

# **GPAT Online Class for B Pharm students**

## **Human Anatomy and Physiology part -1**

**(Digestive and Cardiovascular systems)**

**By**

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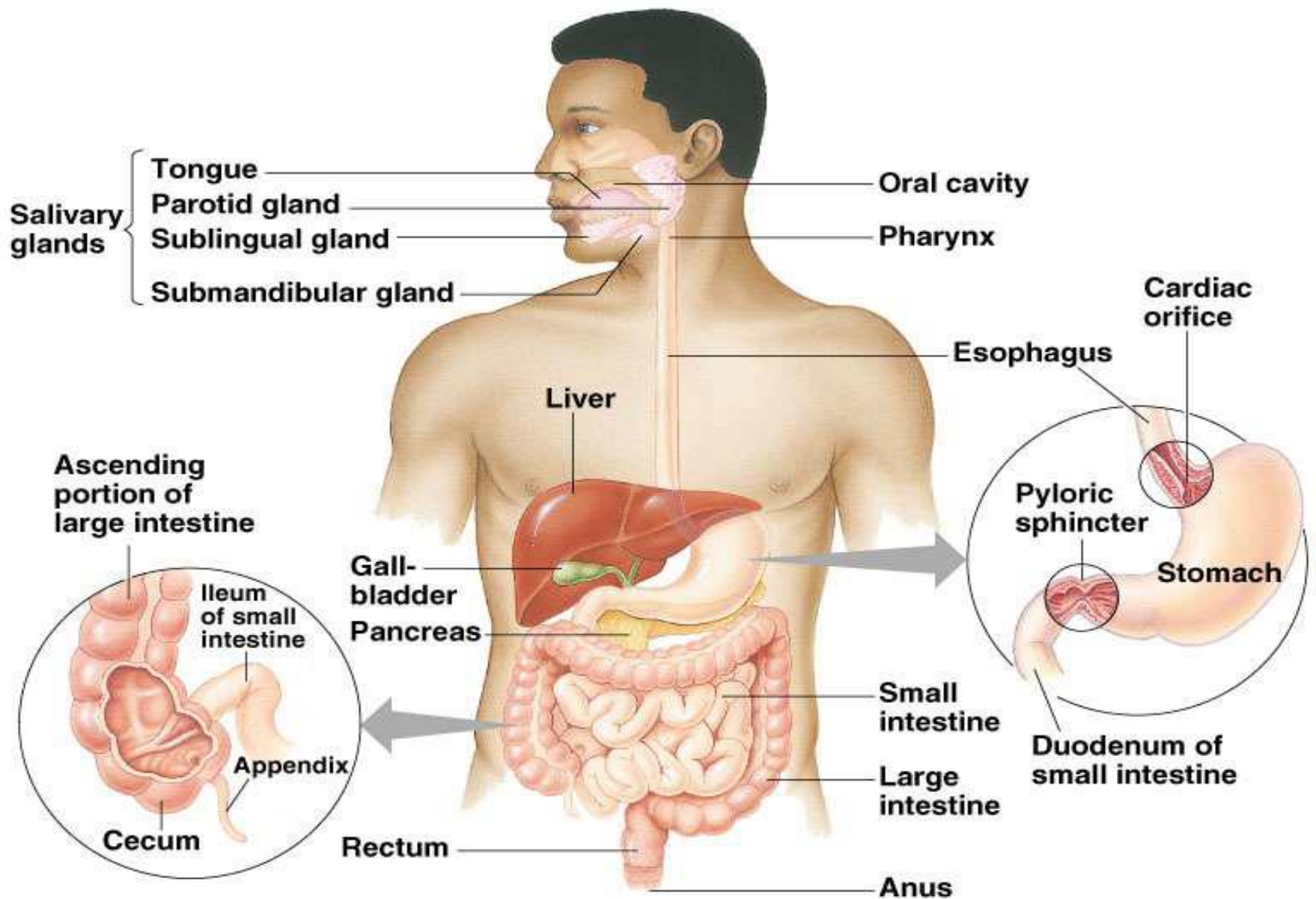
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- The **gastrointestinal tract (or alimentary canal)** is an **organ system within** humans and other animals which takes in food, digests, absorb nutrients, and expels the remaining waste as feces.
- **The major organs of the digestive system**  
Mouth, Pharynx, Esophagus, Stomach, Small Intestine, Large Intestine, Rectum.



## Accessory digestive organs

Liver, Gallbladder, Pancreas, Salivary gland.

## Functions of GI tract

- **Ingestion:** taking of food into the alimentary tract eating & drinking.
- **Propulsion:** mixes & moves the contents along the alimentary tract.
- **Digestion:**
  - Mechanical breakdown of food e.g. mastication (chewing)
  - Chemical digestion of food into small molecules by enzymes



**Absorption:** this is the process by which digested food substances pass through the walls some organs of the alimentary canal into the blood for circulation.

**Elimination:** food substances that have been eaten but cannot be digested & absorbed are excreted from the alimentary canal as faeces by the process of defaecation.



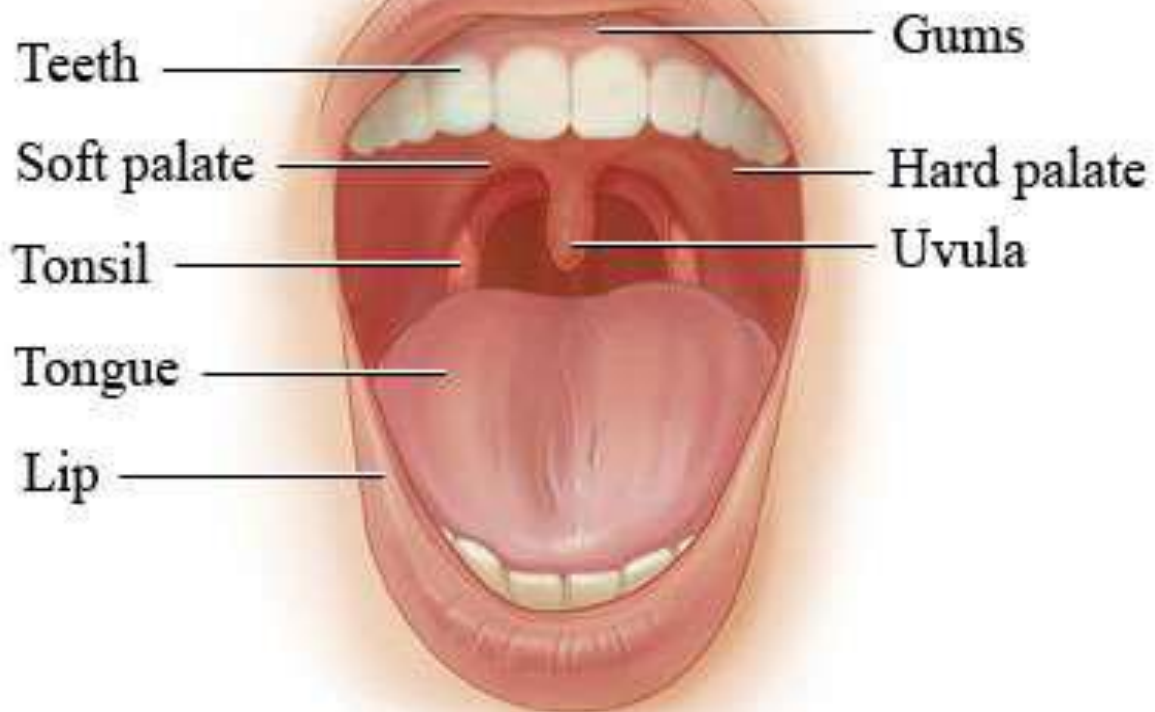
- **MOUTH**

- The mouth is the first portion of the alimentary canal that receives food and produces saliva.
- The oral mucosa is the **mucous membrane epithelium lining the inside of the** mouth.
- **Relations**
- **Anteriorly-lips**
- **Posteriorly-continue with the oropharynx**



- Laterally-muscles of cheeks
- Superiorly-bony hard palate
- Inferiorly-muscular tongue & the soft tissues of the floor of the mouth
- The palate forms the roof of the mouth & is divided into the **anterior hard palate & posterior soft** palate.
- The uvula is a curved fold of muscle covered with mucous membrane,hanging down from the middle.







## Tongue

- The **tongue is a muscular organ in the mouth**, that manipulates food for mastication, and is used in the act of swallowing (Deglutition).
- It is of importance in the digestive system and is the primary organ of taste in the gustatory system.
- The tongue's upper surface (dorsum) is covered by taste buds housed in numerous lingual papillae.
- The human tongue is divided into two parts, an oral part at the front and a pharyngeal part at the back.



- **BLOOD SUPPLY**

lingual artery

external carotid artery

- **VENOUS DRAINAGE**

lingual veins

internal jugular vein

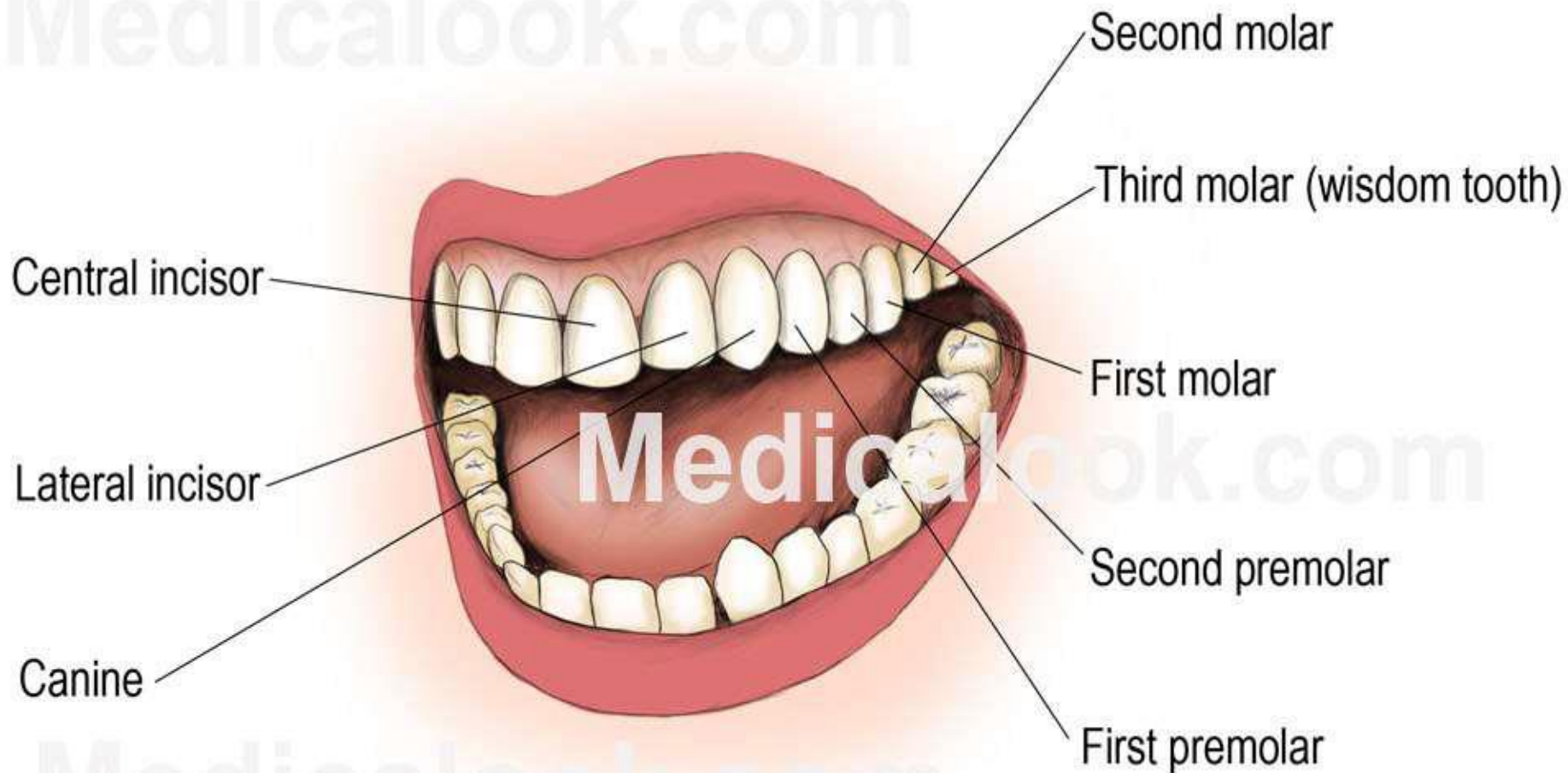
- **NERVE SUPPLY**

hypoglossal nerve

Taste and sensation: glossopharyngeal nerve



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## Primary teeth

- Among **deciduous (primary) teeth**, **ten are found in the maxilla (upper jaw) and ten in the mandible (lower jaw)**, for a total of 20. The dental formula for primary teeth is 2.1.0.2/2.1.0.2.

Start to come in (erupt) at about 6 months of age

- In the primary set of teeth, **two types of incisors – centrals and laterals, one canine & two types of molars – first and second.**
- All primary teeth are normally later replaced with their permanent counterparts.



## Permanent teeth

- Among permanent teeth, 16 are found in the maxilla and 16 in the mandible, for a total of 32. The dental formula is 2.1.2.3/2.1.2.3.
- Age 21, all 32 of the permanent **teeth have usually** erupted.

The permanent teeth are the

- **Two incisor (for cutting)-central incisor, lateral incisor**  
**One canine (for tearing), Two premolar(for crushing)-**  
**first premolar, second premolar**



- **Three molar (for grinding)-first molar, second molar, and third molar.**
- **PARTS**

## **ENAMEL**

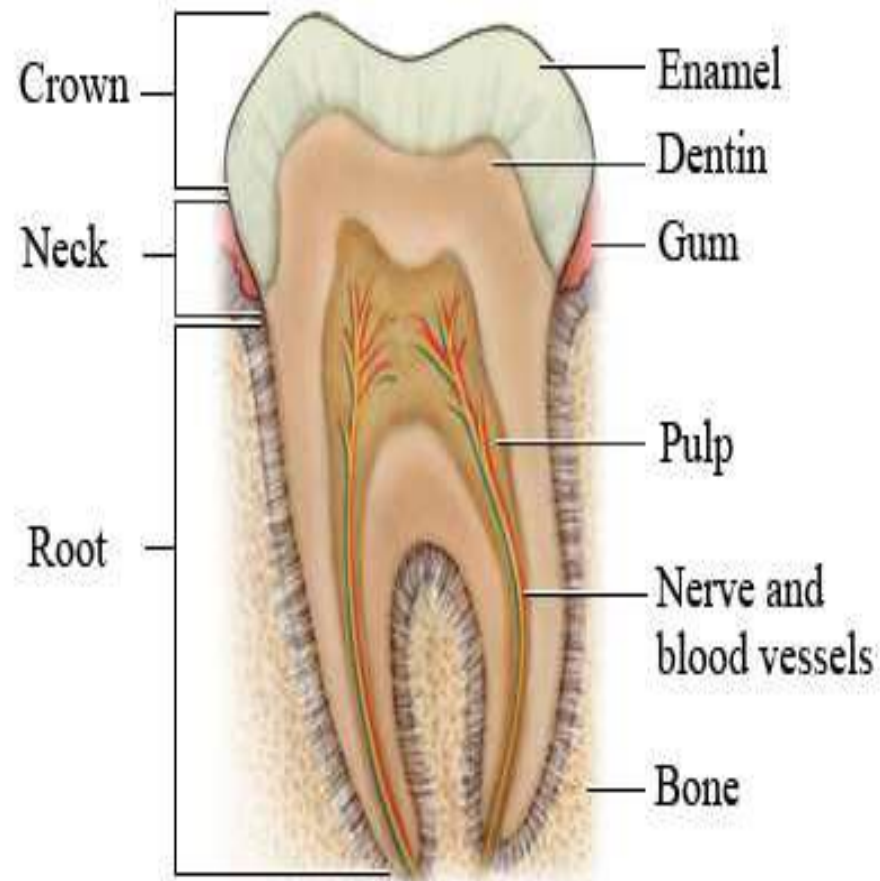
- Enamel is the **hardest** and most highly mineralized substance of the body.
- It is one of the four major tissues which make up the tooth, along with dentin, cementum, and dental pulp.
- 96% of enamel consists of **mineral**, with water and organic material comprising the rest.
- The normal color of enamel varies from light yellow to grayish white.



# DENTIN

- Dentin is the substance between enamel or cementum and the pulp chamber.
- The porous, yellow-hued material is made up of 70% inorganic materials, 20% organic materials, and 10% water by weight.
- Dentin is a **mineralized connective tissue** with an organic matrix of **collagenous proteins**.







## Cementum

- Cementum is a specialized bone like substance covering the root of a tooth.
- Its coloration is yellowish and it is softer than dentin and enamel.

## Dental pulp

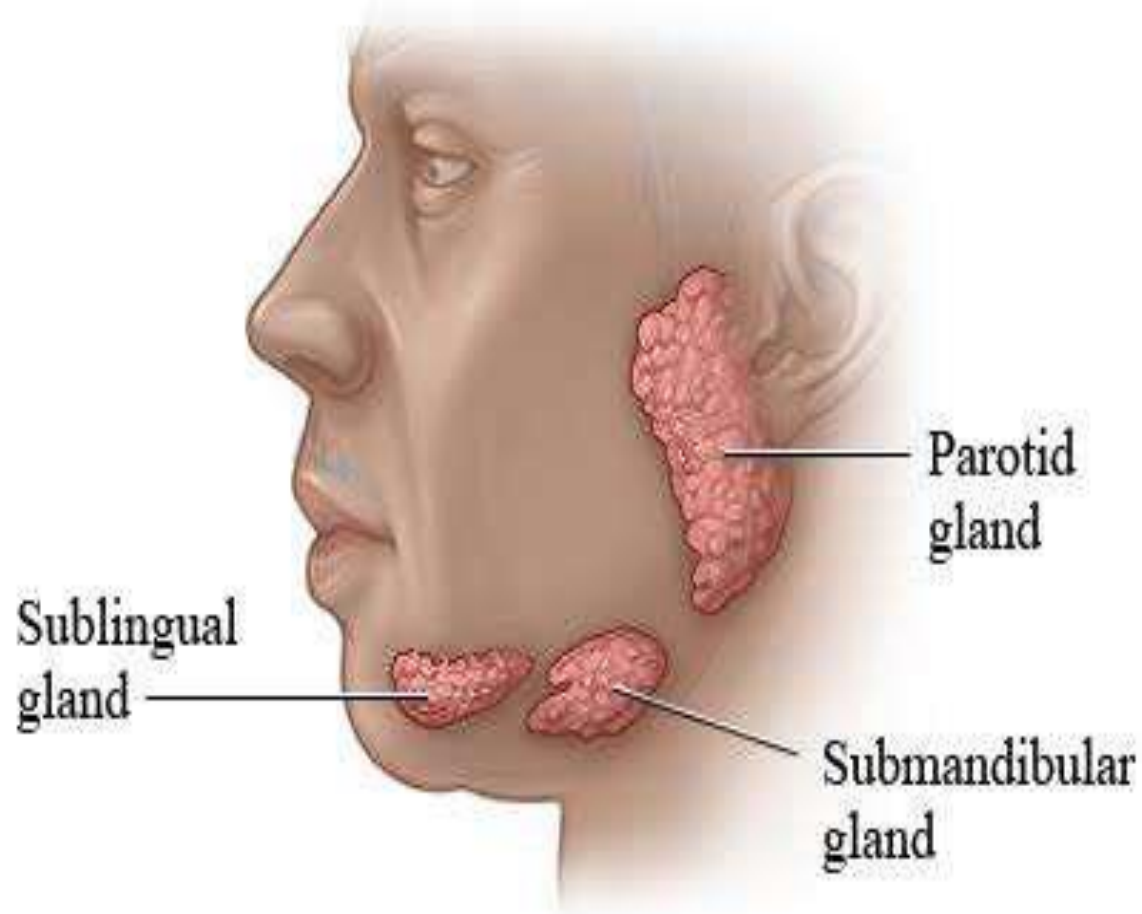
- The dental pulp is the central part of the tooth filled with soft connective tissue.
- This tissue contains blood vessels and nerves that enter the tooth from a hole at the apex of the root.



# SALIVARY GLANDS

- The **salivary glands** in are **exocrine glands** that produce saliva through a system of ducts.
- Humans have **3 paired major salivary glands**:  
Parotid, submandibular and Sublingual as well hundreds of minor salivary glands.
- **Parotid glands**
- The two parotid glands are major salivary glands wrapped around the mandibular ramus in humans.
- The largest of the salivary glands.





They secrete saliva to

- facilitate mastication and swallowing, and **amylase** to begin the digestion of **starches**.
- It enters the oral cavity via the parotid duct.
- **Submandibular glands**
- The submandibular glands are a pair of major salivary glands located beneath the lower jaws, superior to the digastric muscles.
- The secretion produced is a mixture of both **serous fluid and mucus, and enters the oral cavity** via the submandibular duct.



## Sublingual glands

- The sublingual glands are a pair of major salivary glands located inferior to the tongue, anterior to the submandibular glands.
- Approximately 5% of saliva entering the oral cavity comes from these glands.
- The secretion produced is mainly mucous in nature.
- **Minor salivary glands**
- There are 800 to 1,000 minor salivary glands located throughout the oral cavity within the submucosa of the oral mucosa in the tissue of the buccal and lingual mucosa



## **BLOOD SUPPLY**

External carotid artery

## **VENOUS DRAINAGE**

Jugular veins

## **COMPOSITION OF SALIVA**

About **1.5 litres of saliva is produced daily & it consists** of: Water, Mineral salts, An enzyme, Mucus, Lysozyme Immunoglobulins.



- **THE PHARYNX**

- The pharynx is the part of the throat that is behind the mouth and nasal cavity and above the esophagus and the larynx, or the tubes going down to the stomach and the lungs.
- The pharynx is the portion of the digestive tract that receives the food from your mouth.
- Branching off the pharynx is the esophagus, which carries food to the stomach.



## THE ESOPHAGUS

- The esophagus or oesophagus, commonly known as the food pipe or gullet, The esophagus is a muscular tube connecting the throat (pharynx) with the stomach.
- The esophagus runs behind the windpipe (trachea) and heart, and in front of the spine.





# **FUNCTIONS**

- **Formation of a bolus**
- **Swallowing**
- Food is ingested through the mouth and when swallowed passes first into the pharynx and then into the esophagus.
- **Reducing gastric reflux**
- Constriction of the upper and lower esophageal sphincters help to prevent reflux (backflow) of gastric contents and acid into the esophagus,
- Protecting the esophageal mucosa.



- **STOMACH**

- The stomach is a muscular organ located on the left side of the upper abdomen. The stomach receives food from the esophagus.
- As food reaches the end of the esophagus, it enters the stomach through a muscular valve called the **lower esophageal sphincter**.



## GI structure

### **Mucosa (lumen side)**

Epithelial tissue

### **Submucosa**

elastic connective tissue contains lymph and blood  
Vessels

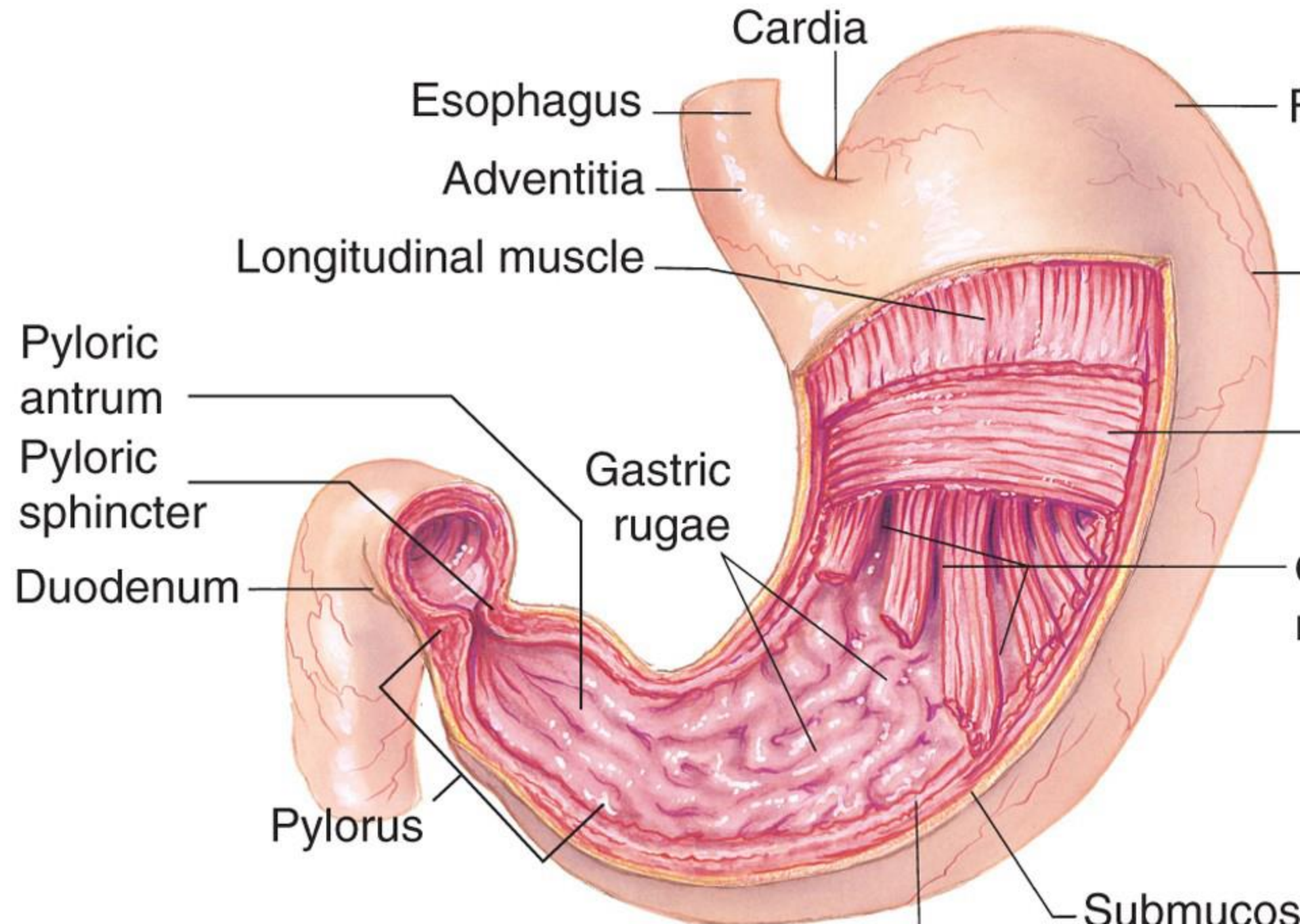
### **Muscularis externa**

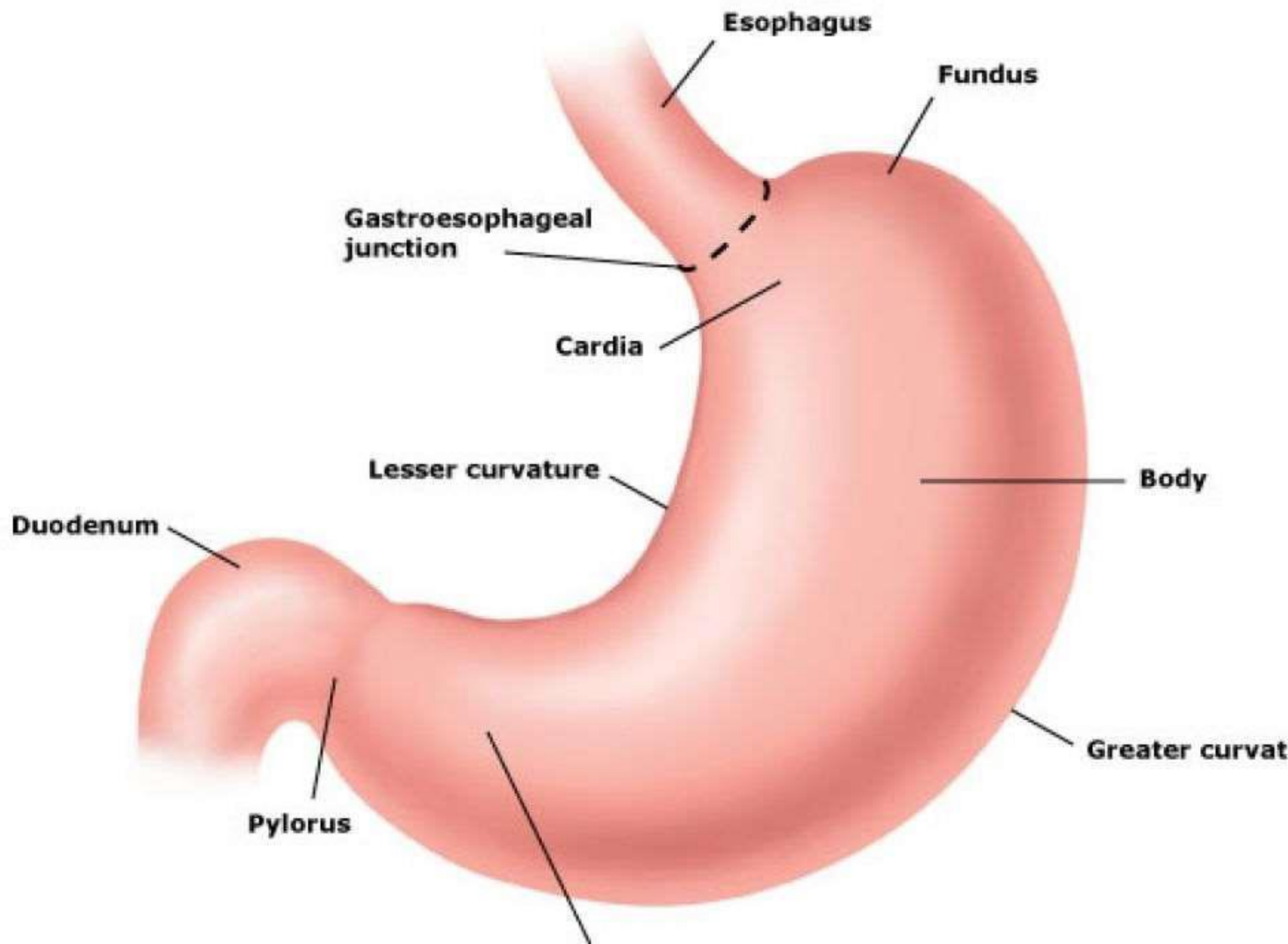
smooth muscle layers

### **Serosa**

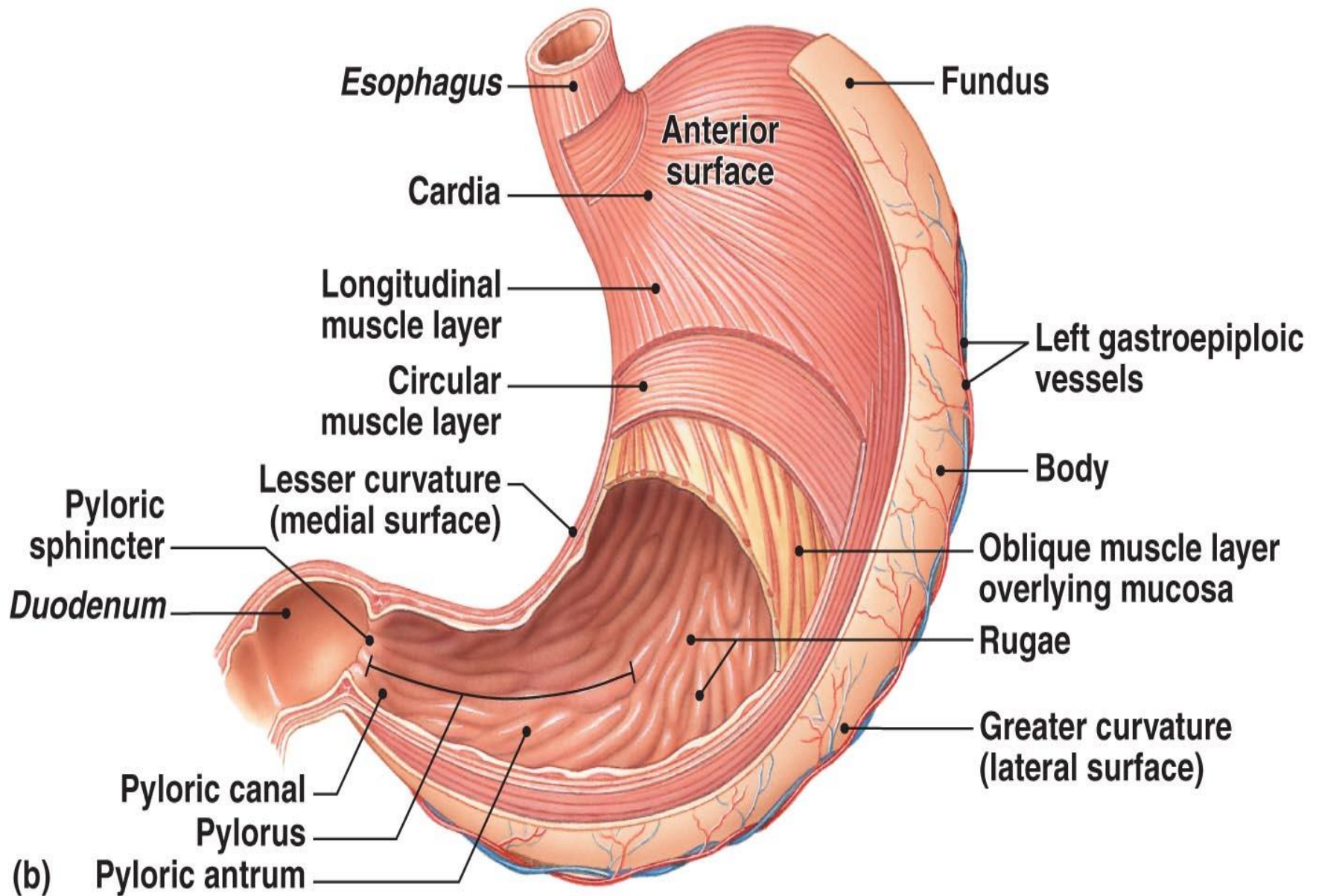
Outermost lining of GI organs











- A pouch-like organ primarily designed for food storage (for 2-4 hours) , some mechanical and chemical digestion also occur .
- Contains two sphincters at both ends to regulate food movement
- **cardiac sphincter near the esophagus**
- **pyloric sphincter near the small intestine**
- Divided into **4 regions** :
  - cardiac stomach (or cardiac), fundic stomach (or fundic) , body of stomach, pyloric stomach (or Pylorus).

Contain thick folds called **rugae** at its layer, for providing larger surface area for expansion, secretion, digestion , and some absorption.

## FUNCTIONS

### Digestion

- The stomach releases proteases (protein-digesting enzymes such as pepsin) and hydrochloric acid, which kills or inhibits bacteria and provides the acidic pH of 2 for the proteases to work.
- Food is churned by the stomach through muscular contractions of the wall called **peristalsis**.





# Absorption

- some absorption of certain small molecules nevertheless does occur in the stomach through its lining
- **GASTRIC JUICE**
  - Gastric acid, gastric juice or stomach acid, is a digestive fluid formed in the stomach and is composed of hydrochloric acid (HCl), potassium chloride (KCl) and sodium chloride (NaCl).
  - The acid plays a key role in digestion of proteins, by activating digestive enzymes, and making ingested proteins unravel so that digestive enzymes break down the long chains of amino acids.



## **Gastric Secretory Cells**

- **Chief cells: secrete pepsinogen (an inactive enzyme).**
- **Parietal cells: secrete hydrochloric and (HCl) and "intrinsic factor" (which helps absorption of vitamin B12 in the intestines).**
- **Mucous cells: secrete mucus and alkaline substances to help neutralize HCl in the gastric juice .**
- **G cells: secrete a hormone called gastrin , which stimulates the parietal cells and overall gastric.**



- **Small intestine**

The small intestine can be divided into 3 major regions:

The **duodenum** is the first section of intestine that connects to the pyloric sphincter of the stomach. It is the shortest region of the small intestine, measuring only about 10 inches in length.

The **jejunum** is the middle section of the small intestine that serves as the **primary site of nutrient absorption**. It measures around 3 feet in length.



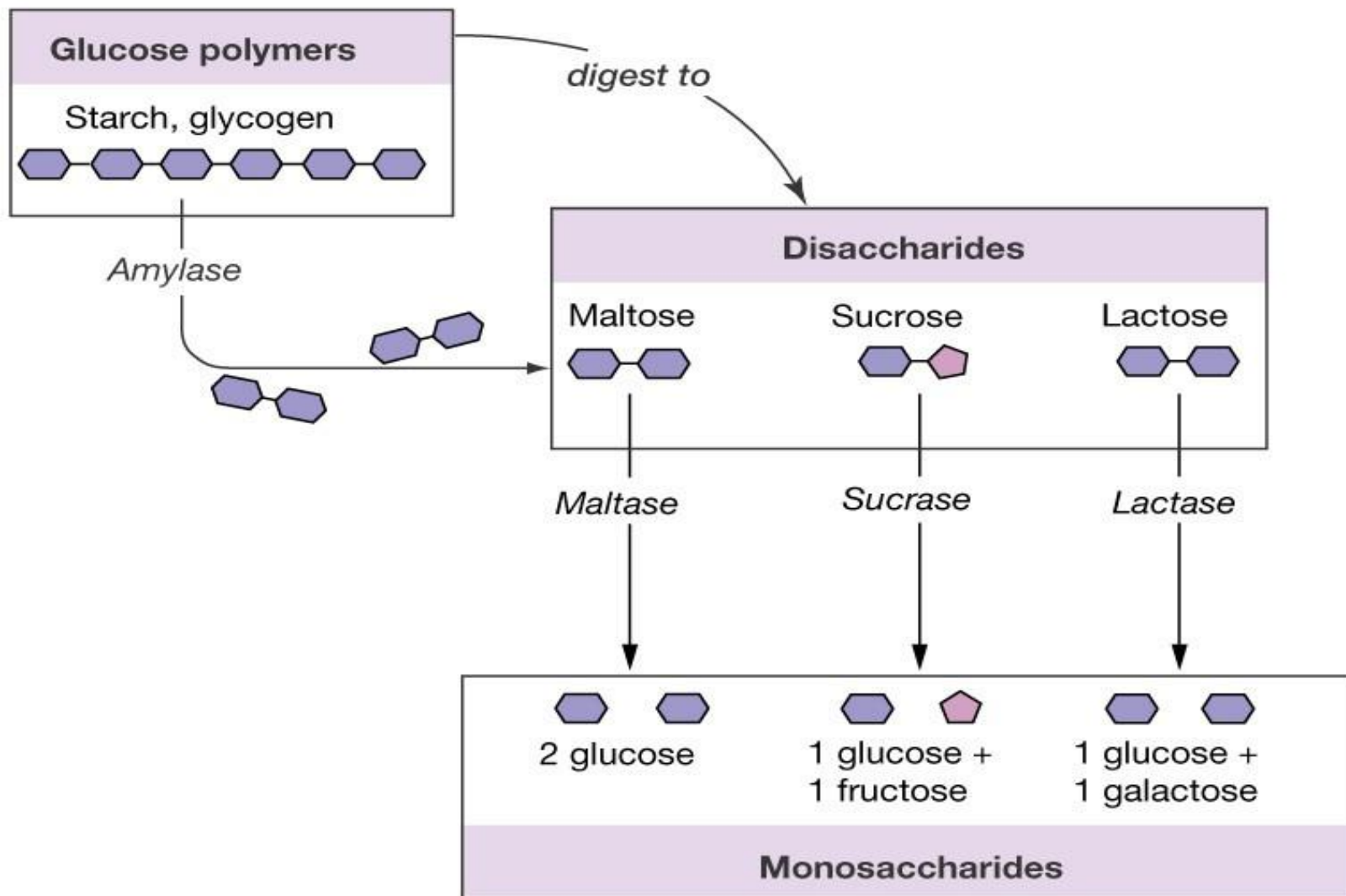
The **ileum** is the final section of the small intestine that empties into the large intestine via the **ileocecal sphincter**. The ileum is about 6 feet long and completes the absorption of nutrients that were missed in the jejunum.



## Function of small intestine

1. Onward movement of its contents by peristalsis, which is increased by parasympathetic stimulation.
2. A secretion of intestinal juice, also increase by parasympathetic stimulation.
3. Many of the digestive enzymes that act in the small intestine are secreted by the **pancreas** and **liver** and enter the small intestine.
4. Secretion of the hormones cholestykinin (CCK).
5. Absorption of nutrients.





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**TABLE 21.11 ENZYMATIC DIGESTION IN THE SMALL INTESTINE**
**Carbohydrates**

Starch  $\xrightarrow{\text{Pancreatic amylase}}$  Maltose (and other disaccharides)  $\xrightarrow{\text{Maltase, sucrase, lactase, etc.}}$  Monosaccharides

**Proteins**

Polypeptides  $\xrightarrow{\text{Trypsin, chymotrypsin}}$  Smaller polypeptides  $\xrightarrow{\text{Aminopeptidase, carboxypeptidase, dipeptidase}}$  Amino acids

**Nucleic acids**

DNA and RNA  $\xrightarrow{\text{Nucleases}}$  Nucleotides  $\xrightarrow{\text{Other enzymes}}$  Nitrogenous bases, sugars, and phosphates

**Fats**

Fat globules  $\xrightarrow{\text{Bile salts}}$  Fat droplets (emulsified)  $\xrightarrow{\text{Lipase}}$  Fatty acids and glycerol

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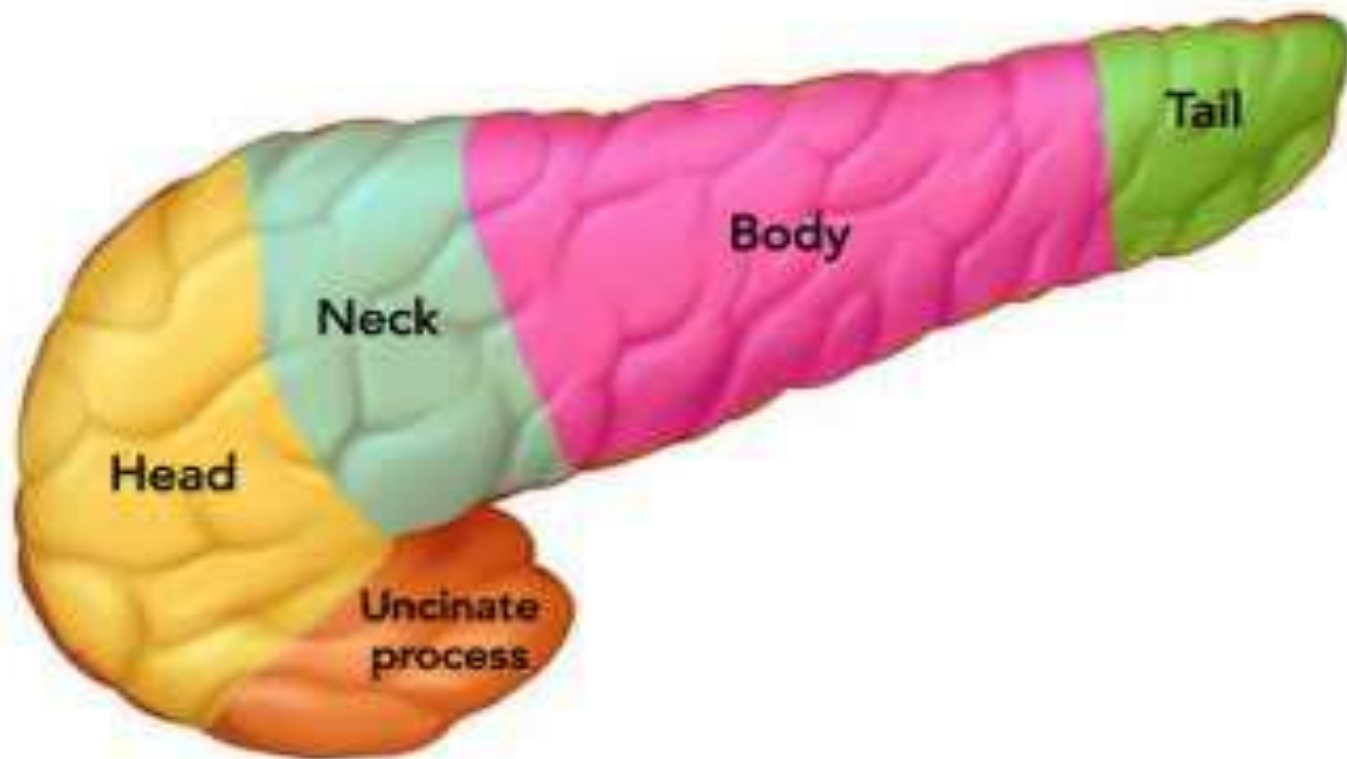
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## Pancreas

- The pancreas is a glandular organ in the digestive system (**exocrine**) and **endocrine system** of vertebrates.
- It is located in the abdominal cavity behind the stomach.  
It is an endocrine gland producing several important hormones, including insulin, glucagon, somatostatin, and pancreatic polypeptide, all of which circulate in the blood.

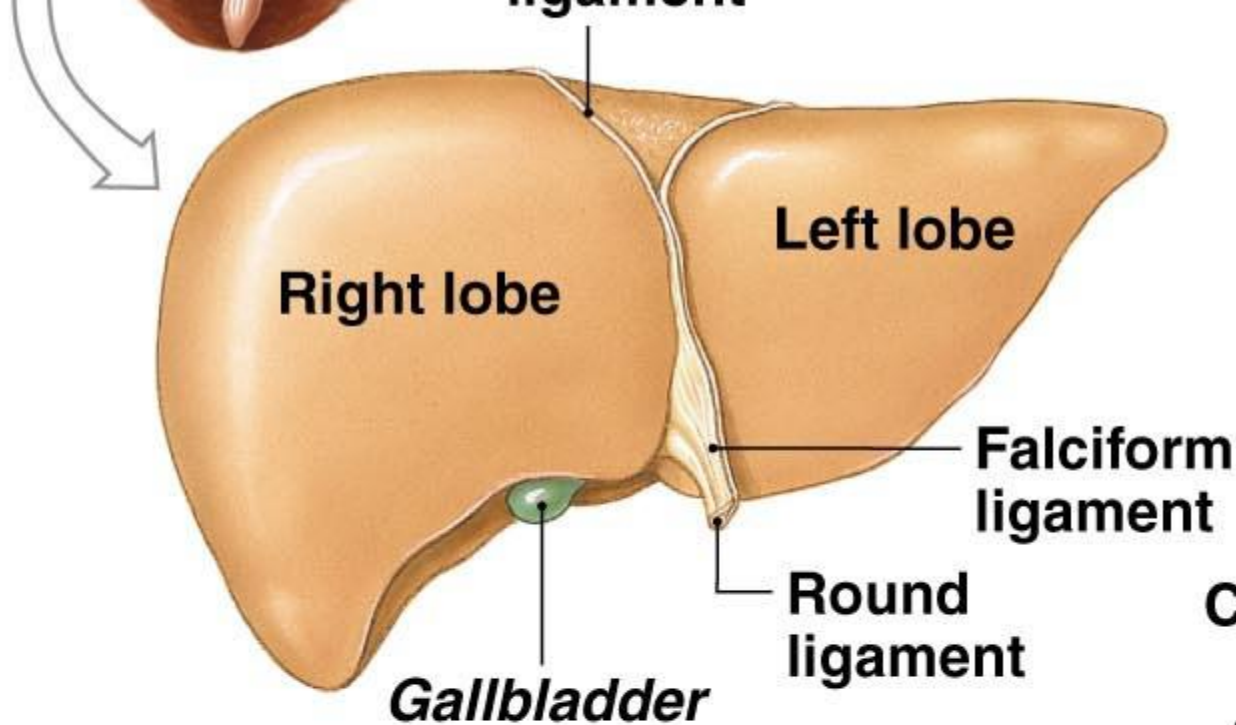




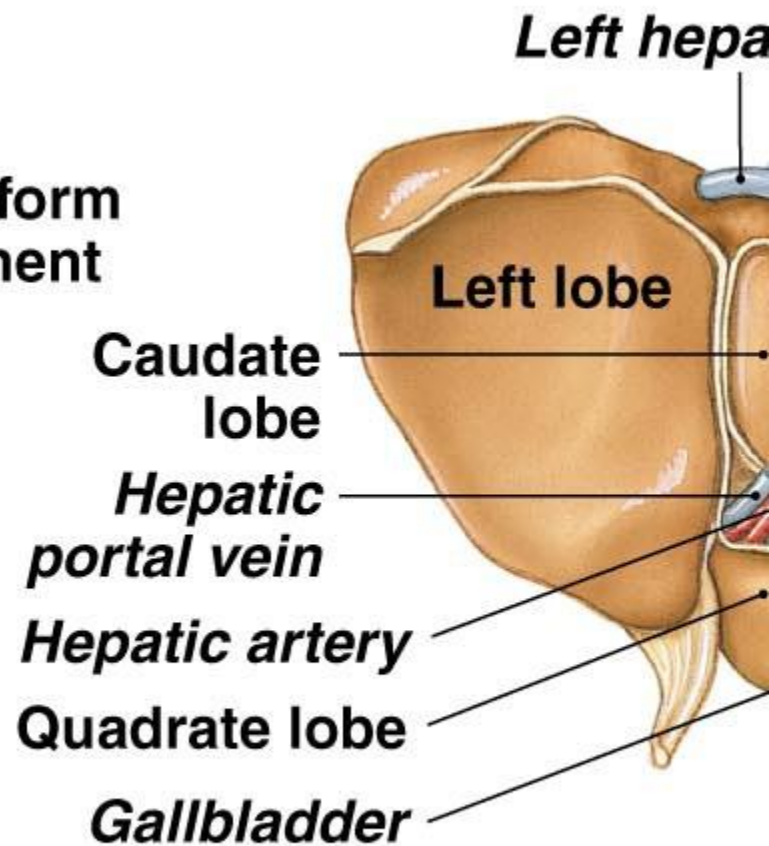


- **Function**
- The pancreas is involved in blood sugar control and metabolism within the body.
- Within these islets are four main types of cells which are involved in the regulation of blood glucose levels.
- **$\alpha$  alpha cells secrete glucagon (increase glucose in blood).**
- **$\beta$  beta cells secrete insulin (decrease glucose in blood)**
- **$\delta$  delta cells secrete somatostatin (regulates/stops  $\alpha$  and  $\beta$  cells) and**
- **$\gamma$  (gamma) cells, secrete pancreatic polypeptide.**



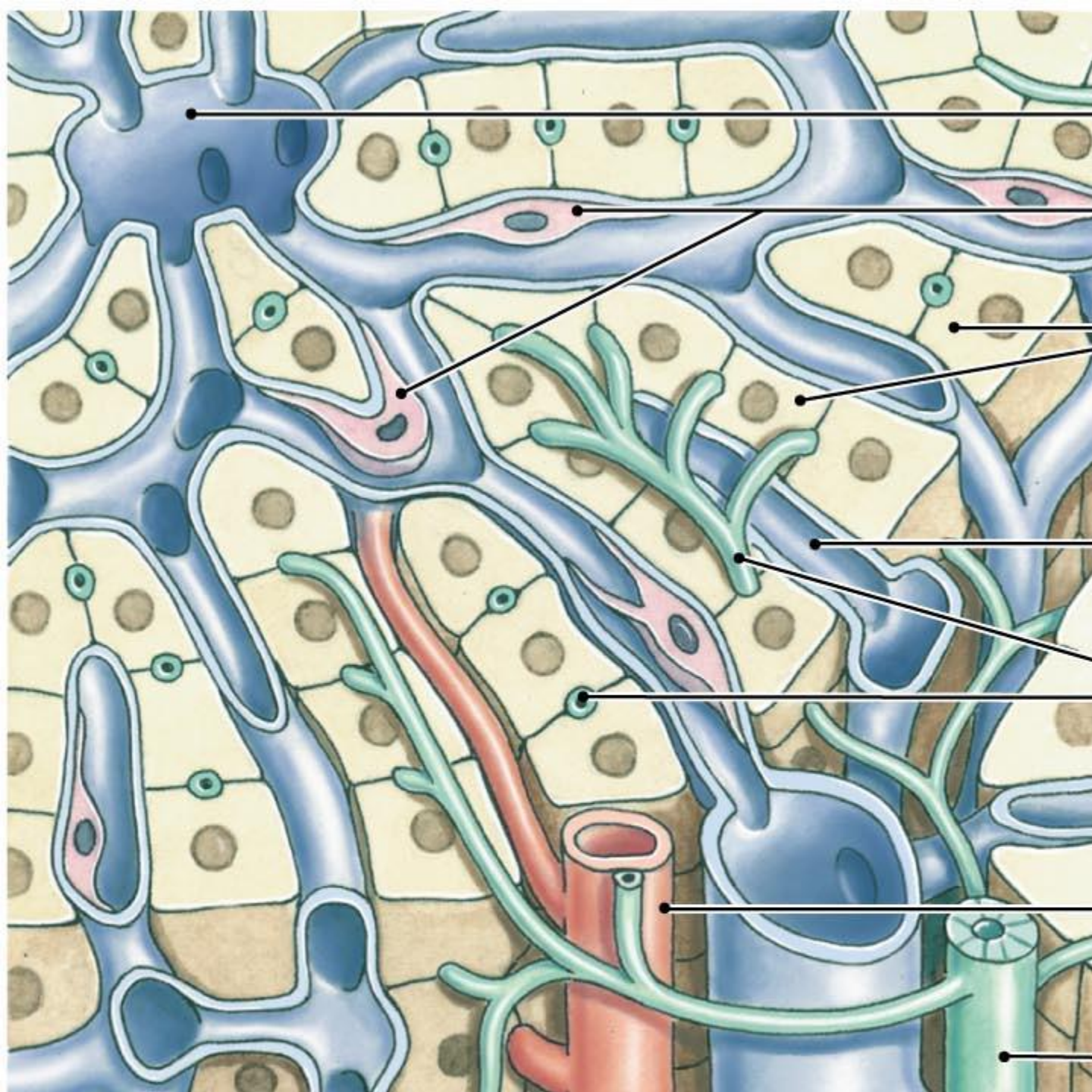


**(a) Anterior surface**



**(b) Posterior surface**





**Central**

**Kupffer**

**Hepato**

**Sinusoi**

**Bile can**

**Branch**

**Bile du**

# Liver

- Hepatocytes produce bile, which gets secreted into bile canaliculi of lobule
- Bile canaliculi merge to form bile ducts which eventually merge to create the right & left hepatic ducts
- Right & left hepatic ducts unite to form common hepatic duct which merges with cystic duct of gall bladder to form common bile duct which joins with pancreatic duct & enters the duodenum
- **Gall bladder** – hollow muscular sac under right lobe of liver; stores & concentrates bile; releases bile through cystic duct

- Bile released into duodenum functions in emulsification of lipids, absorption of fats (due to presence of bile salts), & excretion of bilirubin





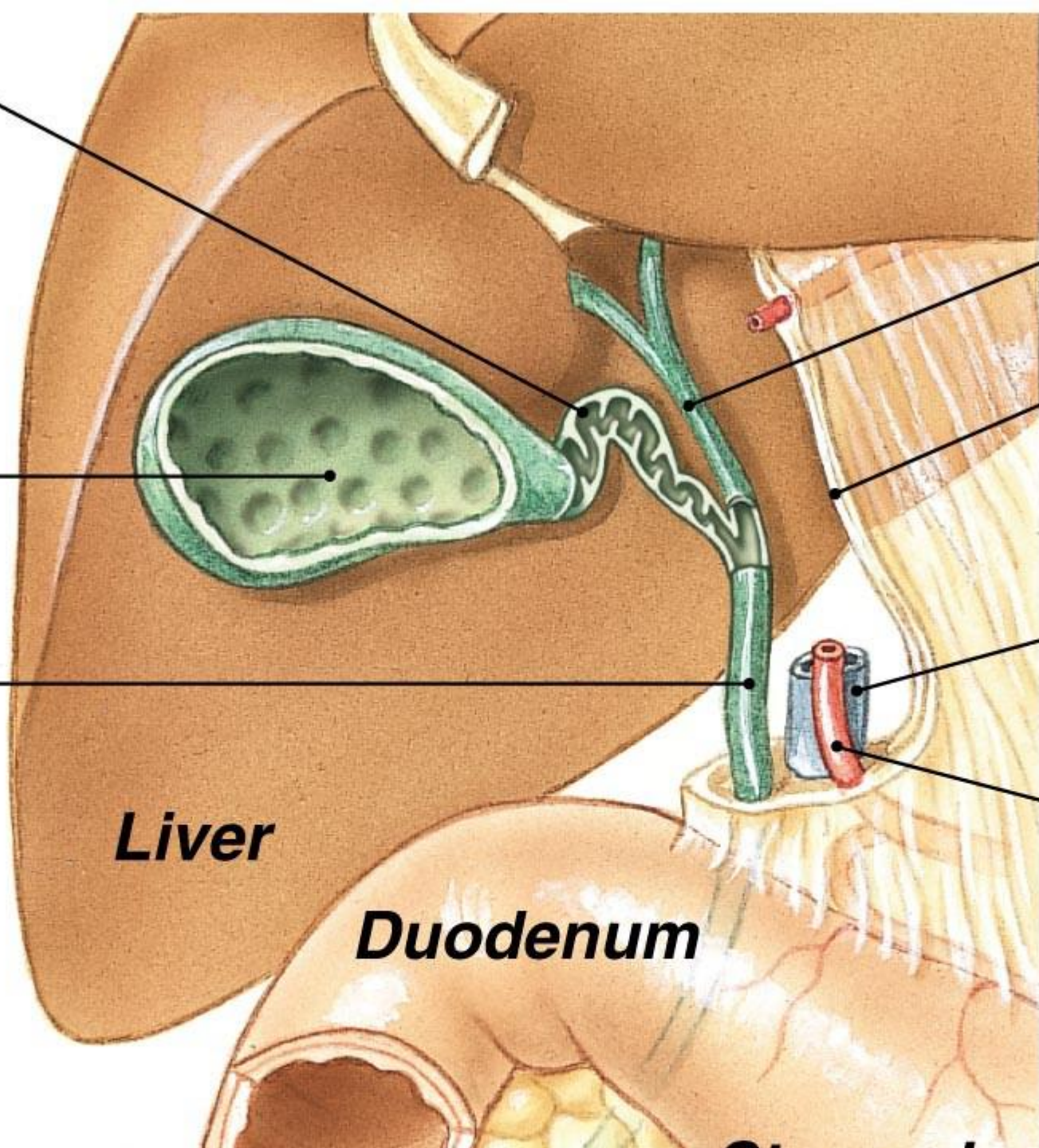
**Cystic duct**

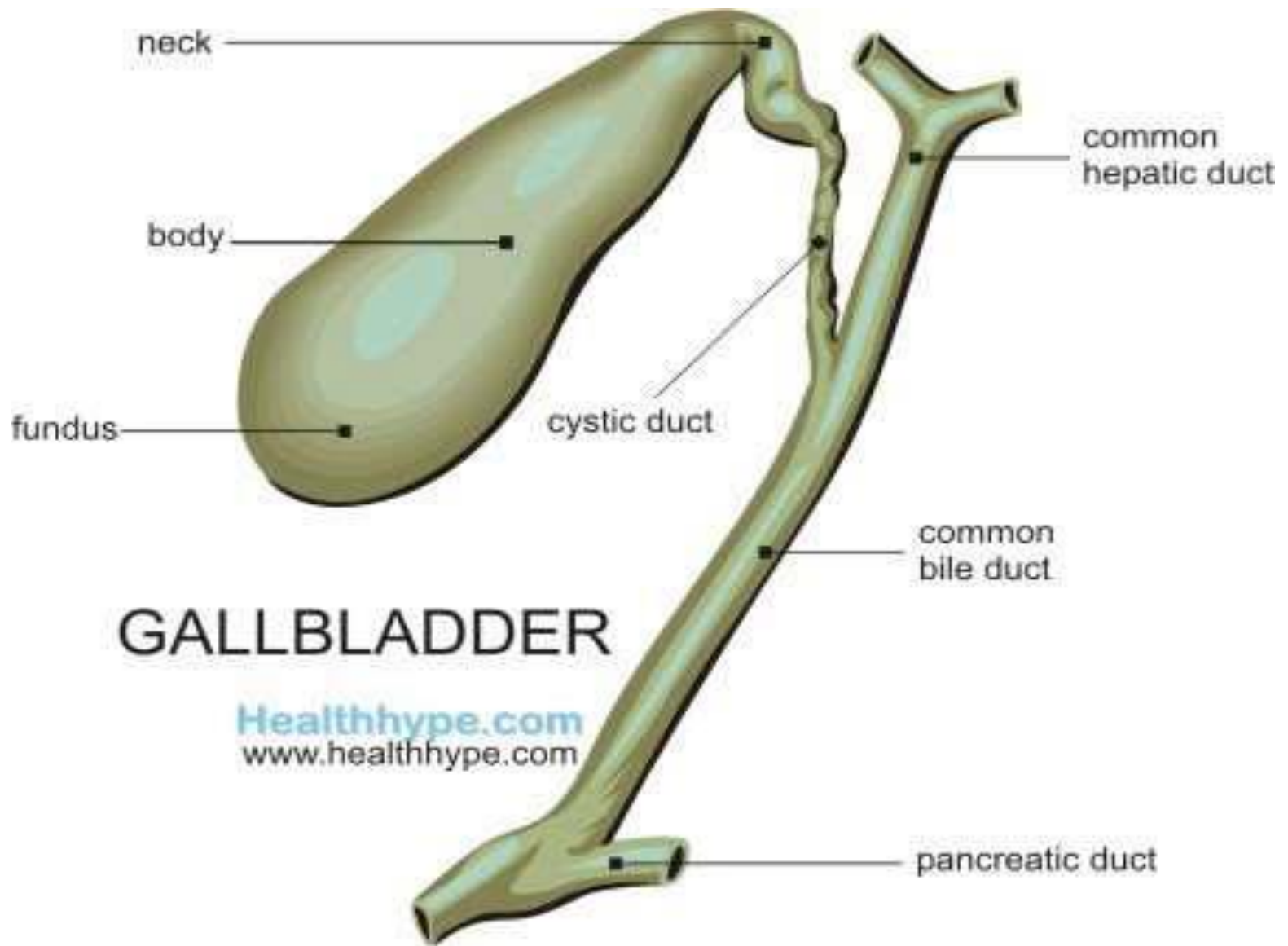
**Gallbladder**

**Common  
bile duct**

*Liver*

*Duodenum*





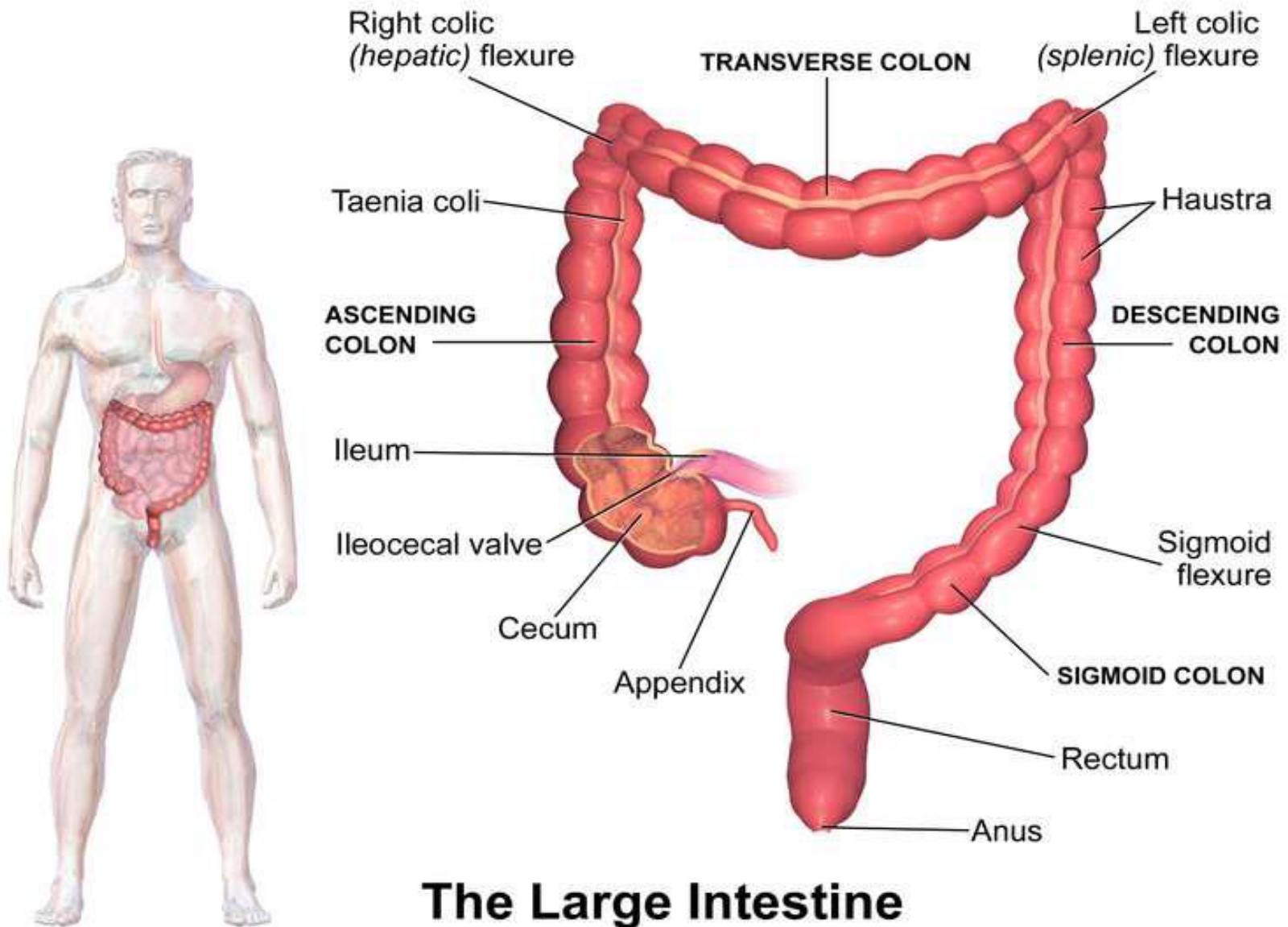


## Large intestine

The large intestine, also known as the **large bowel or colon, is the last part of the** gastrointestinal tract.

Water is absorbed here and the remaining waste material is stored as feces before being removed by defecation.





**The Large Intestine**

- Sections of the colon are:
- **The ascending colon including the cecum and appendix**
- **The transverse colon including the colic flexures and transverse mesocolon**
- **The descending colon**
- **The sigmoid colon – the s-shaped region of the large intestine**



- **Cecum**
- The cecum is the first section of the colon and involved in the digestion, while the appendix is a structure of the colon, not involved in digestion.
- The function of the appendix is uncertain containing **Ileocecal valve**
- **The ileocecal valve is a sphincter muscle valve that separates the small intestine and the large intestine.**
- Its critical function is to limit the reflux of colonic contents into the ileum.



- **Transverse colon**

The transverse colon is the part of the colon from the hepatic flexure to the splenic flexure.

- **Descending colon**

The descending colon is the part of the colon from the splenic flexure to the beginning of the sigmoid colon, descending colon is also called the **distal gut**.

One function of the descending colon in the digestive system is to store feces that will be emptied into the rectum.



- **Sigmoid colon**

The sigmoid colon is the part of the large intestine after the descending colon and before the rectum.

The name sigmoid means S-shaped .

The walls of the sigmoid colon are muscular, and contract to increase the pressure inside the colon, causing the stool to move into the rectum.

- **Rectum**

The rectum is the last section of the large intestine. It holds the formed feces awaiting elimination via defecation.

# Anus

The anus is the external opening of the rectum.

Its function is to control the expulsion of feces.

Two sphincters control the exit of feces from the body during an act of defecation. These are the **internal anal sphincter** and the **external anal sphincter**, which are circular muscles that normally maintain constriction of the orifice and which relaxes as required by normal physiological functioning.



## Functions

The large intestine absorbs water and any remaining absorbable nutrients from the food before sending the indigestible matter to the rectum. The colon absorbs vitamins that are created by the colonic bacteria, such as vitamin K.

## Gut flora

The large intestine houses over 700 species of bacteria that perform a variety of functions. The large intestine absorbs some of the products formed by the bacteria inhabiting this region.





# Cardiovascular system

## Blood Vessels

The cardiovascular system has three types of blood vessels:

Arteries (and arterioles) – carry blood away from the heart

Capillaries – where nutrient and gas exchange occur

Veins (and venules) – carry blood toward the heart.



## Arteries

Arteries and arterioles take blood away from the heart. The largest artery is the aorta. The middle layer of an artery wall consists of smooth muscle that can constrict to regulate blood flow and blood pressure.

Arterioles can constrict or dilate, changing blood pressure.



## The Capillaries

Capillaries have walls only one cell thick to allow exchange of gases and nutrients with tissue fluid. Capillary beds are present in all regions of the body but not all capillary beds are open at the same time.

## The Veins

Venules drain blood from capillaries, then join to form veins that take blood to the heart. Veins have much less smooth muscle and connective tissue than arteries



Veins often have valves that prevent the backward flow of blood when closed. Veins carry about 70% of the body's blood and act as a reservoir during hemorrhage.



## Structure of Vessels

- Arteries, veins and capillaries differ in structure.
- Three layers are found in arteries and veins.
- The outermost layer = **tunica externa or adventitia**. It is made of **connective tissue fibers** to reinforce the walls under pressure.
- **The tunica media is the smooth muscle middle layer**. It is much thicker in arteries than in veins and contains a thin layer of elastic tissue. This layer is under control of the ANS and maintains BP and blood distribution.



- The tunica intima lines the arteries and veins. It is a single layer of **squamous epithelial cells** called endothelium that lines the inner surface of the entire cardiovascular system.



- **Large arteries** are termed conductance or elastic arteries because the tunica media has less smooth muscle and more elastic fibers
- **Medium sized arteries** are termed the nutrient arteries because they control the flow of blood to the various regions of the body
- **Arterioles** have a thin tunica intima and adventitia, but a thick tunica media composed almost entirely of smooth muscle and control blood flow to the capillary bed



## Capillary

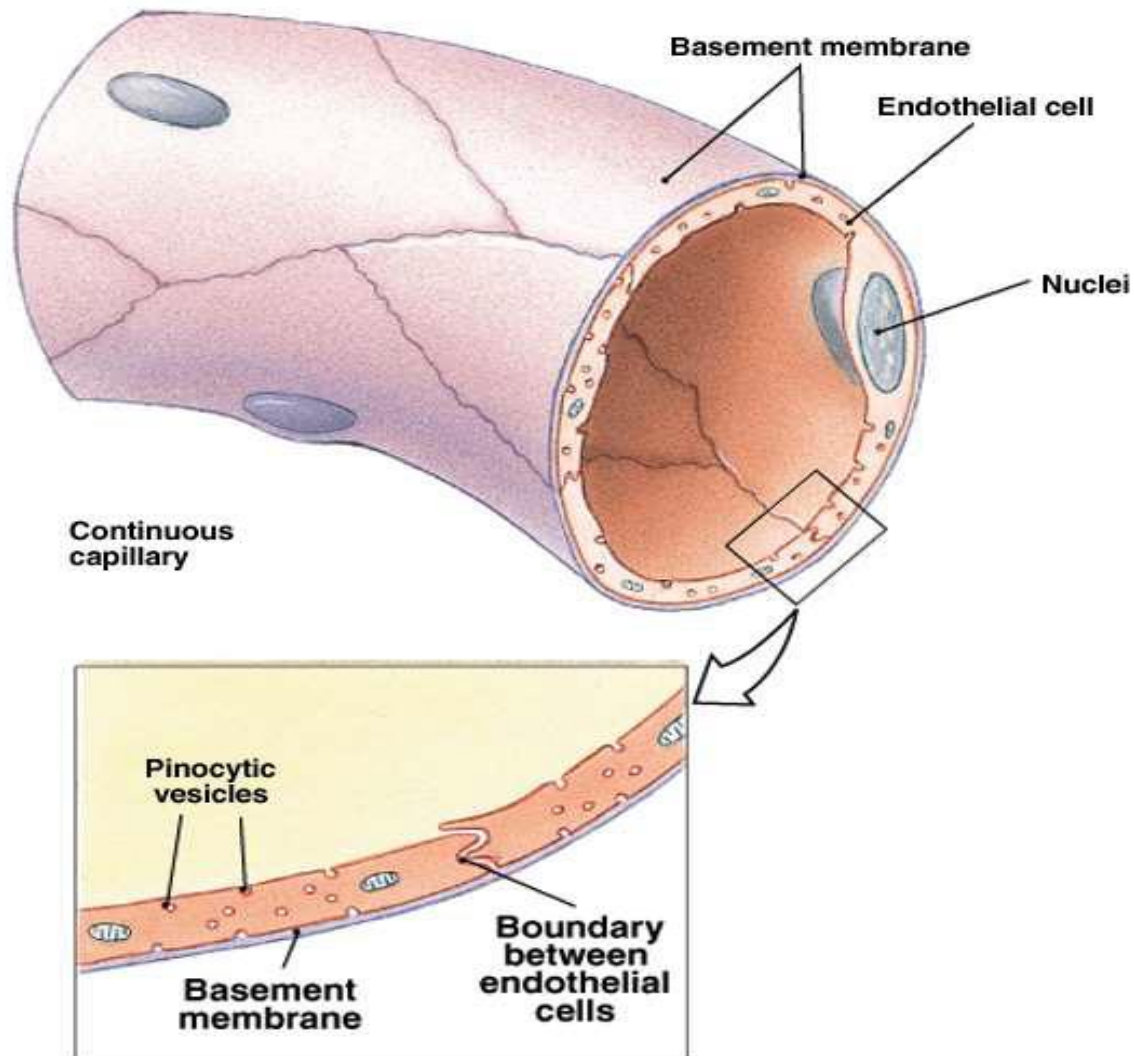
### Pre-capillary sphincter valves

Smooth muscle rings at the proximal end of the capillary

- Contraction decreases blood flow
- Relaxation increases blood flow
- Responsive to local changes in  $\text{PaO}_2$ ,  $\text{PaCO}_2$ , pH and temperature
- Called exchange vessels because they are the site of gas, fluid, nutrient, and waste exchange







## Venous system

- Transport deoxygenated blood back to the heart – exception: pulmonary vein
- Composed of the same layers as arteries, but are thinner Called capacitance or reservoir vessels because 70% to 75% of the blood volume is contained in the venous system
- Peripheral veins contain one-way valves
- Valves are formed by duplication of endothelial lining
- Found in veins >2mm in diameter



## The Heart

The heart is a cone-shaped, muscular organ located between the lungs behind the sternum.

The heart muscle forms the myocardium, with tightly interconnect cells of cardiac muscle tissue.



## Layers of the heart

- The heart resides in the **pericardium**  
A loose membranous sac
- **Epicardium**  
Continuous with the pericardium
- **Myocardium**  
Composed of bands of involuntary striated muscle fibers
- **Endocardium**
- Thin layer of tissue lining the inside of the heart



# Chambers of the heart

## Atria

Thin-walled upper chambers

Separated by atrial septum

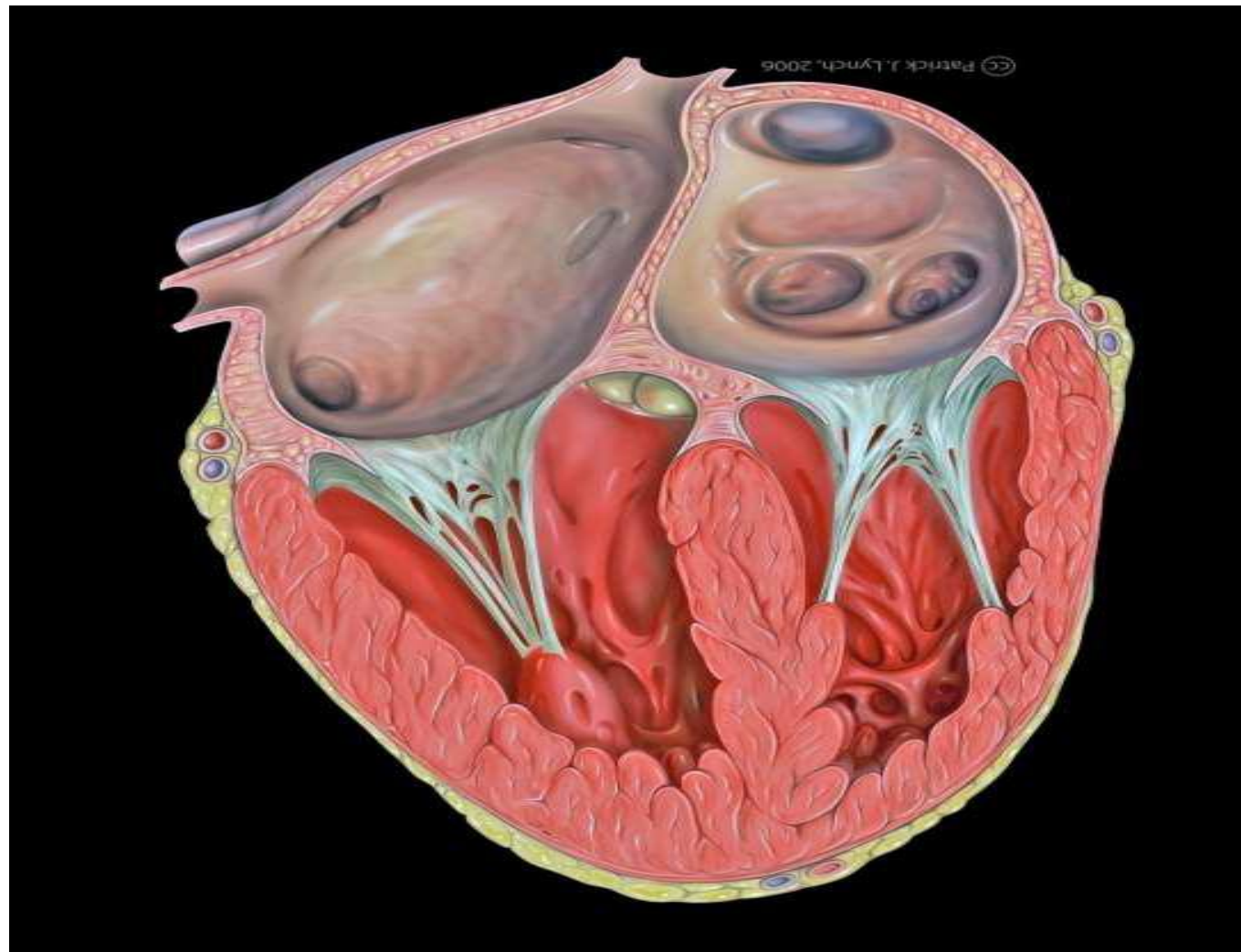
Act as receiving chamber for blood returning from the body and lungs

## Ventricles

Lower chambers which make up the bulk of the muscle mass of the heart

Blood exits from the ventricles into arteries – pulmonary and aorta. The ventricles are referred to as discharging chambers





## Valves of the heart

- The two valves that separate the atrial chambers above from the ventricular chambers below are called the atrioventricular valves (AV).
- The right AV valve is called the tricupsid valve. It consists of three leaf-like valve components.
- The left AV valve is called the bicupsid or mitral valve. It consists of two leaf-like valve components.
- Both AV valves prevent the backflow of blood into the atria when the ventricles contract.





- String like structures called chordae tendineae attach the AV valves to the walls of the ventricles via papillary muscles extending from the floor of the ventricles.
- The **semilunar valves (SL)** valves are located between the two ventricular chambers and the arteries that carry blood away from the heart when systole occurs.
- The ventricles contract at the same time like the atria. The two SL valves open and close at the same time.
- The **pulmonary SL valve** is located at the beginning of the pulmonary artery and opens to allow blood to enter pulmonary circulation. The valve closes to prevent backflow of blood into the right ventricle.



## Passage of blood through the heart

Heart: superior and inferior vena cava → right atrium → tricuspid valve → right ventricle → pulmonary semilunar valve → pulmonary trunk and arteries to the lungs → pulmonary veins leaving the lungs → left atrium → bicuspid valve → left ventricle → aortic semilunar valve → aorta → to the body.

- The heart must perform a great amount of work by pumping through the pulmonary and systemic systems.
- It requires a constant supply of oxygen and nutrients via the coronary circulation to perform this task.



THANK YOU EVERY ONE  
(Will be continued in next class)

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