The Digestive System

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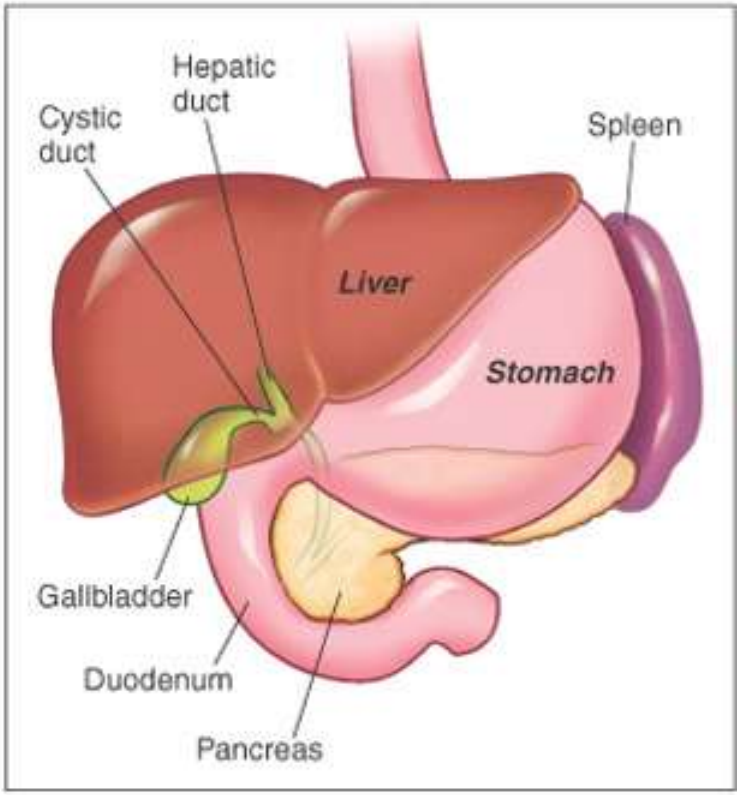
(2021)



Definitions

The Digestive System:

Is the system of the body formed of all the organs responsible for the ingestion, digestion, and absorption of food. It includes the *alimentary canal and the accessory glands.*

The Alimentary Canal:

Is a long continuous tube that extends from the mouth to the anus. It includes: the *mouth, parts of the pharynx, the esophagus, the stomach, the small intestine, and the large intestine*. The Gastrointestinal Tract (GIT) includes the stomach and intestines only.

The Accessory Glands

These produce various secretions that help in the chemical breakdown of food. They include the *salivary glands, the liver, and pancreas.* Food, however, does not pass through them.

Functions:

1. Ingestions: taking food into mouth.
2. Secretion: release of enzymes and other substances.
3. Mixing and propulsion of food.
4. Digestion: mechanical and chemical breakdown of food.
5. Absorption of nutrients
6. Elimination of waste.

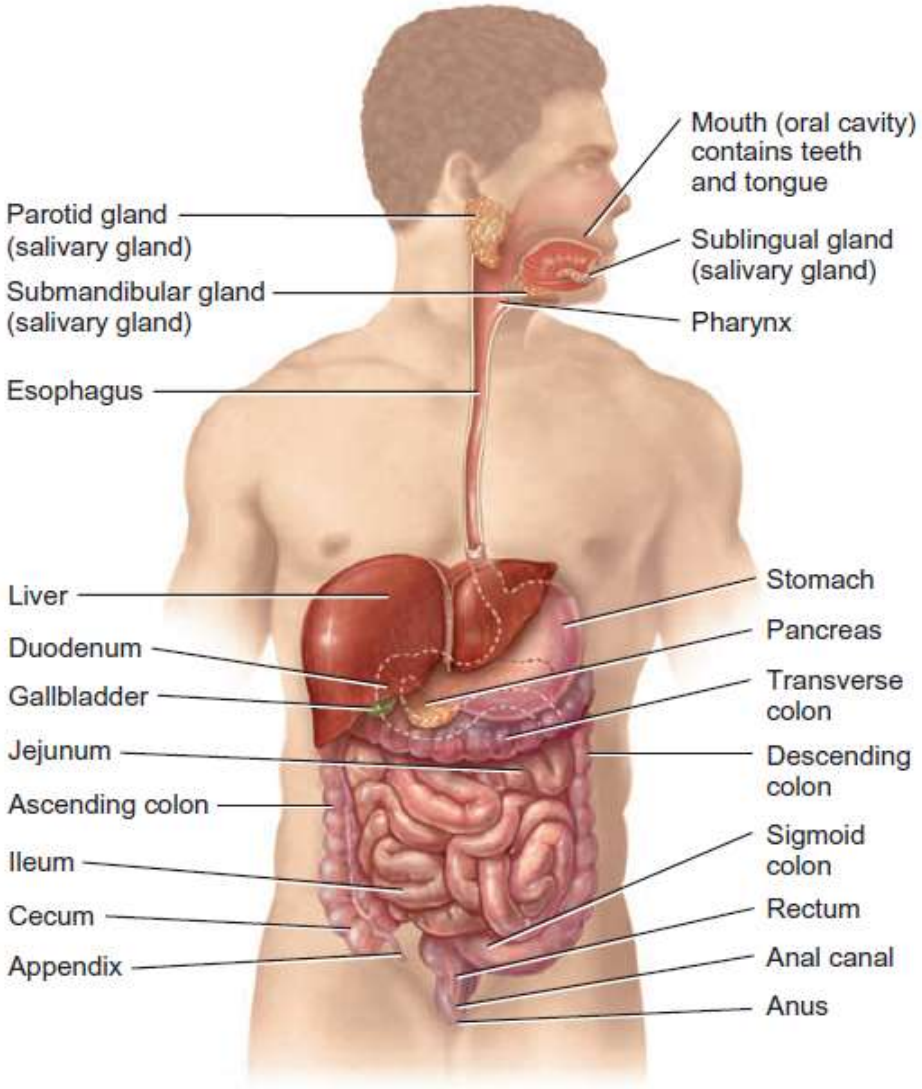


Fig.1: Organs of the digestive system.

Wall of the Gastrointestinal Tract

- Wall of the alimentary canal has a general layout.

1. **Mucosa** – inner lining formed of epithelium and connective tissue (lamina propria). Separated from the submucosa by a layer of smooth muscles (muscularis mucosae).
2. **Submucosa** – Connective tissue layer. Contains the submucosal plexus of nerves.

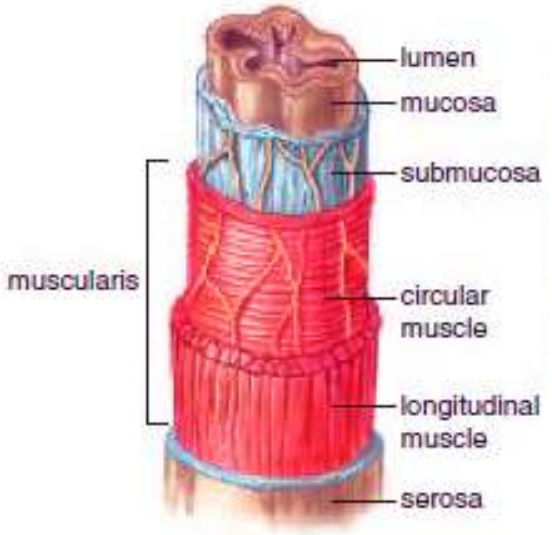


Fig.2: General layout of the wall of the alimentary canal.

3. **Muscularis** – A muscular layer (voluntary or involuntary). Formed of an outer longitudinal and an inner circular layers between which we have the myenteric plexus of nerves.
4. **Serosa/Adventitia** – Intraperitoneal organs are covered by serosa (visceral peritoneum). Retroperitoneal organs are covered by connective tissue adventitia.

The Abdominal Cavity

- Borders:

1. **Anterior**: The anterior abdominal wall.
2. **Posterior**: Posterior abdominal wall.
3. **Superior**: The diaphragm.
4. **Inferior**: The pelvic brim.

- Below the pelvic brim the cavity is called the **pelvic cavity.** The abdominal and pelvic cavities are continuous with each and together form the abdominopelvic cavity.

Body cavities:

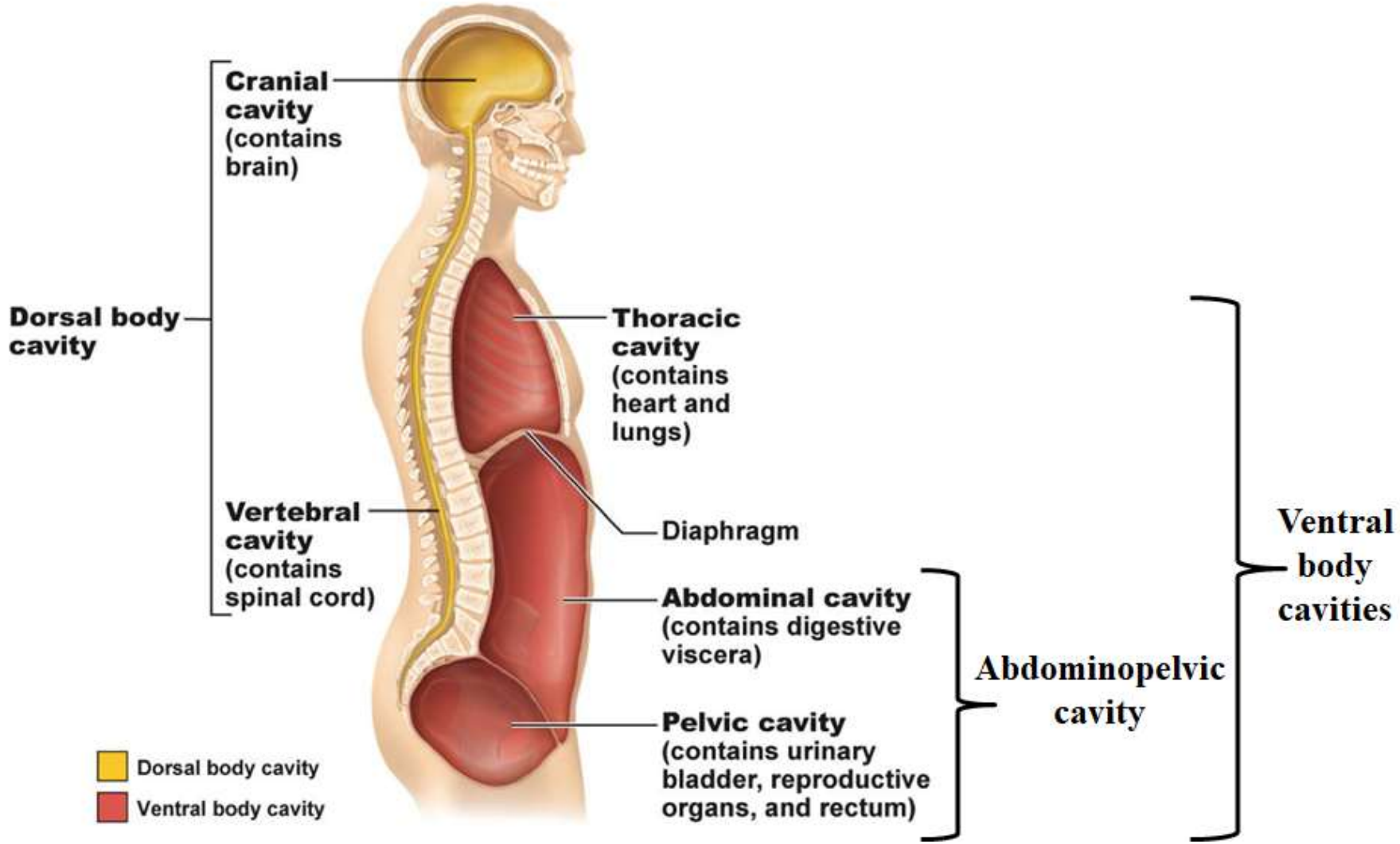


Fig.3: Lateral view of the body showing body cavities.

Peritoneum

- Largest serous membrane of the body.
- Divided into:
  - Parietal peritoneum – lines wall of cavity.
  - Visceral peritoneum – covers some organs (= Serosa).
  - Space between is called the peritoneal cavity and contains the peritoneal fluid.
- Peritoneal folds:
  - Two layers of peritoneum connecting organs to each other and to the anterior and posterior abdominal walls.
  - Examples: greater omentum, lesser omentum, and mesentery.
  - The space between the two walls of the greater omentum is called the lesser sac (located behind the stomach). The rest of the peritoneal cavity is called the greater sac.

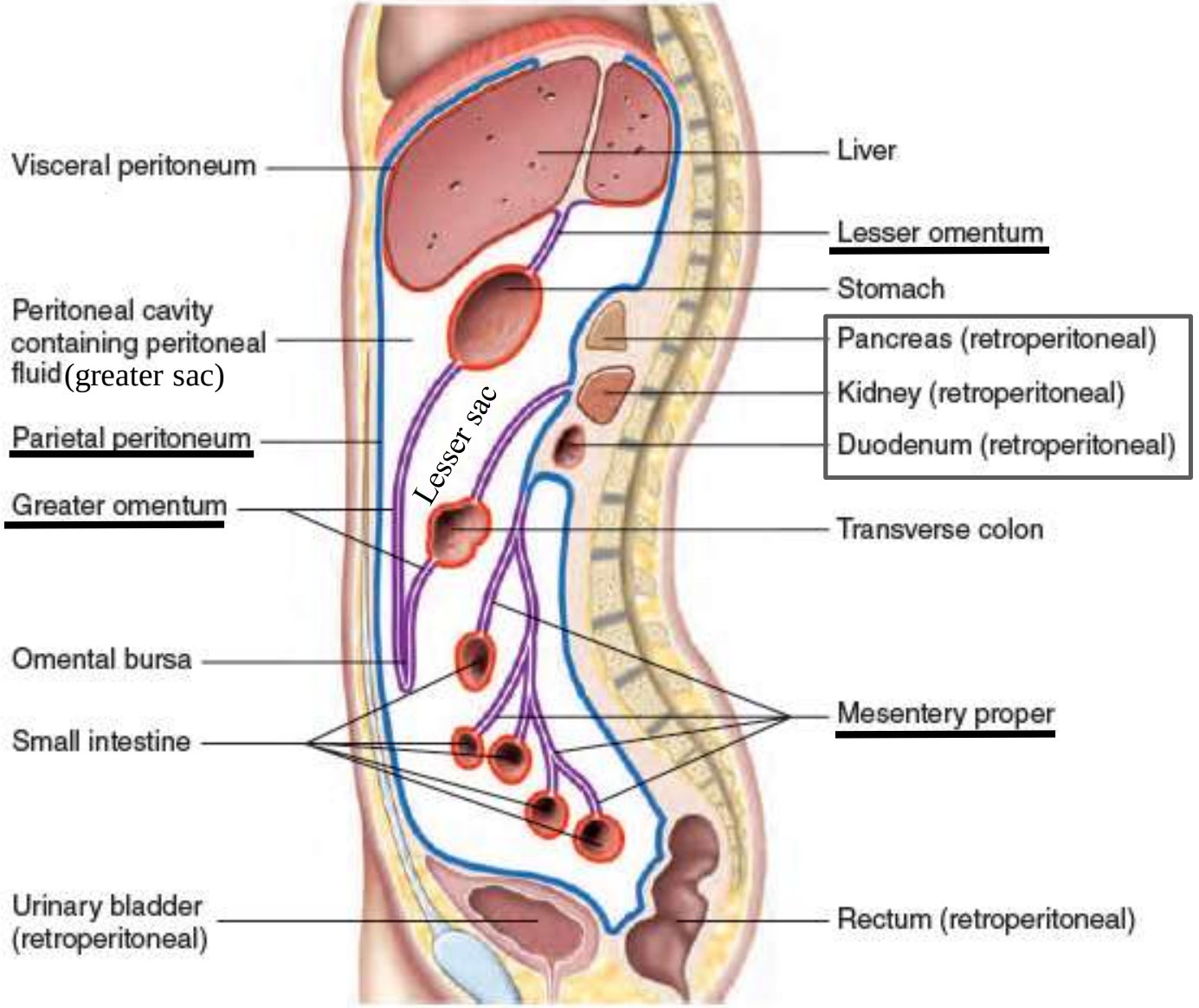


Fig.4: The peritoneum and its folds.

The Mouth (Oral/Buccal Cavity)

- **Bordered** by the cheeks, lips, hard and soft palates, and the tongue.
- ***Vestibule of the mouth*** is the space between the cheeks and lips externally and the gum and teeth internally.
- ***Oral cavity proper*** is the space that extends from the gums and teeth to the fauces.
- ***The cheeks and lips help keep the food in the mouth.***

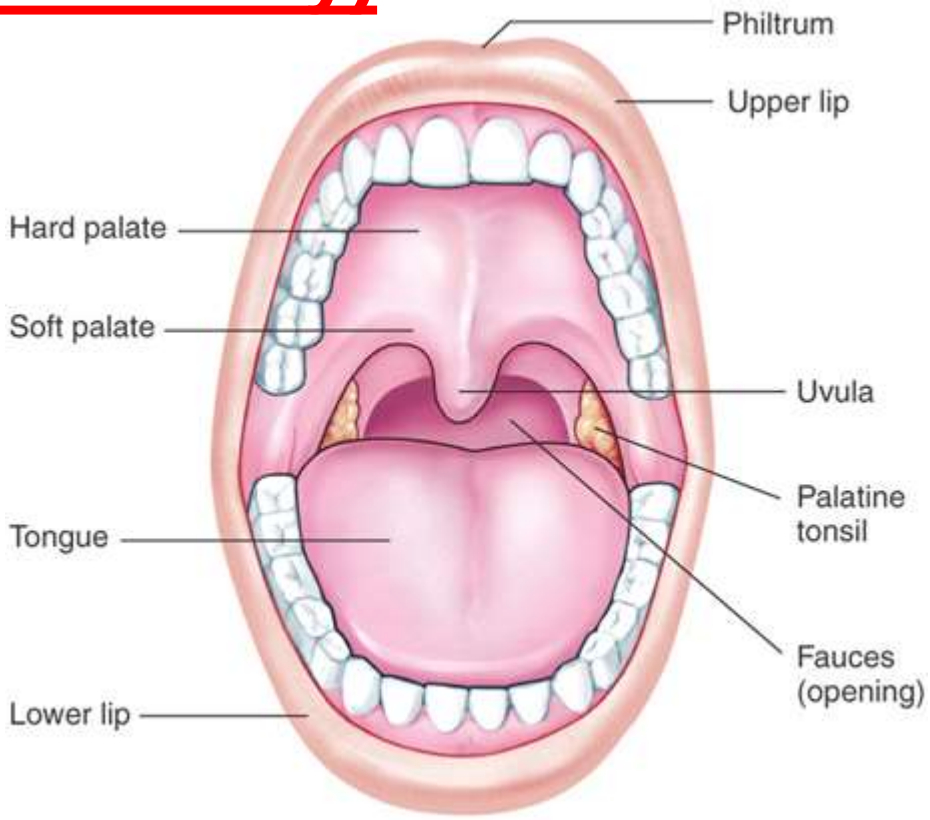


Fig.5: The mouth and its borders.

- The mouth contains the tongue, the teeth and gums and into it open the ducts of salivary glands.

The Tongue

- Skeletal muscles covered by mucous membrane.
- ***Maneuvers food for chewing and forces food back for swallowing.***
- Contains ***Lingual glands*** which ***secrete lipase.***
- Dorsal surface has 3 types of projections called lingual papillae: ***Filiform, Fungiform***, and ***Vallate***. The vallate type is the least numerous but it's the largest and contains most of the taste buds (for the ***sense of taste***). Fungiform papillae also has taste buds. Filiform papillae has no taste buds but assist in moving food around the mouth.

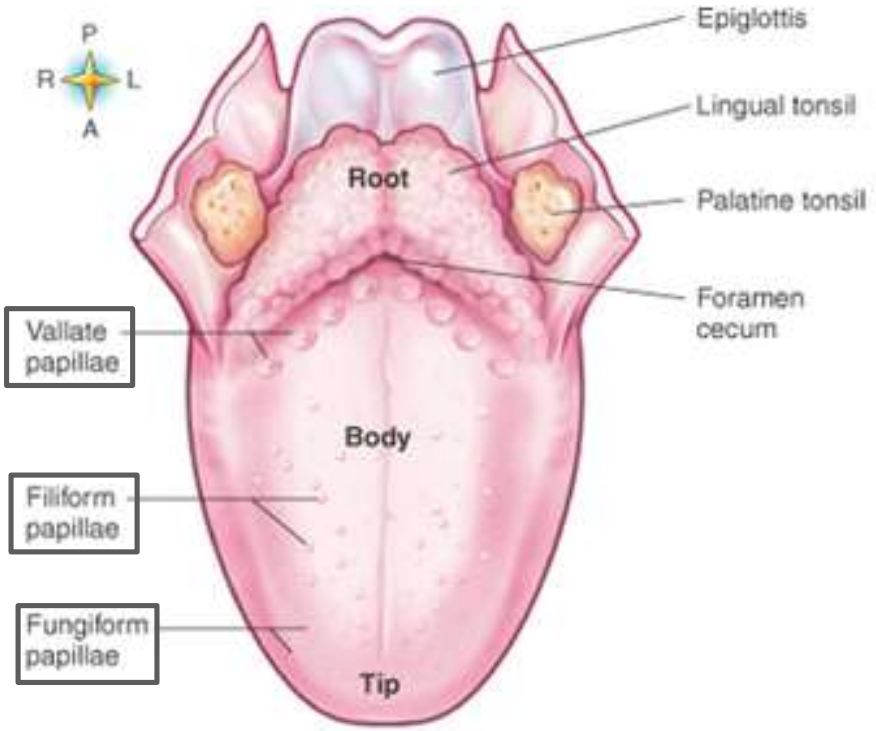
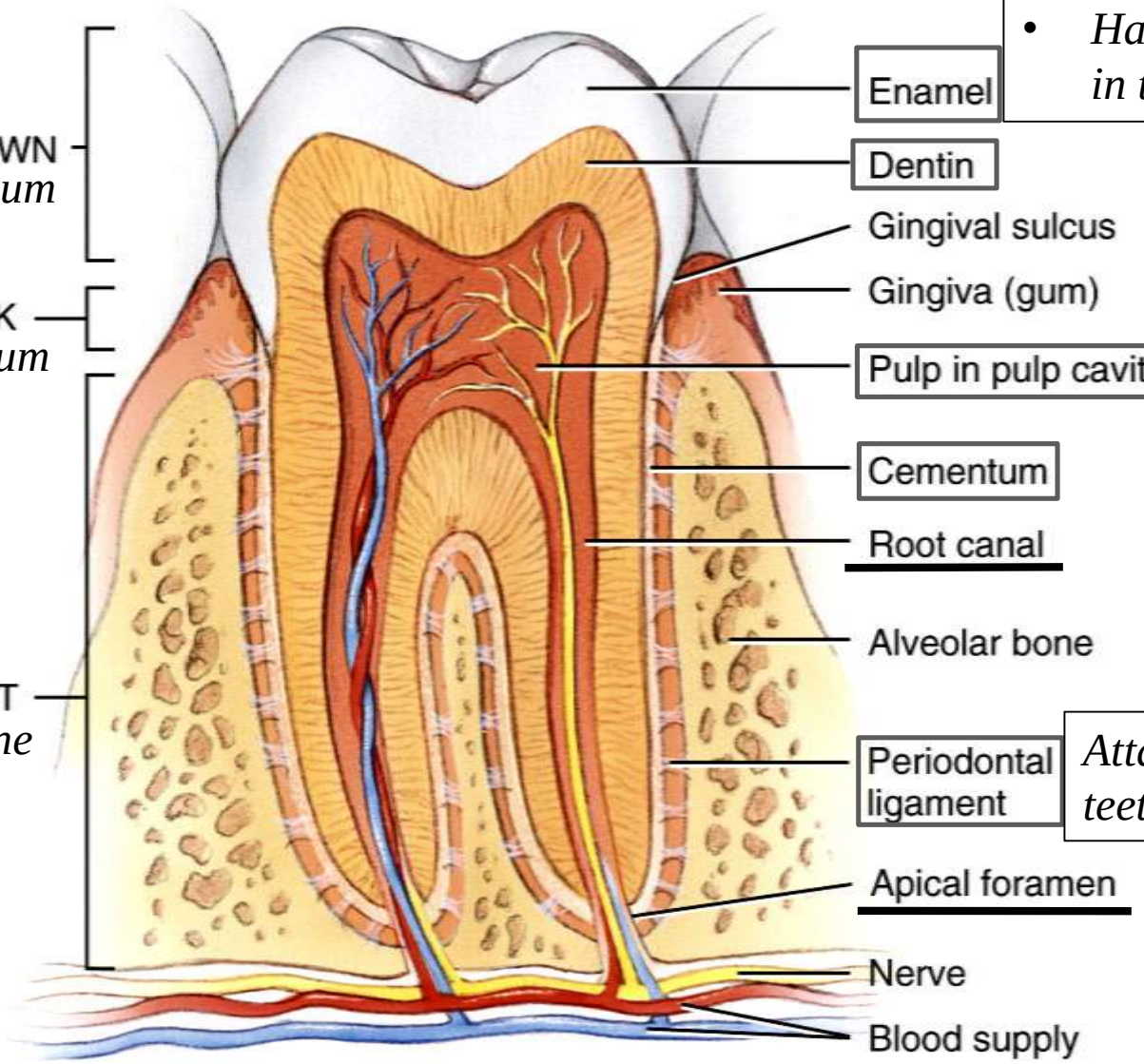


Fig.6: The tongue.

The Teeth: (Fig.7*)

- *Covers Dentin of crown*
- *Hardest substance in the body*



Blood and lymphatic vessels and nerves

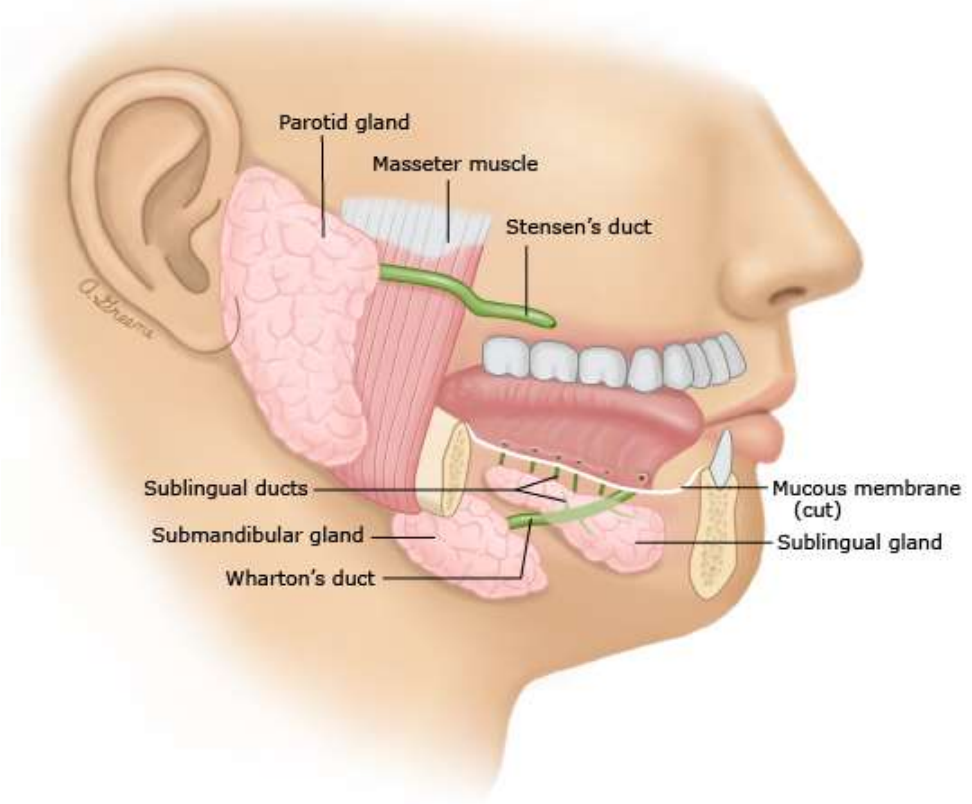
Attaches root of teeth to bone

Function: break down food into smaller particles (mastication)

The Salivary Glands

Fig.8: The major salivary glands.

- Salivary glands release saliva into the mouth:
  - Ordinarily, just enough is secreted to ***keep mouth and pharynx moist and clean.***
  - When food enters mouth, secretion increases to ***lubricate mouth, dissolve food, and begin chemical digestion.***



- There are 3 pairs of major salivary glands. The ducts of these glands into the mouth.

1. **Parotid**: The largest. Located anterior and inferior to the ear.
2. **Submandibular**: Located near the angle of the mandible.
3. **Sublingual**: Located under the tongue.

The Esophagus

- A long muscular tube
- Course:
  - **Begins** in the neck at the level of **C6** vertebra.
  - Runs down posterior to the trachea.
  - Enters the superior mediastinum and then passes into the posterior mediastinum where it runs anterior to the vertebral column and posterior to the heart.
  - Passes through the **esophageal hiatus** of the diaphragm (**T10 vertebra**) to enter the abdomen.
  - Enters the stomach at the cardia.

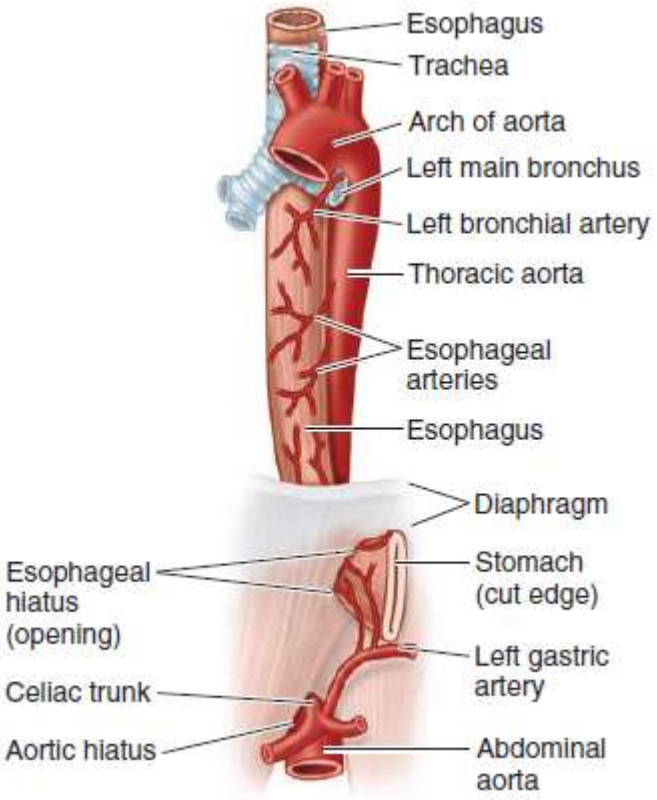


Fig.9: Course of the esophagus in the thorax.

- The muscularis layer of the wall of the esophagus is formed of:
  - Upper part – Skeletal muscles
  - Middle part – Skeletal and smooth muscles
  - Lower part – Smooth muscles
- ***The esophagus is a passageway for the food from the pharynx to the stomach and it, thus, plays a part in deglutition***
  - To facilitate this, the esophagus secretes some mucous. And it pushes food down by a series of muscle contractions and relaxations called **peristalsis.**

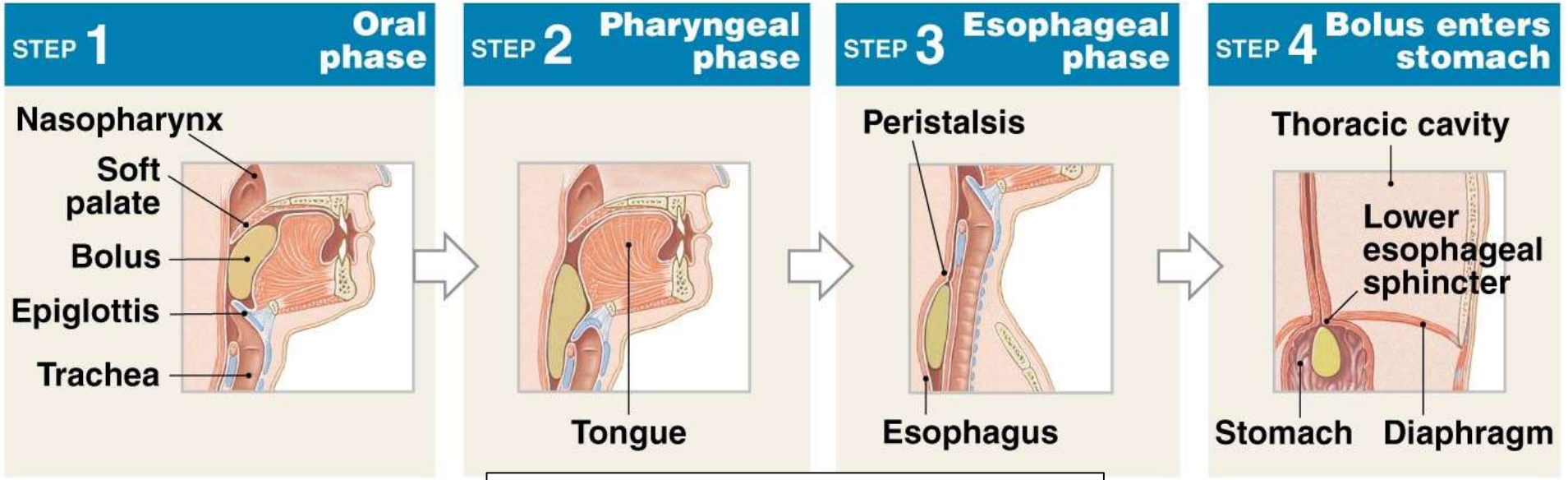


Fig.10: The process of swallowing.

The Stomach

- A J-shaped dilation of the alimentary tract located inferior to the diaphragm in the left hypochondriac and epigastric regions and even the umbilical region when it's distended.
- ***The stomach churns and breaks down food and it mixes the food with its digestive secretions converting it into the semisolid chyme. The stomach also acts as a reservoir for the food.***
- The wall of an empty stomach shows several folds called ***rugae***. These increase surface area.
- Mucosa – gastric glands:
  - 3 types of exocrine cells – mucous cells (mucus), parietal cells (HCl and intrinsic factor), and chief cells (pepsinogen and gastric lipase).
  - Endocrine cells – G cells – secrete gastrin.
- The muscularis of the stomach is formed of 3 layers.

Anatomy of the stomach

- The stomach can be divided into 4 regions:

1) The **Cardia** – the part that surrounds the opening of the esophagus.
2) The **Fundus** – Usually filled with gas.

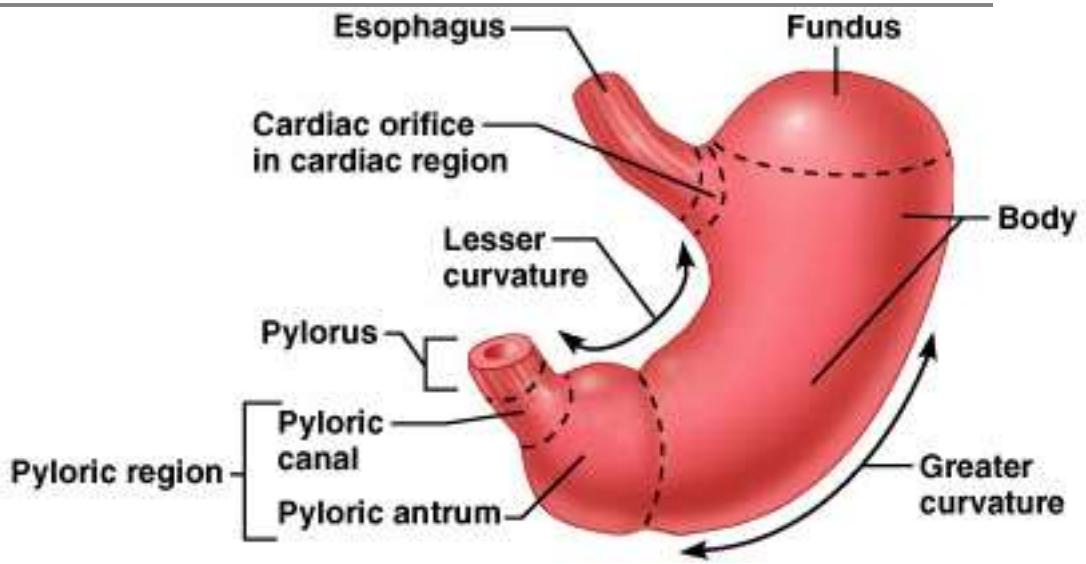


Fig.13: Anatomical features of the stomach.

3) The **Body** – The main part of the stomach.
4) The **Pyloric region** – The distal part of the stomach. Ends at the pylorus which opens into the duodenum and possesses the pyloric sphincter (a thickening in the muscularis layer).

- The longer left border of the stomach is called the **greater curvature**. The shorter right border is called the **lesser curvature.**
- At the junction between the esophagus and the stomach, there's an angle called the **cardiac angle.**

The Small Intestine

- It’s a long coiled tube formed of 3 parts – duodenum, jejunum, and ileum.
- ***Its function is the digestion of food particles delivered from the stomach and the subsequent absorption of nutrients.***

- Its wall is characterized by the presence of folds called the **plicae circulares.**
- The submucosa of the duodenum features numerous mucous glands. The submucosa of the ileum features numerous large lymphatic nodules called Payer's patches.

- The duodenum is a C-shaped tube connecting the stomach with jejunum.
  - The concavity of the C is directed to the left and is occupied by the head of the pancreas.
  - The duodenum receives the duct of the pancreas and the bile duct.

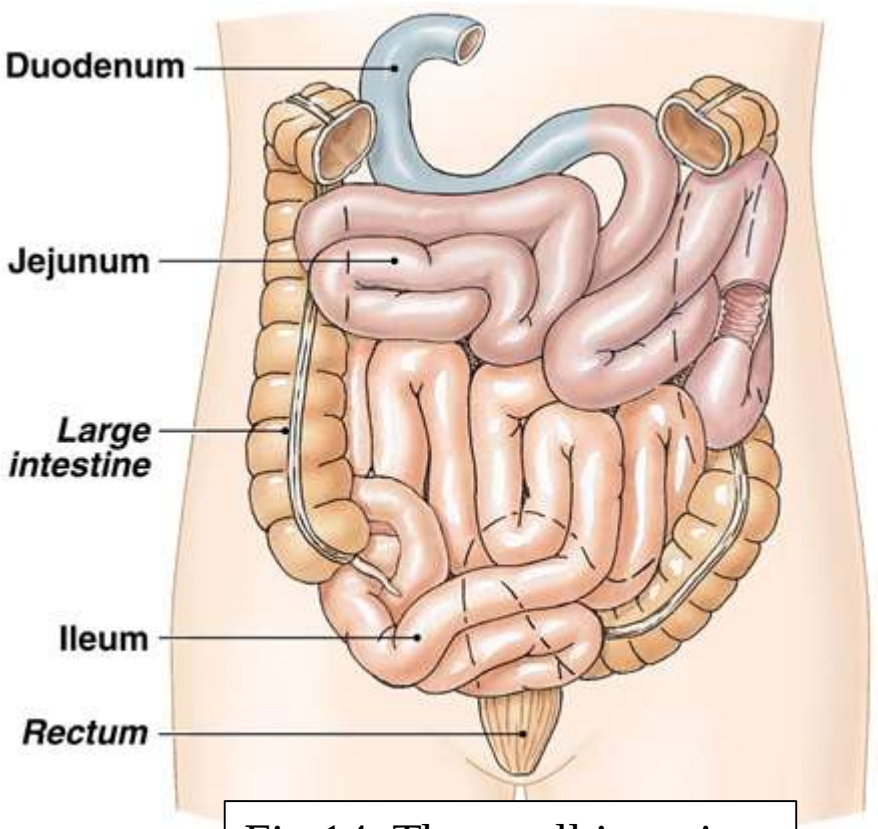


Fig.14: The small intestine.

- The jejunum is located mostly in the left upper quadrant of the abdomen. Most absorption takes place here.
- The ileum is located mostly in the right lower quadrant. It opens into the cecum. This opening is guarded by the ileocecal valve.

Features that increase the surface area of the small intestine:

- ***Circular folds (Plicae circulares)***
  - Permanent ridges of mucosa and submucosa.
  - Cause chyme to spiral, delaying its passage allowing more time for absorption.
- ***Villi***
  - Fingerlike projections of mucosa
  - Contains arteriole, venule, blood capillary, and lacteal (lymphatic).
- ***Microvilli***
  - Projections of apical membrane of absorptive cells.
  - Contains digestive enzymes.

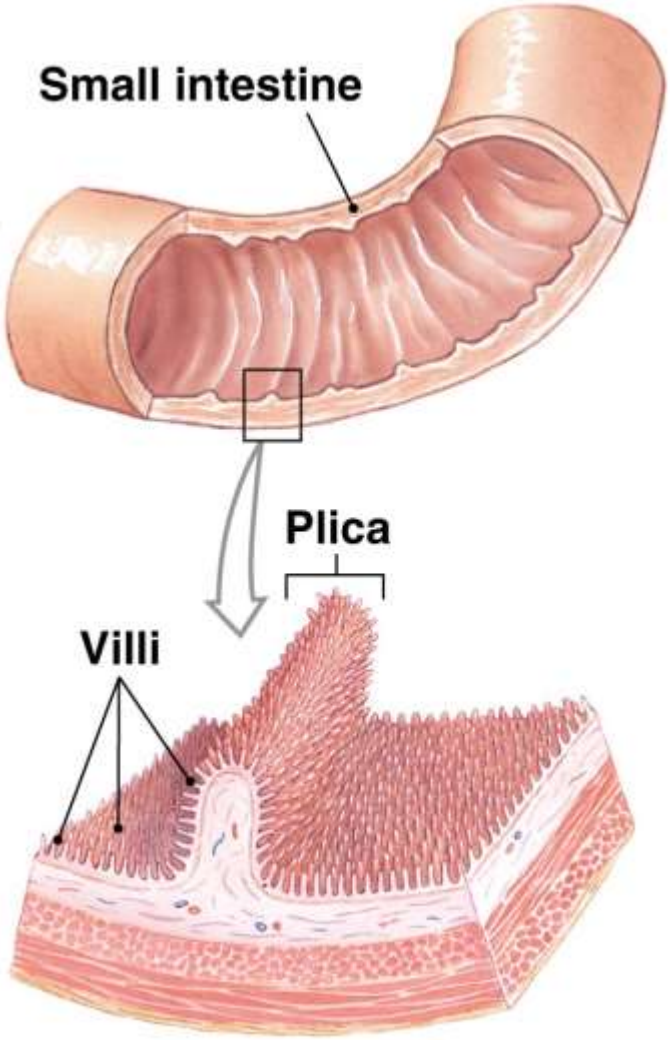


Fig.15: Plicae and villi.

The Large Intestine

- The terminal portion of the alimentary canal.
- ***Overall function is to complete absorption (mainly water), produce certain vitamins (Vitamin K produced by intestinal bacteria), and form and expel undigested food (feces).***
- The longitudinal muscle layer of the muscularis is arranged in bundles called **taenia coli**. Because of their tone, they form pouches in the large intestine called **haustra.**
- 4 major regions – cecum, colon, rectum, and anal canal.
- The **cecum** is a blind pouch. To it is attached a blind tube called the appendix. ***The appendix contains several lymphatic nodules and, thus, plays an immune role.***
- **Colon** divided into ascending, transverse, descending and sigmoid colon. The colon is the part in which the main function of the large intestine takes place.

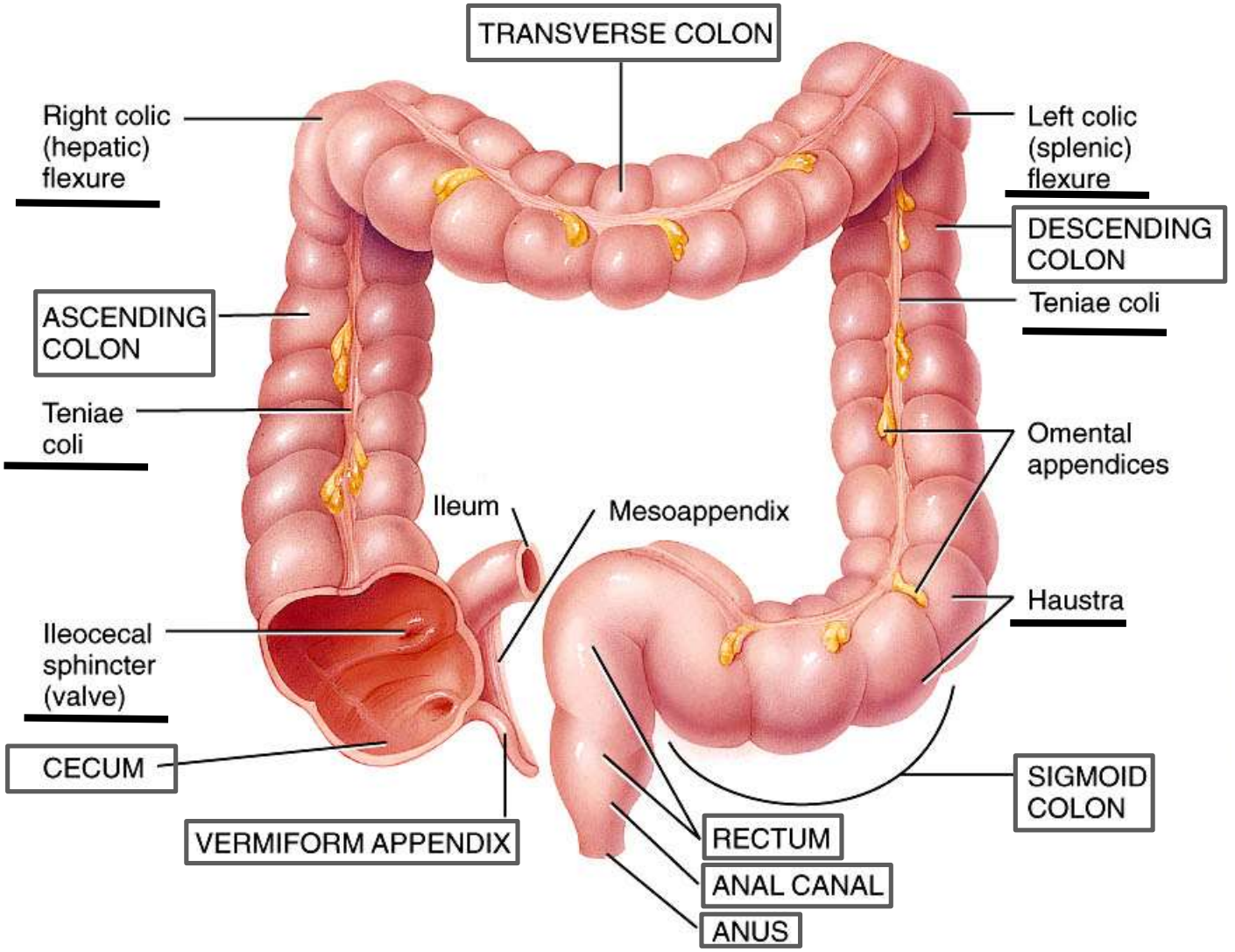


Fig.16: The large intestine.

- The **rectum** acts as a reservoir for the feces. It lies anterior to the sacrum and coccyx.

- The **anal canal** is characterized by the presence of longitudinal folds called the *anal columns*. The opening of anal canal (anus) is guarded by the *internal anal sphincter* of smooth muscle and the *external anal sphincter* of skeletal muscle.

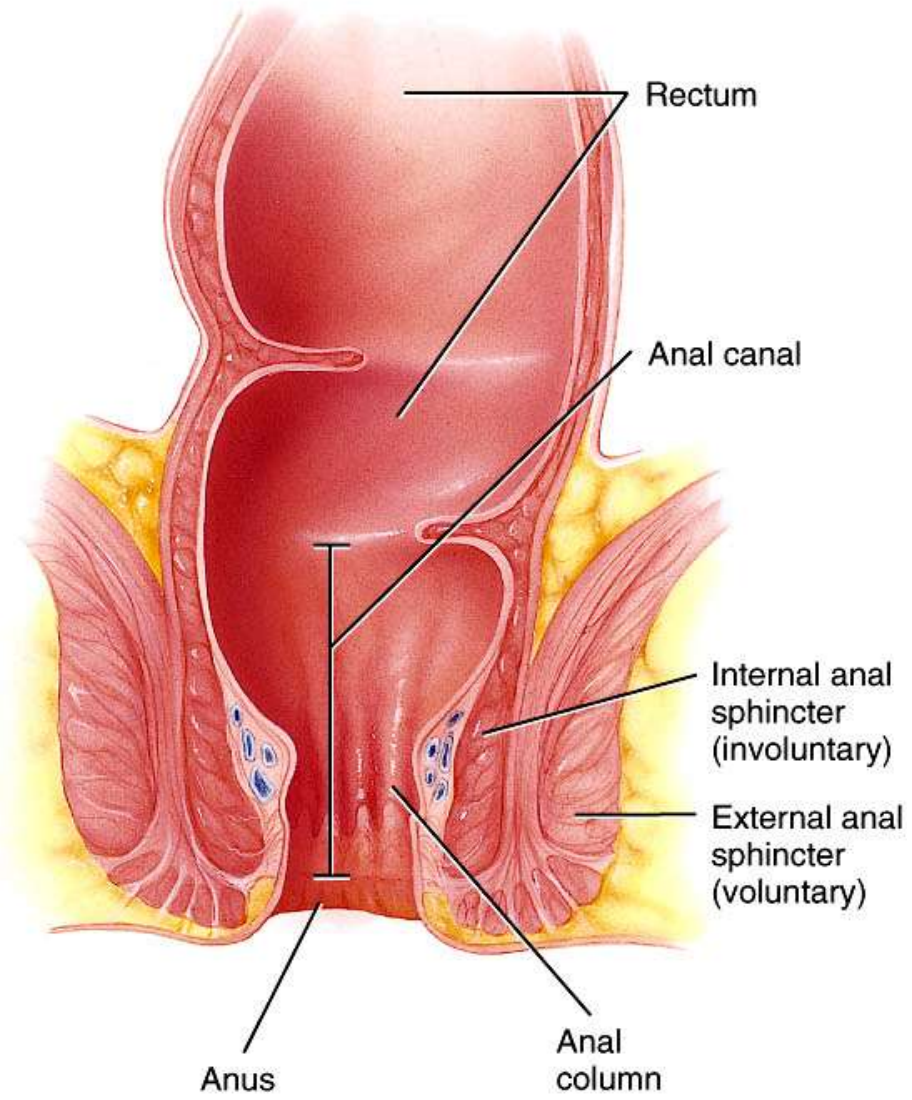


Fig.17: The anal canal.

The Liver and Gallbladder

- The liver is the largest internal organ and the heaviest gland in the body.
- It's located beneath the diaphragm in the right hypochondriac region and extends into the epigastric region.
- Anatomically, it's divided into right and left lobes. The right lobe also has the quadrate and caudate lobes.
- ***Functions of the liver:***
  1) ***Metabolism of carbohydrates, lipids and proteins.***
  2) ***Detoxification.***
  3) ***Synthesis of bile and proteins.***
  4) ***Storage of glycogen, vitamins and minerals.***
  5) ***Activation of vitamin D.***
  6) ***Phagocytosis of RBCs.***

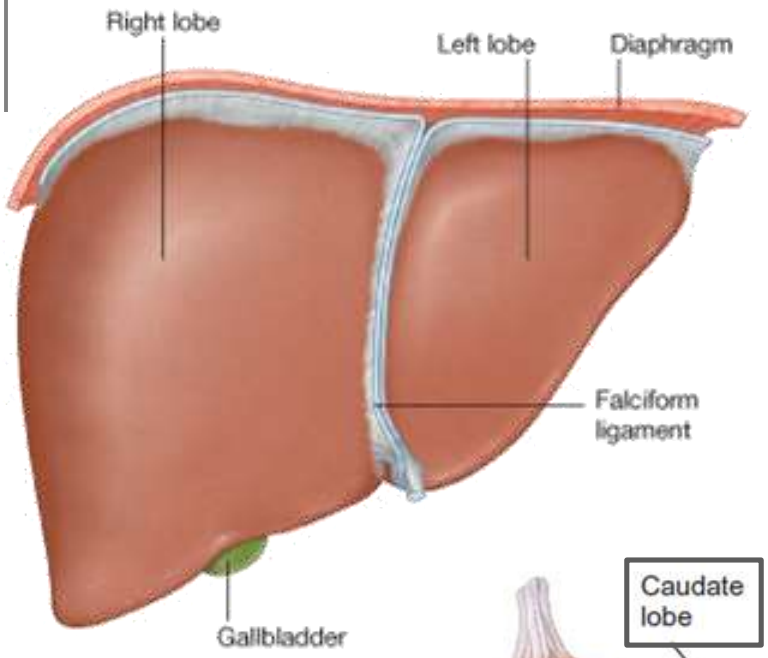
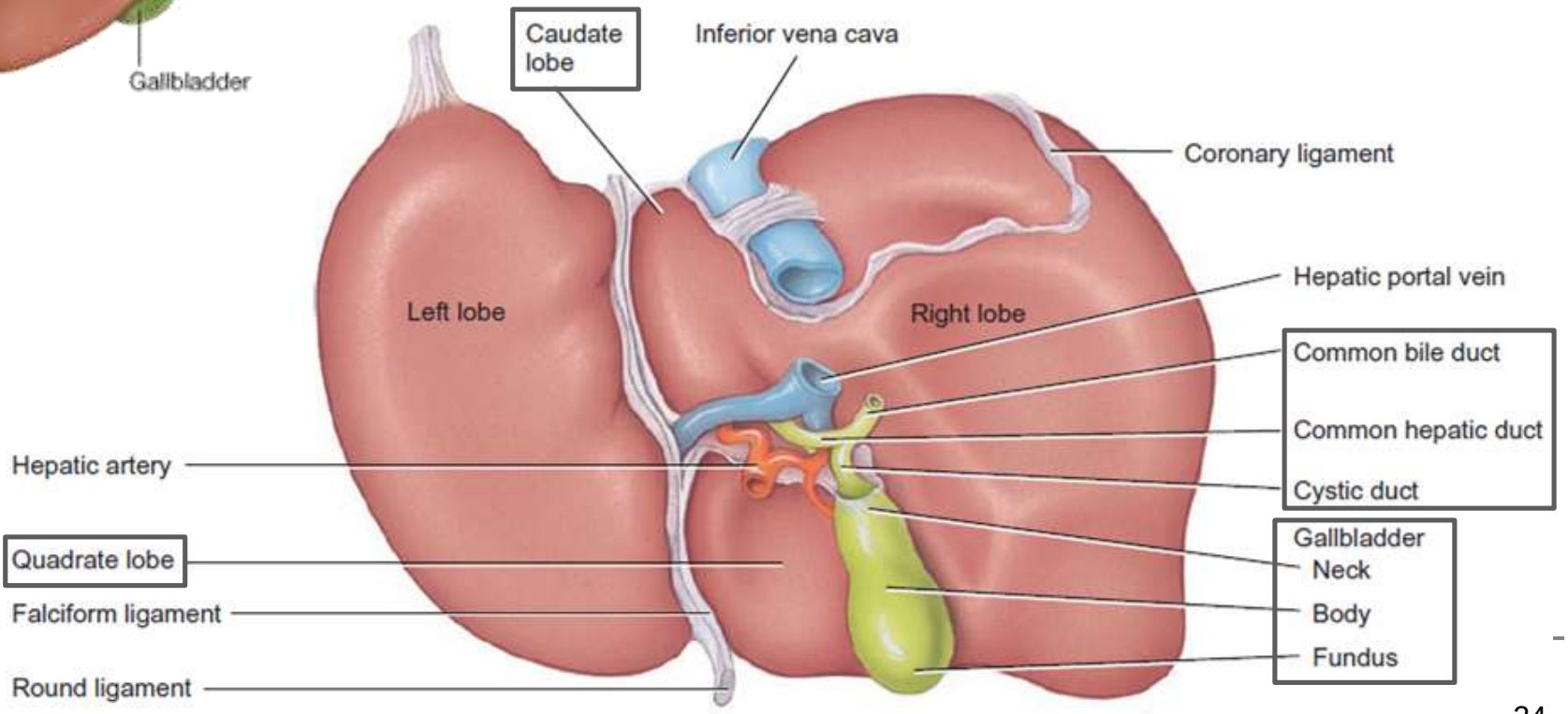


Fig.18: The liver.

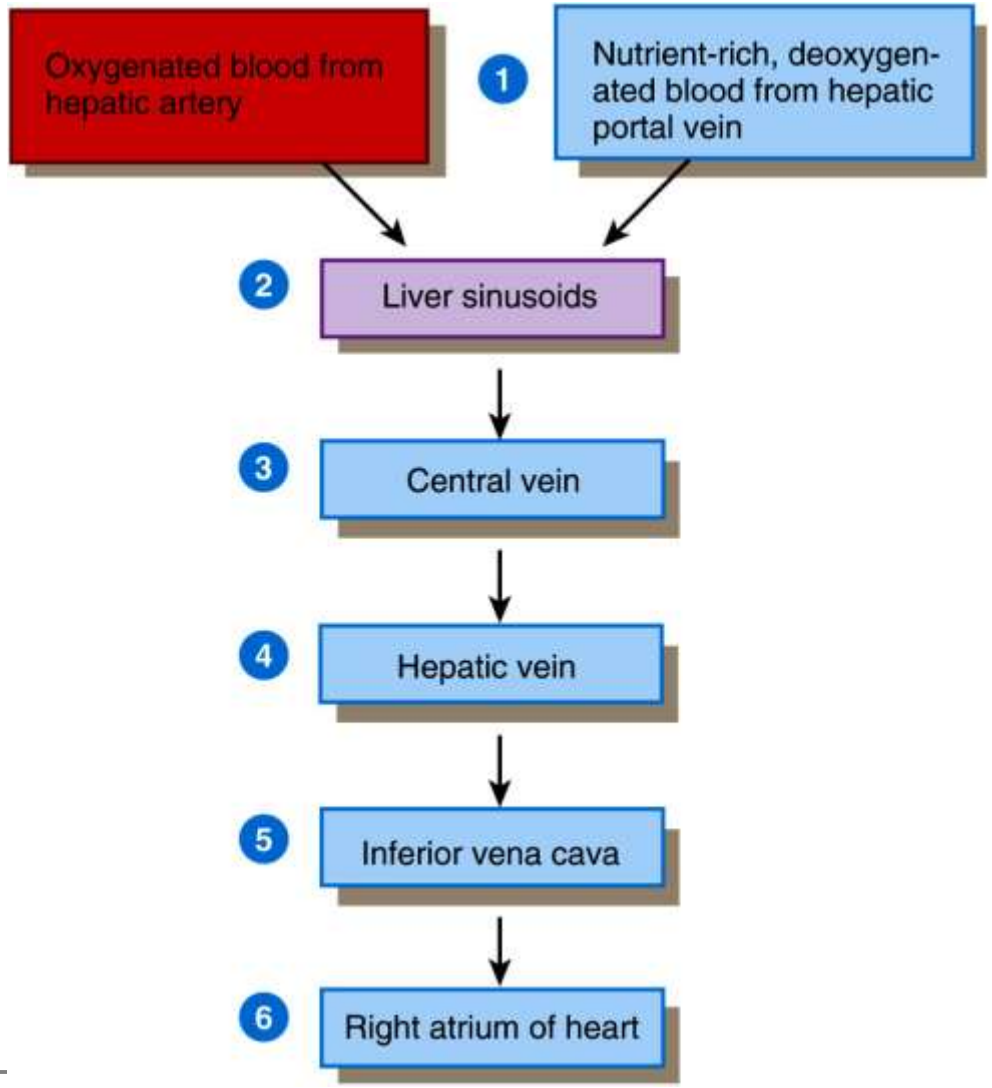
The caudate and quadrate lobes are anatomically part of the right lobe, but functionally part of the left



- Liver is composed of:
  - **Hepatocytes** – major functional cells of liver.
  - **Ito cells** (stores vitamin A) and **Kupffer cells** (phagocytosis).
  - **Bile canaliculi** – narrow spaces between hepatocytes that collect bile secreted from the hepatocytes. Canaliculi unite to form small bile ducts. Eventually bile leaves the liver through the right and left hepatic ducts. These unite to form the common hepatic duct
  - **Hepatic sinusoids** – highly permeable blood capillaries receiving oxygenated blood from hepatic artery and deoxygenated nutrient-rich blood from hepatic portal vein.
  - **portal triad** composed of: bile duct, branch of the hepatic artery and a branch of the portal vein.

Blood flow through the liver

- Liver receives blood from:
  a) Hepatic artery carrying oxygenated blood.
  b) Hepatic portal vein carrying deoxygenated blood with newly absorbed nutrients and possibly drugs, microbes or toxins from the alimentary tract.



The Gallbladder

- The gallbladder is a pear-shaped organ situated on the under surface of the liver.
- It's composed of 3 parts: a large fundus which protrudes from the anterior margin of the liver, a body, and a narrow neck (the last two are located under the liver). The neck opens into the cystic duct. The cystic duct joins the common hepatic duct to form the common bile duct.
- ***Function: storage and concentration of bile and the release of bile into the small intestine when needed.***

PATH OF BILE FLOW FROM THE LIVER INTO THE DUODENUM

Hepatocytes → Bile capillaries → Small bile ducts → Right and left hepatic ducts →

Common hepatic duct → Common bile duct (or cystic duct for storage in gallbladder) →

Hepatopancreatic ampulla (ampulla of Vater)

The Pancreas

- The pancreas is an elongated gland located posterior to the stomach. It has both exocrine and endocrine functions.
- It is formed of: head, neck, body, and tail.
- The ***head*** is the expanded right part of the pancreas. It's located in the concavity of the duodenum. The ***neck*** is a constricted region after the head. To its left, the ***body*** passes upwards and to the left. The ***tail*** is the left tapering end of the pancreas that's related to the spleen.
- Histology: 99% of cells are ***exocrine acini*** that secrete pancreatic juice (mixture of fluid and digestive enzymes). 1% of cells form the endocrine ***pancreatic islets*** (islets of Langerhans) that secrete hormones like glucagon, insulin and others.

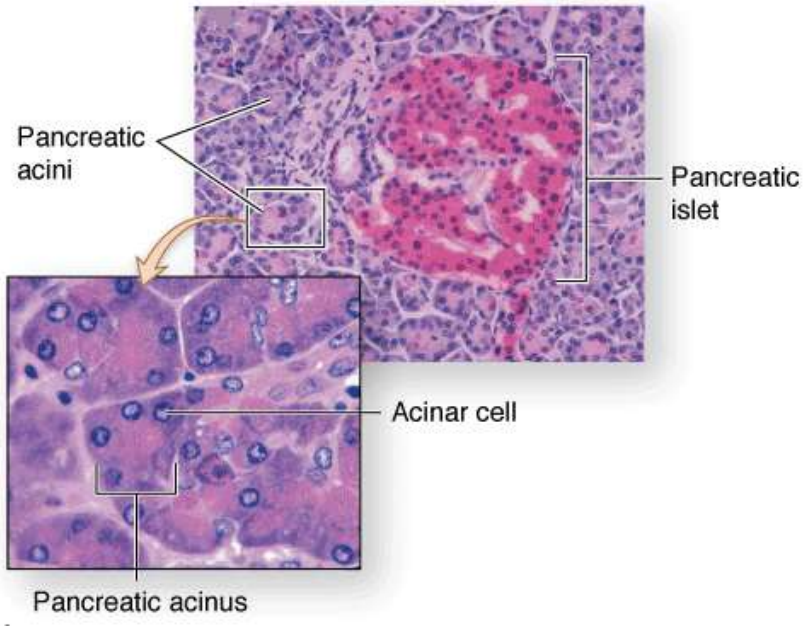


Fig.20: Histology of the pancreas.

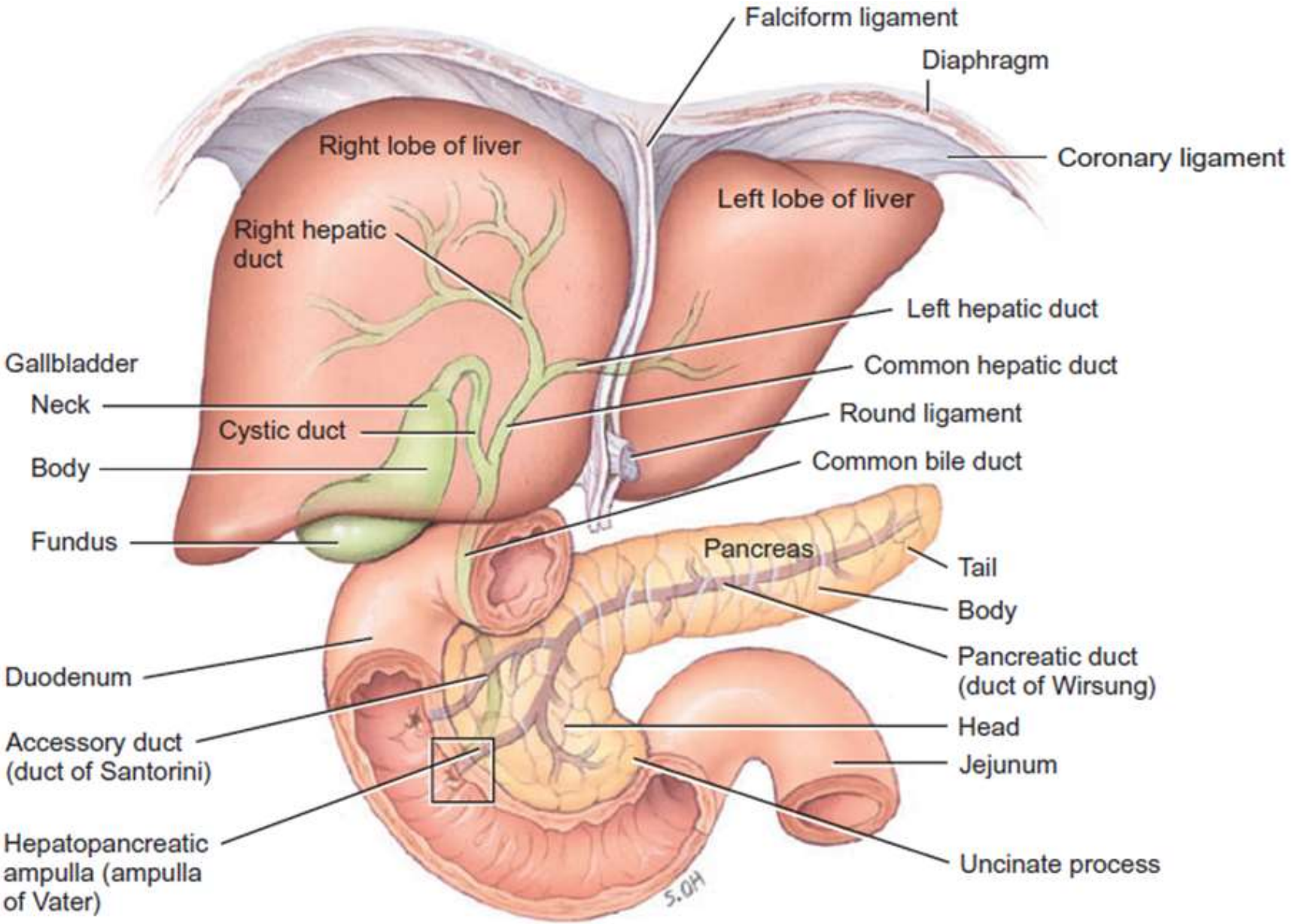


Fig.21: The pancreas.

- Pancreatic juice secreted into the main and accessory pancreatic ducts and then pass to the small intestine:
  - The ***main pancreatic duct*** joins the common bile duct to form the ***hepatopancreatic ampulla*** (of Vater). This opens into the duodenum at the ***major duodenal papilla*** which's guarded by the ***sphincter of Oddi***.
  - The ***accessory pancreatic duct*** opens into the ***minor duodenal papilla*** superior to the major duodenal papilla.

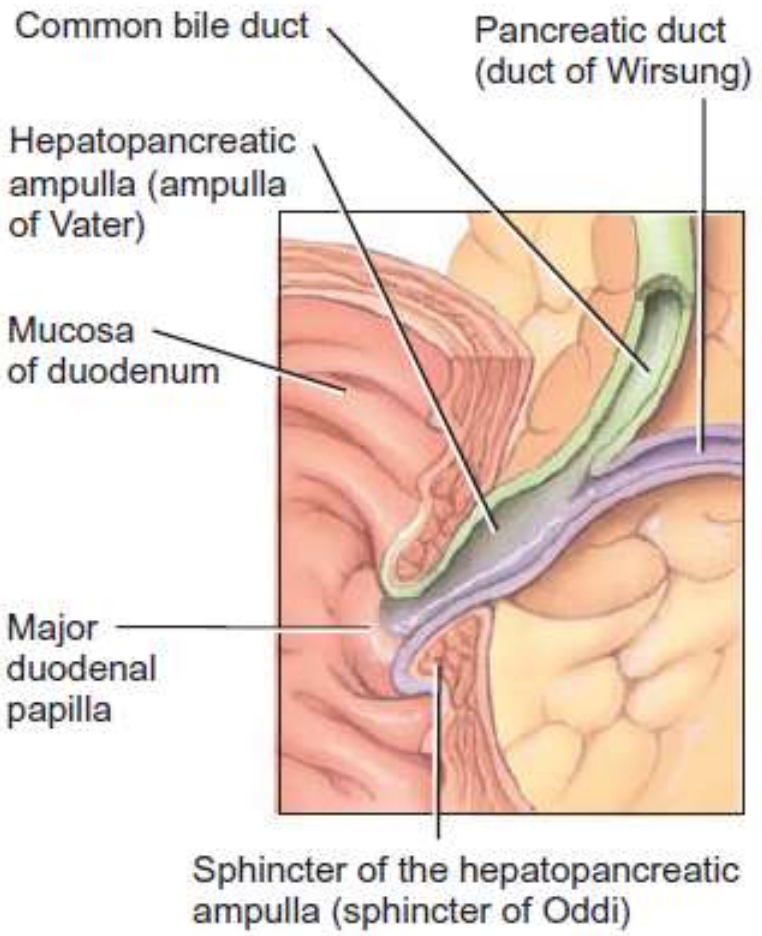


Fig.22: The hepatopancreatic ampulla.