature and convex greater curvature
  3. Four parts: Fundus, body, pyloric antrum, and pyloric canal
- The pyloric sphincter regulates the entry of food from stomach into the duodenum.
- *Functions of stomach*
  1. Stores the food.
  2. Secretes the gastric juice containing hydrochloric acid, pepsinogen, and intrinsic factor.

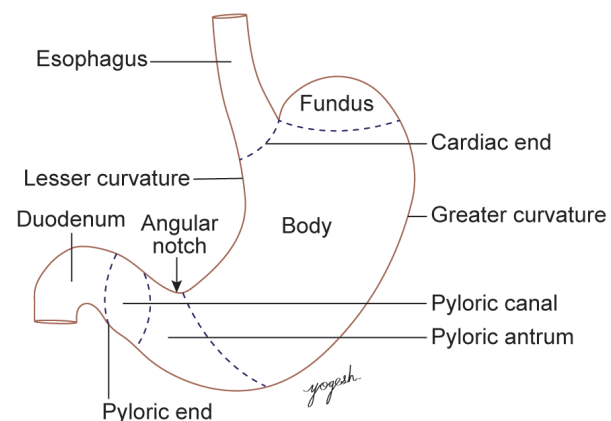


Fig. 14.5: Parts of stomach

3. Absorbs glucose, sodium and alcohol.
  4. Initiates digestion and kills the microorganisms of food.
- Vagus nerve stimulates the secretion of acid in stomach.

### Clinical Integration

- *Gastritis* is an inflammation of stomach. It occurs due to stress, alcohol, consumption of spicy food, and so on.

## SMALL INTESTINE

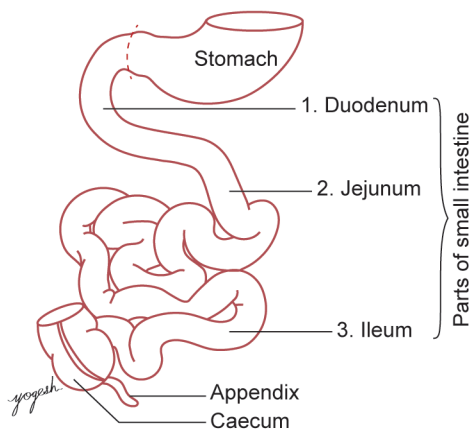
- The small intestine is the longest part of digestive tube. It extends from pylorus of stomach to ileocaecal junction.
- It is about 6 m long muscular tube. It has three parts (Fig. 14.6):
  1. Duodenum – proximal part (25 cm)
  2. Jejunum – middle 2/5th part
  3. Ileum – distal 3/5th part.

### Duodenum

- It is the first part of small intestine (*dudekadutualas* = 12 finger long). It is C-shaped loop that connects stomach with jejunum.
- Duodenum receives bile from liver and gallbladder and pancreatic juice from pancreas through common bile duct and main pancreatic duct.
- The wall of duodenum contains Brunner's glands which secrete mucous for protection against acidic content of stomach.

### Jejunum and Ileum

- Jejunum forms 2/5th of small intestine, and ileum from 3/5th of small intestine.
- Jejunum is the major site for digestion and absorption of nutrition from food.
- To increase the surface area for absorption, the small intestine shows:
  1. Plicae circulares (valves of Kerking), which are circumferential permanent mucosal folds.



**Fig. 14.6:** Parts of small intestine

2. Intestinal villi, which are finger-like projections of mucosa.
  3. Microvilli, which are cell surface projections.
- The wall of ileum shows Peyer's patches which are aggregation of lymphoid tissue in mucosa. They form the part of immune system.

### Functions of Small Intestine

1. Digestion of food
2. Absorption of nutrients, water, electrolyte, and vitamins
3. Transport of food
4. Peristalsis – wavelike coordinated muscular contraction of intestine for mixing of food
5. Immune function.

## LARGE INTESTINE

- The large intestine is 1.5 m long, it extends from ileocaecal junction to the external anal orifice.
- There are three cardinal features of large intestine as follows:
  1. Taenia coli are three ribbon-like bands of longitudinal muscle fibers.
  2. Appendices epiploicae are small bags of fat attached on the surface of large intestine.
  3. Sacculations or haustrations are series of dilations.
- For the differences between small and large intestine, refer to Table 14.1.

### Parts of Large Intestine (Fig. 14.7)

1. Caecum
2. Appendix
3. Colon ascending transverse descending sigmoid colon
4. Rectum
5. Anal canal.

**TABLE 14.1:** Differences between small and large intestine  
Q. List the differences between small and large intestines.

Feature	Small intestine	Large intestine
Length	6 m	1.5 m
Caliber	Narrower	Wider
<i>Cardinal features</i> <sup>Viva</sup>		
Taenia coli	Absent	Present
Haustrations	Absent	Present
Appendices epiploicae	Absent	Present
Mobility	Mobile except duodenum	Fixed except appendix, transverse, and sigmoid colons
<i>Microscopic features</i>		
Villi	Present	Absent
Plicae circularis	Permanent	Temporary (obliterated on relaxation of longitudinal muscle coat)
Peyer's patches	Present	Absent
Goblet cells	Few	Numerous

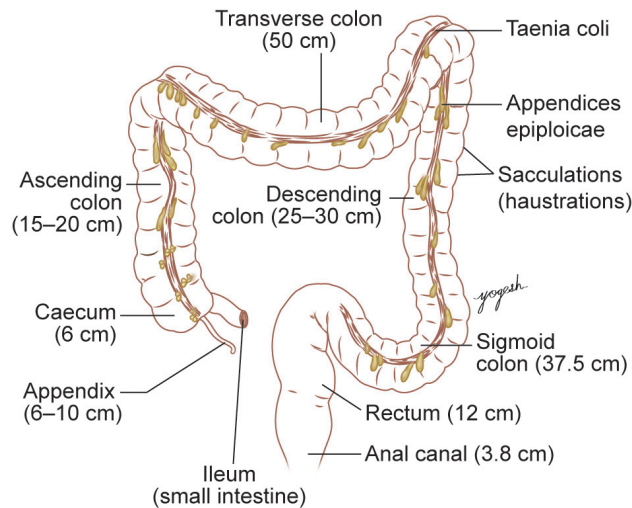


Fig. 14.7: Parts of large intestine

### Functions of Large Intestine

The large intestine performs the following functions:

1. Absorption of water and minerals
  2. Secretion of mucus to lubricate feces
  3. Storage and expulsion of feces
  4. Synthesis of vitamin B with the help of bacterial flora
  5. Protection from microorganisms by secreting of IgA antibodies.
- *Caecum* is a blind pouch. It receives remains of food from ileum. It gives attachment to the appendix.
  - *Appendix* is a worm-like tubular diverticulum. It is about 6–10 cm long and 5 mm wide. The base of appendix is attached to the caecum. The appendix is considered a vestigial organ. It plays a role in immune system.
  - *Rectum* is the distal part of large intestine that connects sigmoid colon with the anal canal. It is located in the pelvic cavity.
  - *Anal canal* is the terminal part of the intestine. It is located in the perineal region. It is about 4 cm long. It opens on the surface at the anal orifice. At the lower end of anal canal there are internal and external anal sphincters that control defecation. It is a site of portacaval anastomosis – anastomosis between tributaries of portal vein and inferior vena cava.

### Clinical Integration

- Appendicitis is the inflammation of appendix. It is surgical emergency pain in the appendicitis is referred to umbilicus and right iliac fossa through T10 segment of spinal cord. Maximum tenderness is located at McBurney's point – at the junction of medial 2/3rd and lateral 1/3rd of line joining umbilicus and anterior superior iliac spine.
- Hemorrhoids or piles are the dilated veins in the lower part of anal canal. It occurs due to portal hypertension (increased venous pressure in portal vein).

## MAJOR DIGESTIVE GLANDS

- The digestive function of intestine is supported by salivary glands, livers, gall bladder, and pancreas.

### Salivary Glands

- There are three pairs of major salivary glands: Parotid, submandibular, and sublingual glands, these are exocrine glands (Fig. 14.8).
- *Parotid glands* are the largest salivary glands. <sup>MCQ</sup> It is located just below the ear. The parotid duct opens into the vestibule of mouth opposite the 2nd upper molar tooth.
- *Submandibular glands* are located below the tongue and mandible. Its duct opens into the floor of the mouth onto a papilla on the side of frenulum linguae.
- *Sublingual glands* lie under the mucous membranes of the floor of the mouth. The submandibular ducts (10–12) open on the floor of the mouth.
- These salivary glands are branched tubuloacinar glands that secrete serous watery and mucous fluids, they are stimulated by autonomic nerve that enhances salivation.

### Clinical Integration

- Mumps is an inflammation of the parotid gland by viral infection. In mumps, parotid glands become swollen, and it is painful condition.

### Liver

- Liver is the largest gland of the body. It weighs about 1500 g in an adult.
- It is wedge-shaped reddish brown in color solid and friable. It occupies right upper part of the abdomen. It lies below the diaphragm (Fig. 14.9).
- The liver is wedge-shaped. Its base is directed to the right, and apex to the left.
- It has four lobes: Right, left, caudate, and quadrate. The vessels and nerves enter the liver through porta hepatis (*porta* = gate).

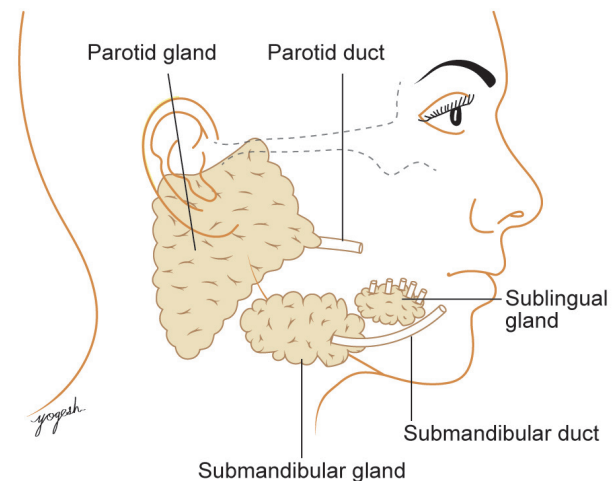
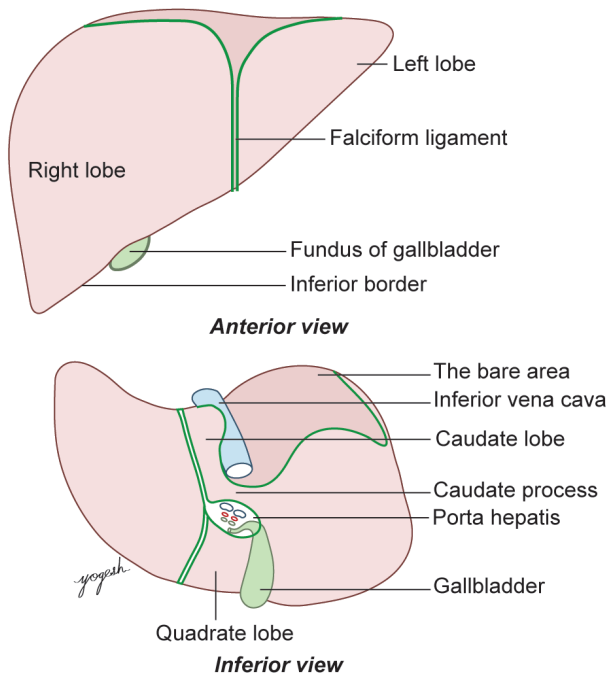


Fig. 14.8: Major salivary glands



**Fig. 14.9:** Liver

- Liver is supplied by portal vein (nutrient-rich blood from intestine) and hepatic artery (oxygenated blood). Blood from the liver enters the inferior vena cava through hepatic veins.
- Internally, the liver has hexagonal *hepatic lobules*, which have a central vein in the center radially arranged rows of hepatocytes and hepatic sinusoidal and peripheral located portal triads. The portal triads consist of a branch of hepatic artery, portal vein, and bile duct.
- *Hepatic sinusoids* are the space between adjacent cords of hepatocytes (liver cells). Sinusoids are lined by endothelium and Kupffer cells (phagocytic cells).
- *Bile canaliculi* join to form right and left hepatic ducts, which later join to form *common hepatic duct*. They carry the bile secreted by the liver.

#### Functions of Liver

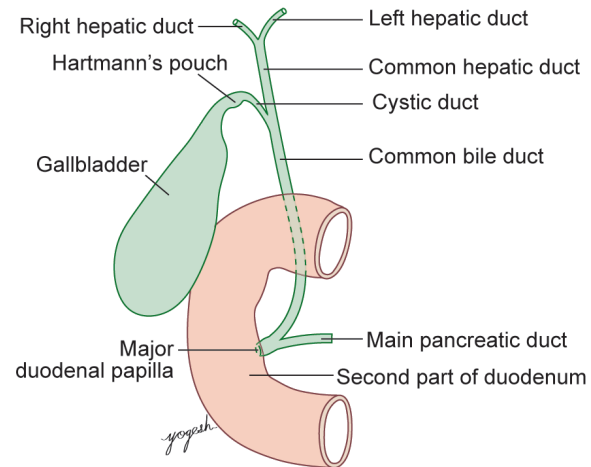
1. Secretion of bile
2. Metabolism of nutrients absorbed from intestine
3. Storage of nutrients
4. Detoxification of drugs (medicine).

#### Clinical Integration

- *Hepatitis* is an inflammation of liver, mostly caused by viruses.
- *Liver biopsy* may be required for the diagnosis of liver diseases. *Cirrhosis of liver* is mostly produced by alcohol or drugs. It results in the replacement of liver cells fibrous tissue.

#### Gall Bladder and Extrahepatic Biliary Apparatus

- The extrahepatic biliary apparatus carries and stores the bile.



**Fig. 14.10:** Practice figure: Extrahepatic biliary apparatus (anterior view)

- It consists of right and left hepatic ducts, common hepatic duct, gall bladder, cystic duct, and bile duct (Fig. 14.10).
- The right and left hepatic ducts join to form common hepatic duct.
- The cystic duct joins the common hepatic duct to form common bile duct, which opens in the duodenum.

#### Gallbladder

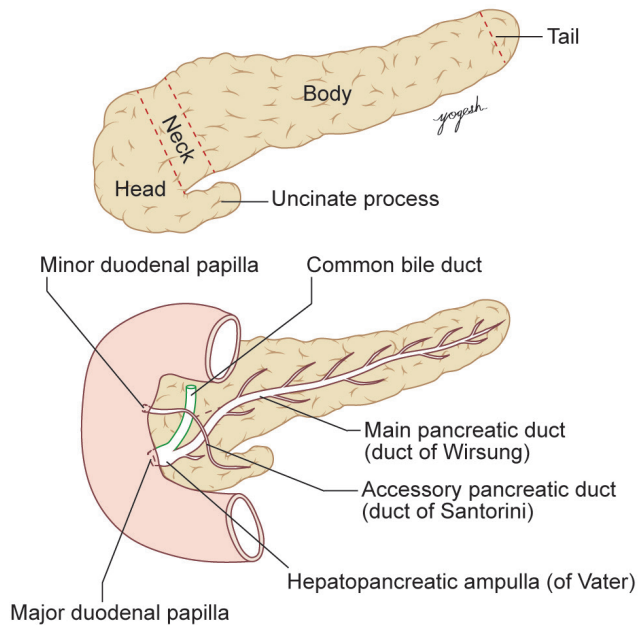
- It is a pear-shaped blind-ending diverticulum on the inferior surface of the liver. It stores the bile and absorbs the water to make it concentrated.
- Gallbladder contract on stimulation of cholecystikinin (secreted by duodenum on entry of food) and release the bile. The capacity of gallbladder is 30–50 cm. The cystic duct connects the gallbladder with common hepatic duct.

#### Clinical Integration

- *Gallstones* are common in fatty, fertile, fair females of forty years. They may block bile duct and cause jaundice.
- *Cholecystitis* is an inflammation of gallbladder. *Acute cholecystitis* is a painful condition.

#### Pancreas

- Pancreas is a soft-lobulated gland located deep in the abdomen. It is about 12–15 cm long.
- It has two parts.
  1. Exocrine pancreas secretes digestive pancreatic juice through ducts.
  2. Endocrine pancreas secretes insulin and glucagon through islets of Langerhans.
- The pancreas has (Fig. 14.11)
  1. Main pancreatic duct that joins common bile duct and drains into duodenum
  2. Accessory pancreatic duct that drains directly into the duodenum.
- Pancreas has four parts: Head, body, neck, and tail.



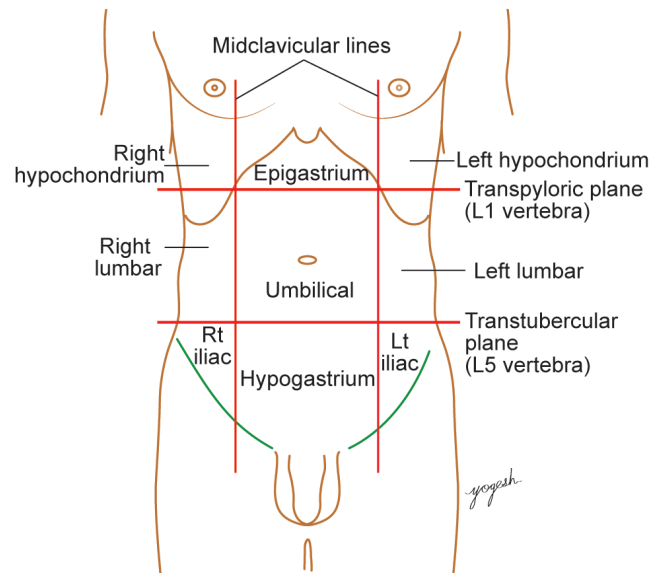
**Fig. 14.11:** External features of pancreas and pancreatic ducts

### Clinical Integration

- *Diabetes mellitus* occurs due to deficiency of insulin.
- Carcinoma of head of pancreas is common.
- *Acute pancreatitis* is an acute inflammation of pancreas. It is difficult to treat.

#### BOX 14.1: Subdivision of abdominal cavity

- The abdomen is divided into nine quadrants/regions by the following planes/lines (Fig. 14.12):
  1. *Midclavicular line* passes vertically through the midpoint of clavicle and mid-inguinal point (midpoint between anterior superior iliac spine and pubic symphysis).
  2. *Transpyloric (Addison's) plane* is a transverse plane that midpoint of line joining the suprasternal notch and pubic symphysis. It passes through the tip of the 9th costal cartilage.
  3. *Transtubercular plane* is a transverse plane that passes through the tubercles of iliac crest.
- These planes divide the abdomen into
  1. Right and left hypochondriac regions
  2. Epigastric region
  3. Right and left lumbar regions



**Fig. 14.12:** Quadrants of abdomen (LHc and RHc: Right and left hypochondriac regions)

4. Umbilical region
5. Right and left iliac regions
6. Hypogastric region.

- These quadrants are useful in the clinical examination for location of organs.

#### PERITONEUM

- The abdominal cavity is internally lined by a thin layer of peritoneum.
- It has two layers — outer parietal and inner visceral layers.
- The *parietal peritoneum* lines the inner surface of abdominal and pelvic cavities. *Visceral peritoneum* lines the outer surface of abdominal and pelvic organs.
- *Functions*
  - Peritoneum permits free movement of viscera.
  - It stores the fat, and it prevents the spread of infection.
- Folds of peritoneum connect the organ to the abdominal wall. Main folds of peritoneum are as follows:
  1. Mesentery for small intestine
  2. Mesocolon for large intestine
  3. Lesser and greater omentum for stomach.