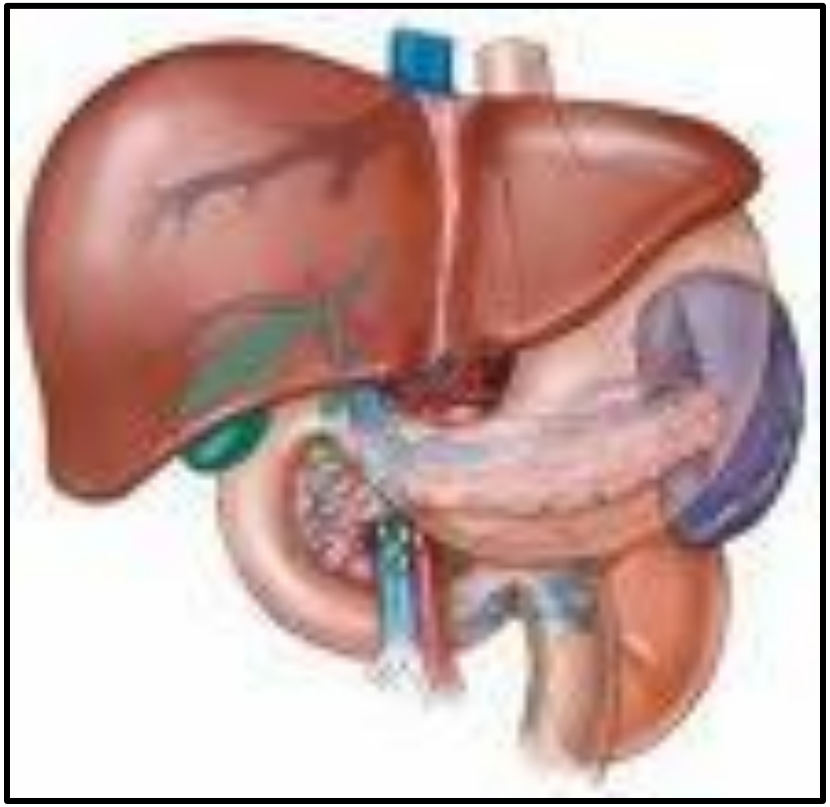
DIGESTIVE SYSTEM



By
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ILOS

1. **Identify the different parts of digestive system.**
2. **Know the general structure of The gastrointestinal tract (GIT).**
3. **Differentiate between the histological structure of different parts of GIT.**
4. **Study the structure of glands associated with the digestive tract**

The digestive system is made up of:

I- The oral cavity (lips, cheeks, tongue, palate, pharynx, teeth)

II- The gastro-intestinal tract (GIT).

1-Esophagus

2- Stomach; (cardiac region, fundus & body region, and pyloric region)

3- Small intestine; (duodenum, jejunum, and ileum)

4-Large intestine; (colon, appendix, rectum and anal canal)

III- Glands associated with the digestive tract

1 - Salivary glands (major and minor)

2 - Pancreas

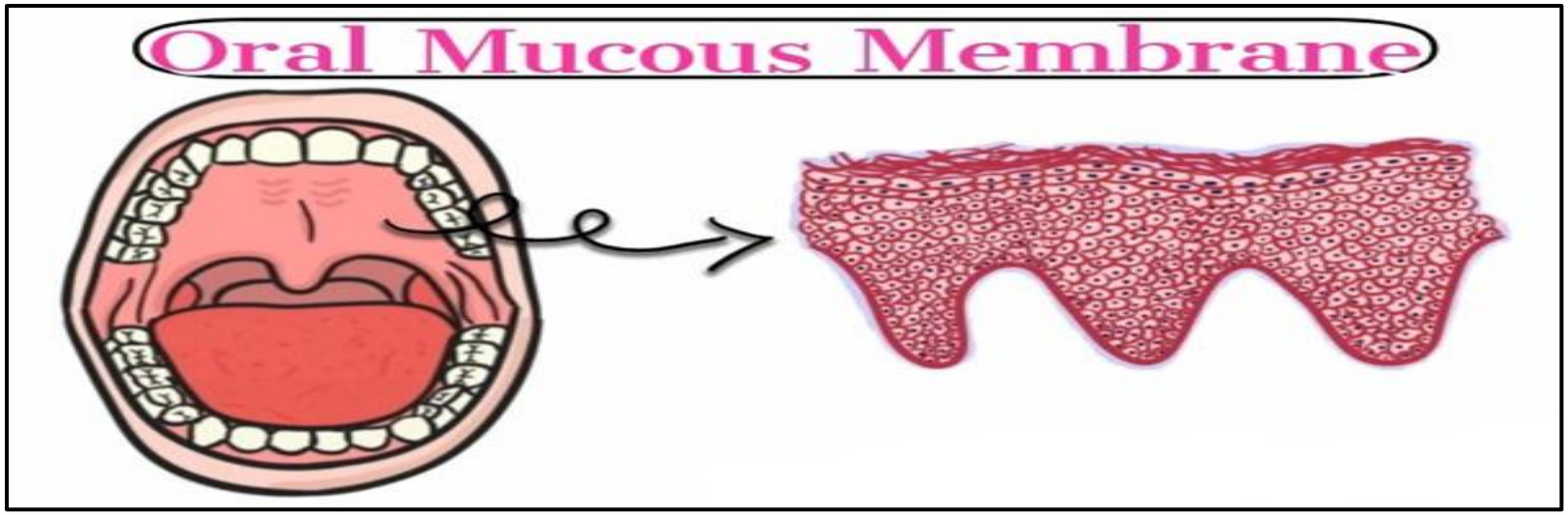
3 - Liver and gall bladder

The Oral Cavity

- It includes: (lips, cheeks, tongue, palate, pharynx, teeth)
- All parts of the oral cavity are lined by mucous membrane.

- This membrane is formed of:

- Epithelium: Stratified squamous mainly nonkeratinized.
- Lamina propria (L.P.): It is a loose C.T. which is continuous with the underlying submucosa that contains diffuse small salivary glands.

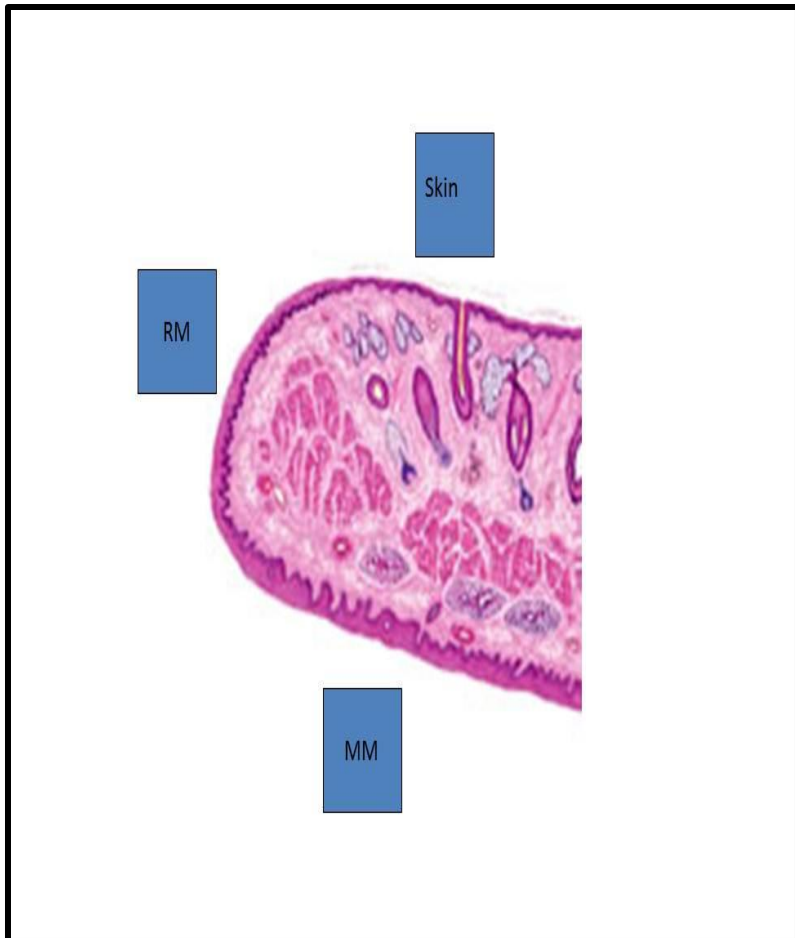


lips

The core of the lip consists of striated muscle fibers (orbicularis oris) *and* connective tissue

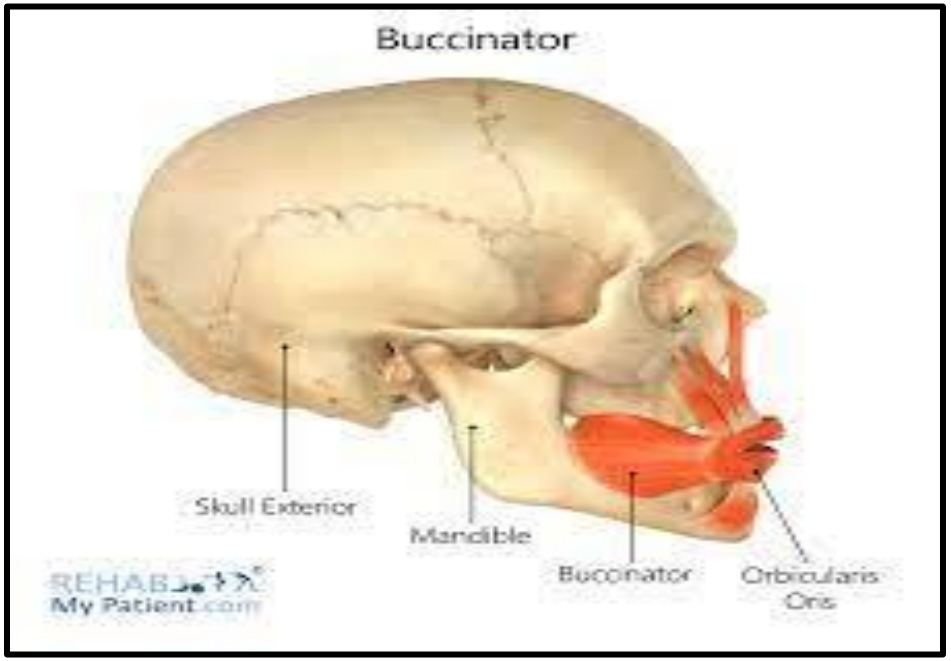
Each lip has 3 surfaces:

- ***Outer surface*** is **skin**
  - stratified squamous keratinized epithelium with hair follicles, sweat & sebaceous glands.
- ***Red margin*** is a **transition zone**
  - between keratinized and non-keratinized epithelium.
  - rich in **blood vessels** that cause redness of the lip margin.
  - has no hair follicles or glands.
- ***Inner surface*** is **mucus membrane**
  - covered with stratified squamous non-keratinized epithelium with mucous secreting glands (labial glands) in the L.P.



Cheeks

- Formed of skeletal muscle (**buccinator**).
- **Covered from outside by** skin and subcutaneous C.T.
- **Lined from inside by** a mucous membrane.



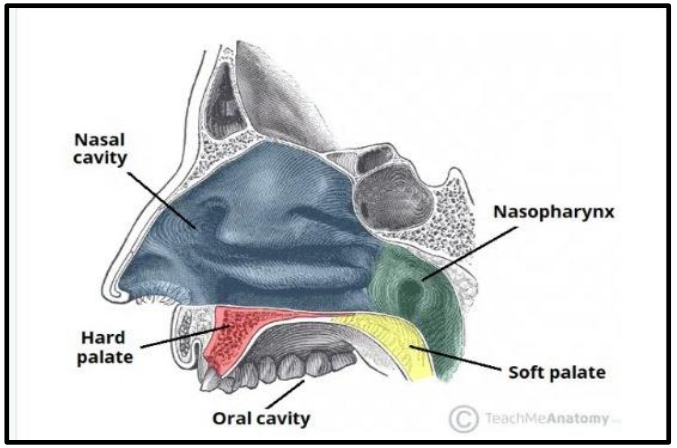
Palate

The roof of the mouth.

- Consists of two parts:

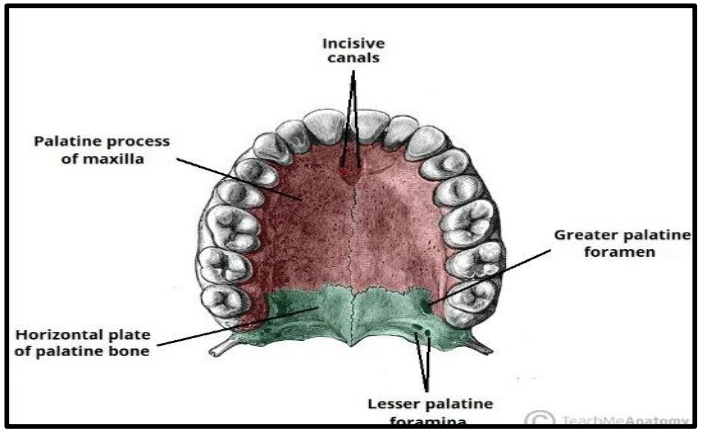
a) Hard palate (the anterior two thirds).

The mucous membrane (keratinized stratified squamous epithelium and L.P) rests directly on bony tissue.



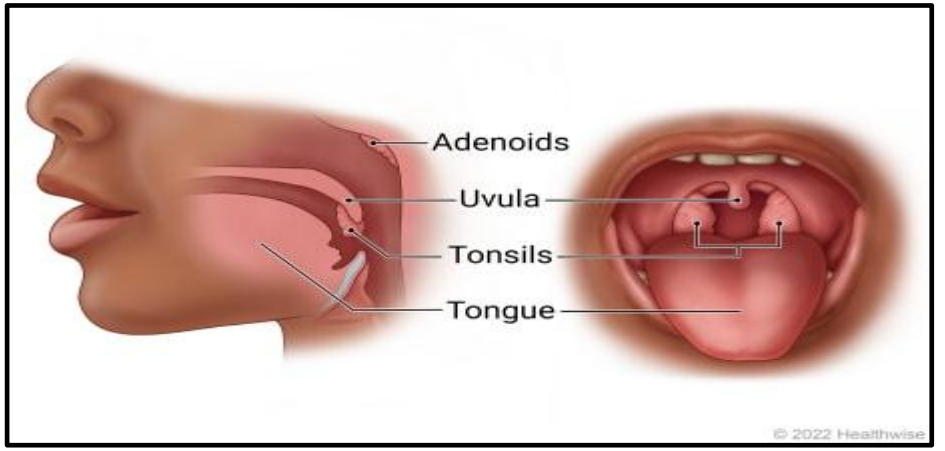
b) Soft palate (the posterior third).

core of skeletal muscle that covered with non-keratinized stratified squamous epithelium.



The uvula

- downward extension of soft palate
- conical in shape
- formed of a core of skeletal muscle
- covered by mucous membrane.

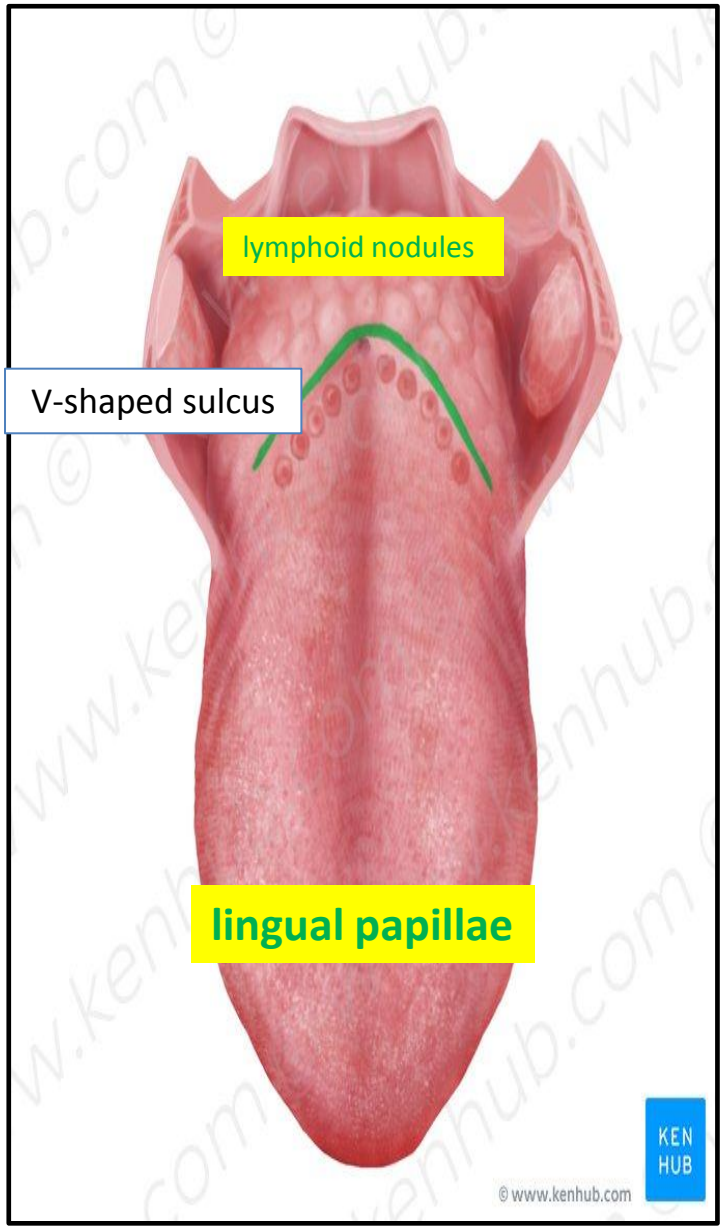


Tongue

- Mass of striated (skeletal) muscle.
- Muscle fibers are grouped in bundles arranged in 3 different planes and separated by C.T. containing blood vessels, nerves and mucous and serous glands.
- **Lower surface** is smooth and covered by mucous membrane.
- **Upper surface** (dorsal surface): the anterior 2/3 of is separated from the posterior 1/3 by a V-shaped sulcus.

a) **The anterior two thirds** are covered by a great number of small mucosal projections called **lingual papillae**.

b) The posterior one third is irregular due to presence of lymphoid nodules (lingual tonsils) in the L.P.



Lingual papillae

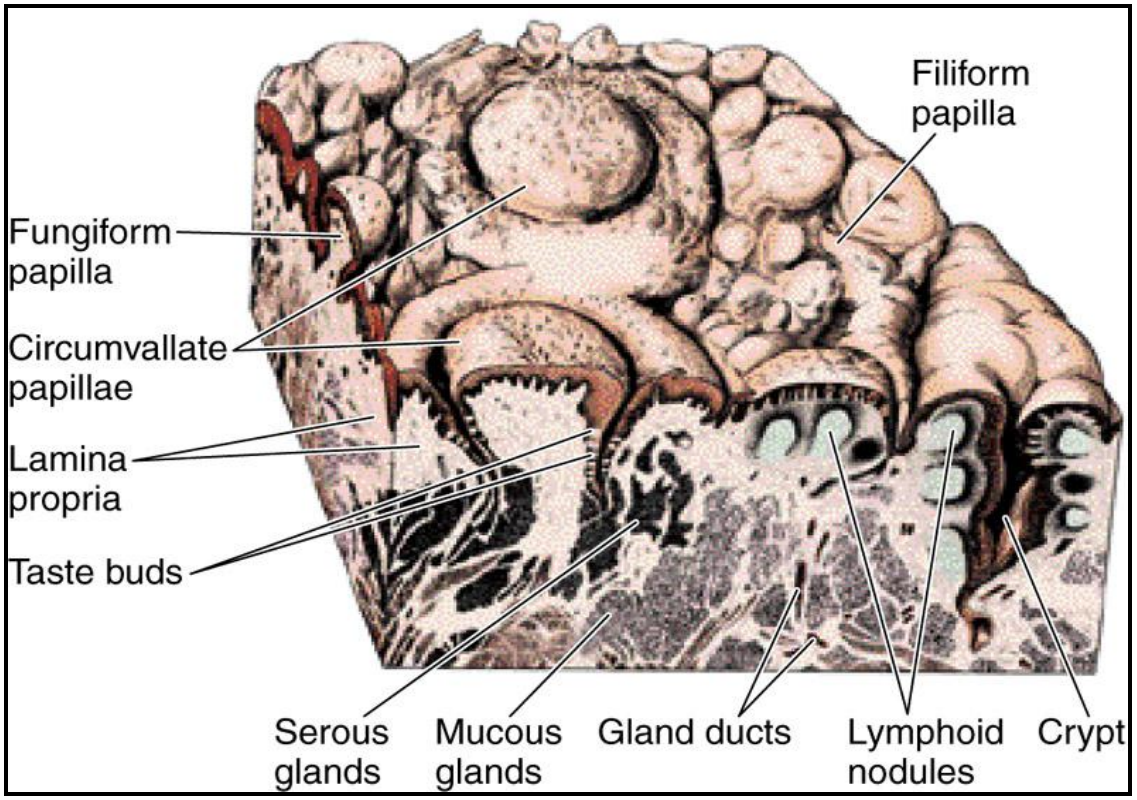
- Each papilla has a core of C.T covered with stratified squamous epithelium.
- There are four types:

a) Filiform

b) Fungiform

c) Circumvallate

d) Foliate



1- Filiform papillae:

- They are conical in shape
- most numerous.
- They have no taste buds.

2- Fungiform papillae:

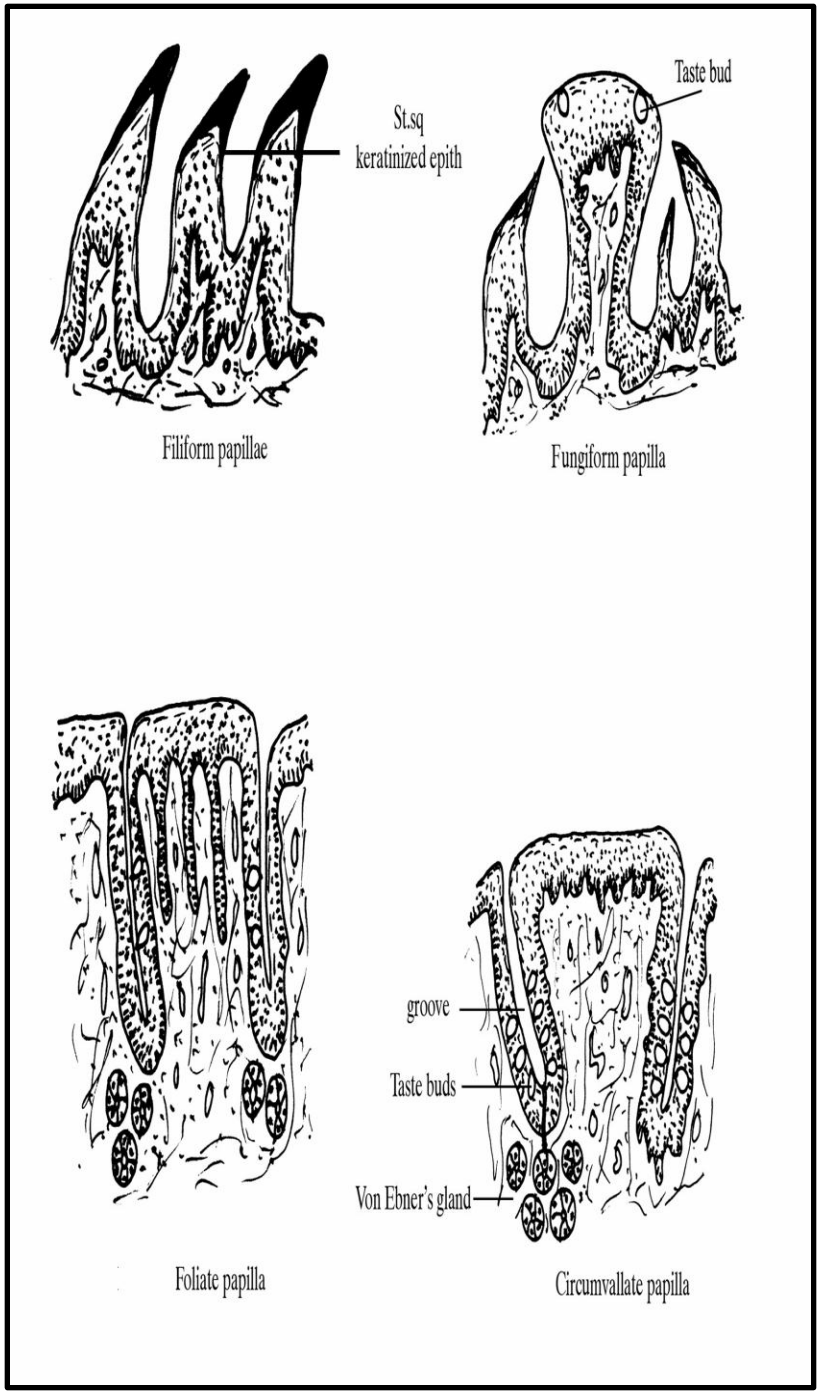
- They have narrow stalk and wide apex.
- Scattered in between filiform papillae.
- They have taste buds on its upper surface.

3- Cirumvallate papillae:

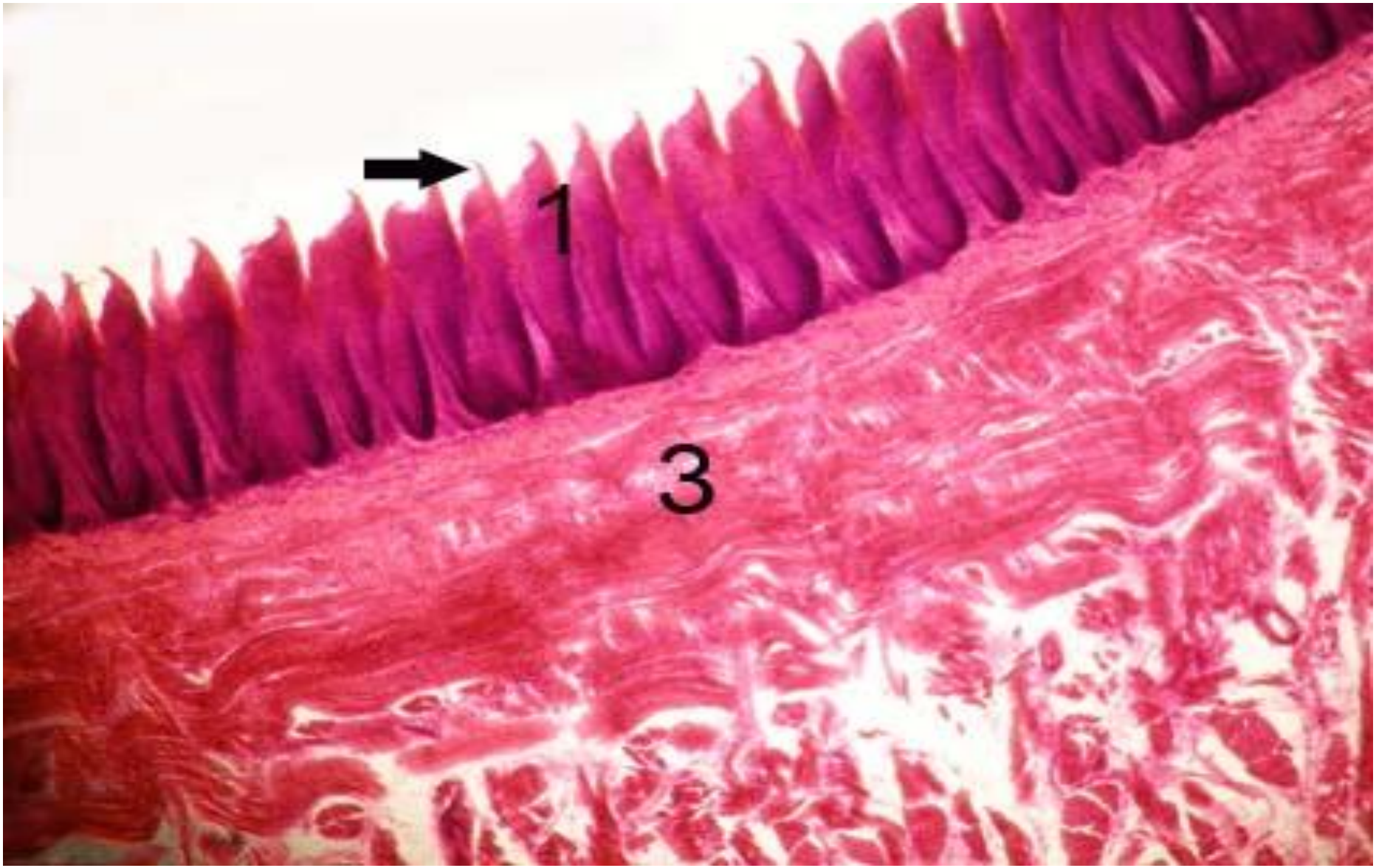
- They are large, rounded and surrounded by a deep groove.
- 7-12 in number along the V-shaped sulcus.
- They have numerous taste buds on the lateral surfaces.

4- Foliate papillae:

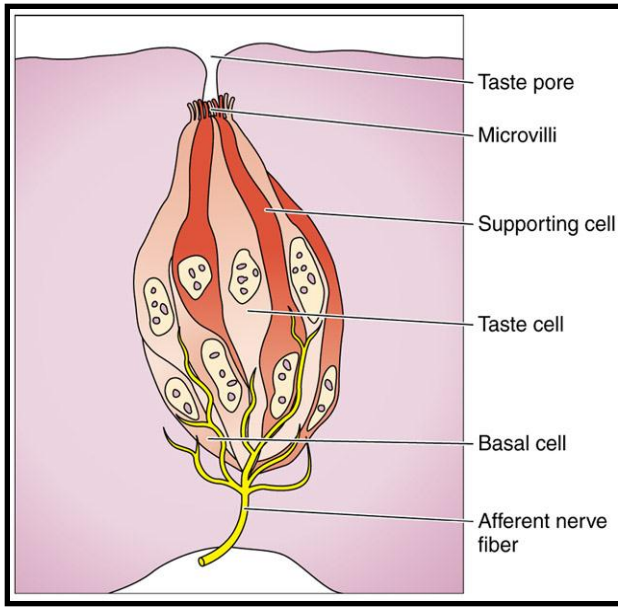
- present in some animals (rabbits).
- They consist of parallel ridges separated by deep furrows.
- They are rich in taste buds.



Tongue



Taste buds



perceive taste.

Sites:

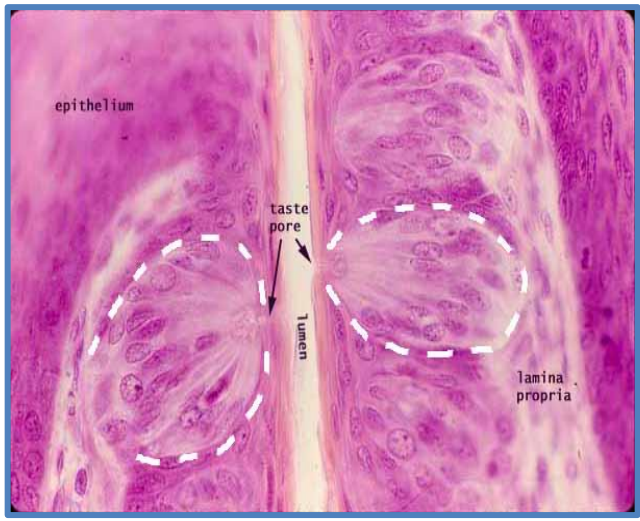
- mainly tongue
- soft palate, epiglottis
- posterior wall of pharynx.

Structure:

- **bud-like** structures with a small opening at the epithelial surface called **taste pore** through which chemicals enter the bud.

Taste buds are composed of 4 types of cells (neuroepithelium):

- tall supporting cells with microvilli.
- sensory cell with sensory nerves at its basal surface.
- Undifferentiated basal cell (stem cells).



Pharynx

- Represents a transitional space between oral cavity and respiratory and digestive tracts.
- **Divided into 3 regions:**

1- Nasopharynx

2- Oropharynx

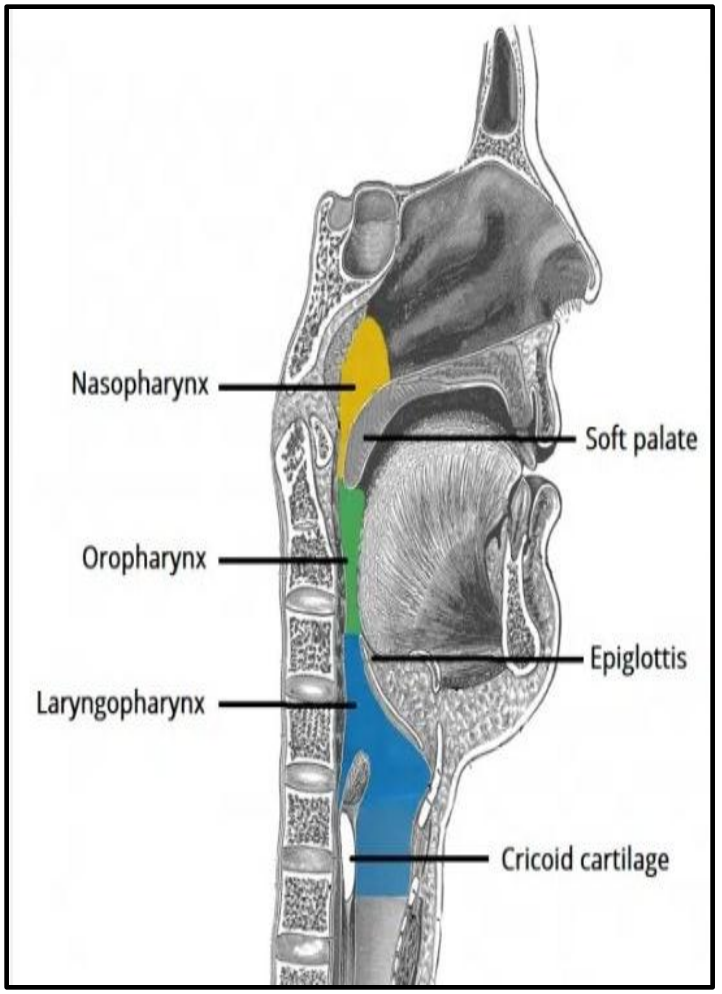
3- Laryngopharynx.

- Its mucous membrane consists of:

-Epithelium

- ***In nasopharynx*** it is pseudostrdified columnar ciliated with goblet cells (*respiratory epithelium)*
- ***In oropharynx and laryngopharynx,*** it is stratified squamous non-keratinized.

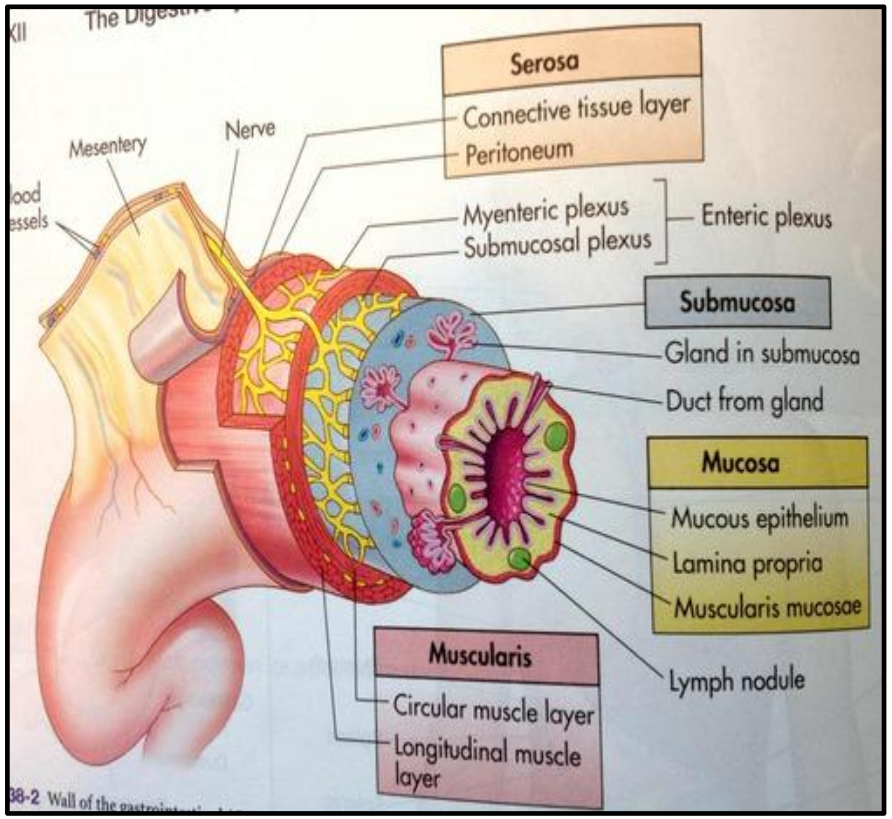
-Lamina propria



II- Gastrointestinal Tract

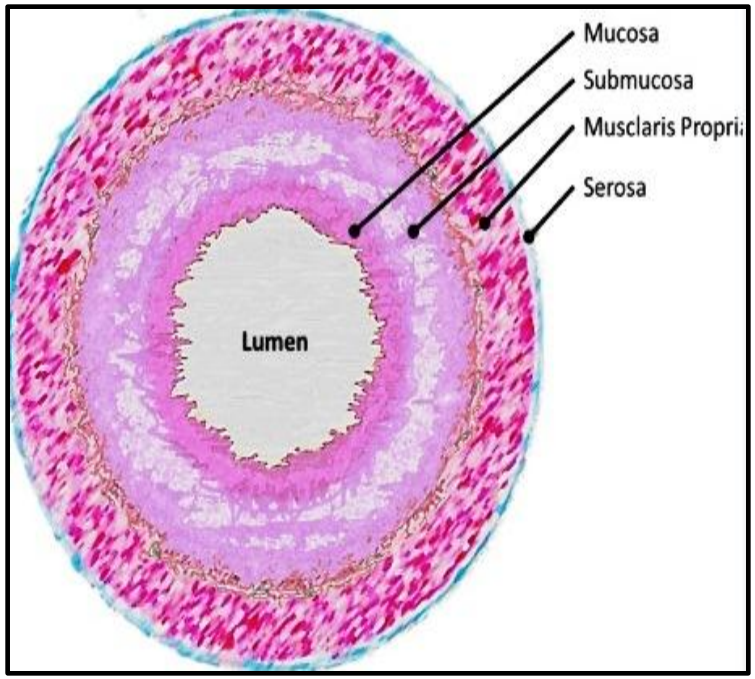
- From esophagus to rectum, the digestive tract is a hollow tube with common histological characteristics.
- There are regional variations based on functional differences.
- The wall of the tube is composed of **4** layers, concentrically arranged around a lumen.

I- Mucosa
II- Submucosa
III- Musculosa
IV- Serosa
(or adventitia)



I- Mucosa (mucous membrane) consists of 3 layers:

- Epithelium differs according to the function of the part it lines:
  - protective (esophagus)
  - secretory (stomach)
  - absorptive (intestine).



- **Lamina propria**

is formed of loose C.T. containing blood vessels, lymphatic vessels, lymph nodules and glands may be present.

- **Muscularis mucosa: smooth muscle**
  - inner circular layer
  - outer longitudinal layer

II- Submucosa: Loose C.T. contains

-blood and lymph vessels

-plexus of nerves

-in some parts mucous glands (as in oesphagus) or lymphoid tissue (as in ileum).

III- Musculosa Muscularis externa: : smooth muscle

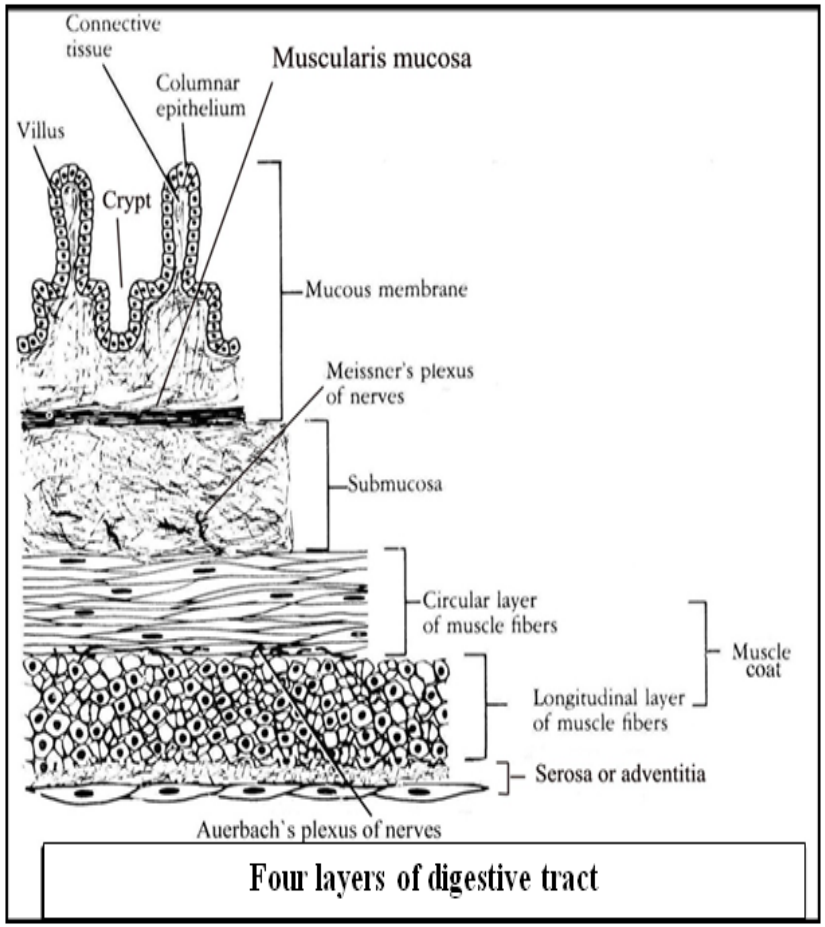
i) Inner circular layer.

ii) Outer longitudinal layer.

IV- Serosa (or adventitia):

Loose C.T. rich in blood and lymph vessels

- It is called adventitia (not covered by serous membrane).
- in intra-abdominal parts, it is covered by a serous membrane (peritoneum) and is called serosa.



Oesophagus

It is a muscular tube transport food quickly from pharynx to stomach.

Structure:

I- Mucosa:

- Epithelium: stratified squamous nonkeratinized (protective)

- Lamina propria: loose C.T.

- Muscularis mucosa: inner circular and outer longitudinal smooth muscle layers.

II- Submucosa:

Dense C.T. containing **mucus secreting esophageal glands.**

III- Musculosa:

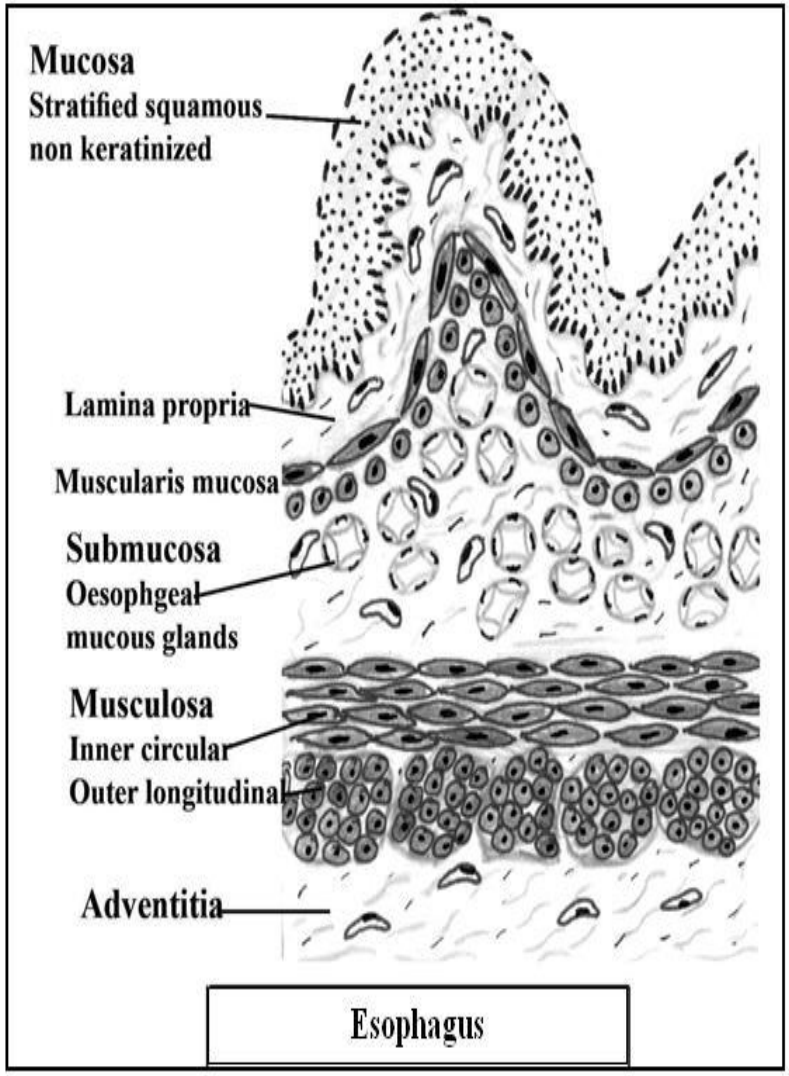
- Inner circular and outer longitudinal layers of muscle fibers:

I- In the upper 1/3, it is formed striated muscle.

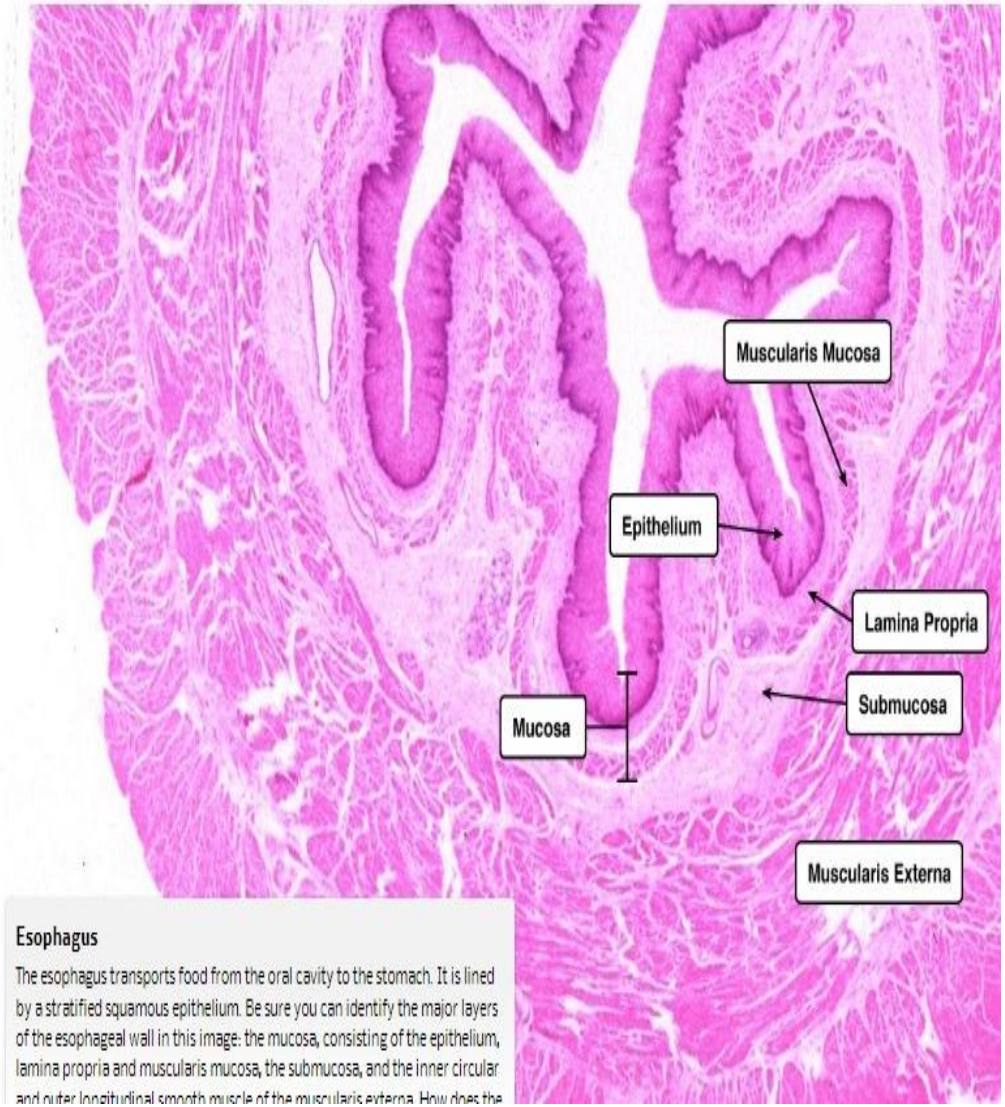
II- In the middle third, it is formed of both smooth and striated muscle fibers.

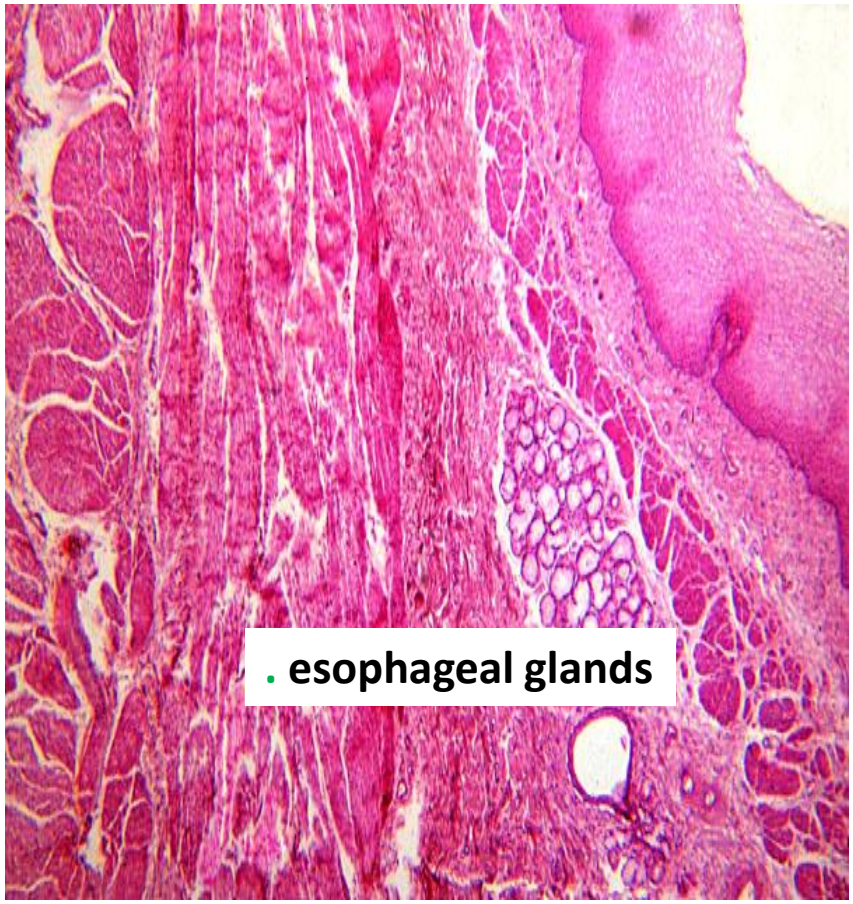
III- In the lower 1/3, it is formed of smooth muscle.

IV- Adventitia: The intra abdominal lower part of the esophagus has a serosa.



Oesophagus


Muscularis Mucosa
Epithelium
Lamina Propria
Submucosa
Mucosa
Muscularis Externa
Esophagus
The esophagus transports food from the oral cavity to the stomach. It is lined by a stratified squamous epithelium. Be sure you can identify the major layers of the esophageal wall in this image: the mucosa, consisting of the epithelium, lamina propria and muscularis mucosa, the submucosa, and the inner circular and outer longitudinal smooth muscle of the muscularis externa. How does the


. esophageal glands

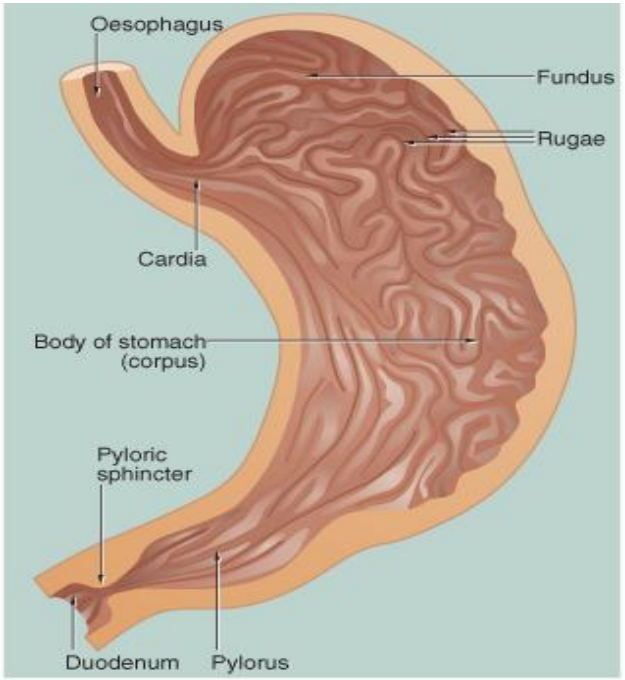
Stomach

Functions:

- Transforms food into semi-fluid viscous mass (chyme).
- Begins digestion of proteins and lipids.
- Absorption of water, drugs and salts.
- Secretion of HCl, mucus, pepsin, lipase.

Histologically, 3 regions

- Cardiac region that surrounds the orifice.
- Fundus and body region.
- Pyloric region.



The wall of the stomach is formed of:

1- Mucosa:

with submucosa, It is folded forming ***rugae***.

I) Epithelium: **simple columnar mucus secreting cells** lining the surface and is invaginated forming the pits (ducts) of **gastric glands.**

II) Lamina propria: contains gastric glands.

III) Muscularis mucosa: inner circular and outer longitudinal smooth muscle layers.

2- Submucosa:

It is formed of C.T rich in blood vessels, nerves and lymphatics.

3- Musculosa:

It is formed of smooth muscle fibers.

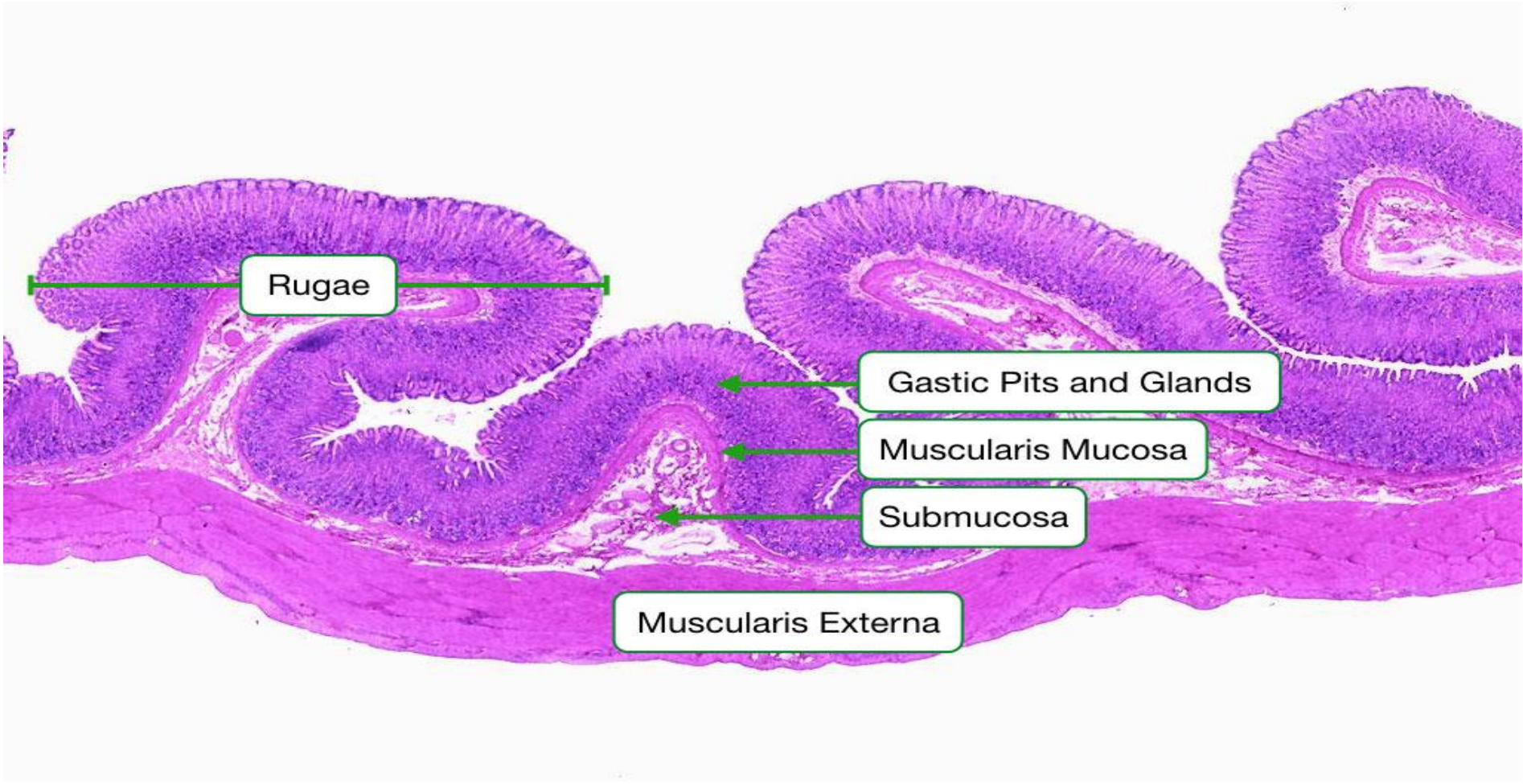
- In the **fundus:** it consists of 3 layers of smooth muscle arranged as inner oblique, middle circular and an outer longitudinal layers.

- - In the **pylorus**: the muscles are arranged into two layers; thick inner circular forming pyloric sphincter and an outer longitudinal layer.

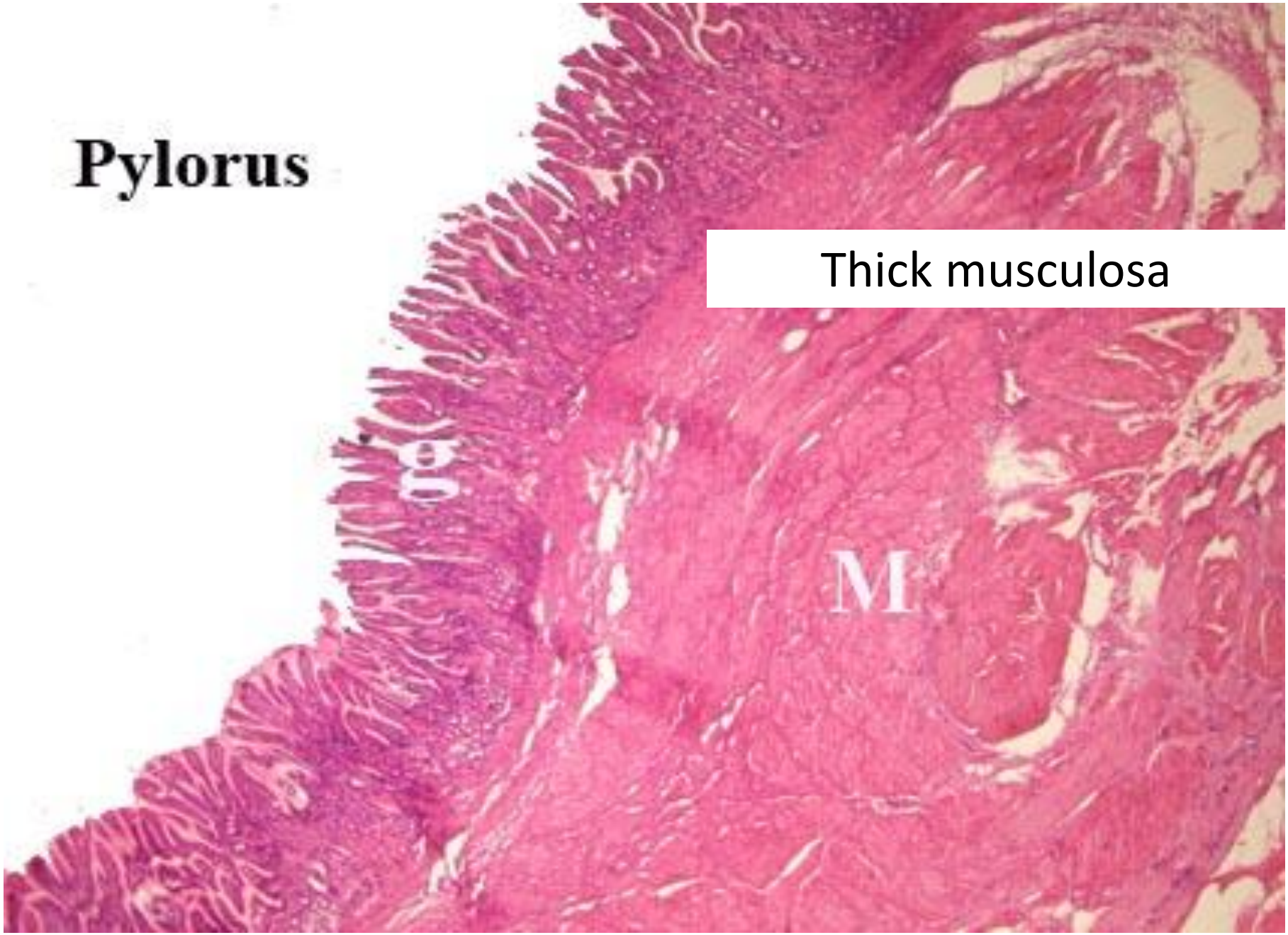
4- Serosa:

- Loose C. T. covered by a serous membrane (peritoneum).

Stomach (fundus)



Pylorus



Thick musculosa

The Gastric Glands:

- They are simple branched tubular glands.

-The glands in the **cardiac and pyloric** regions more **branched glands**

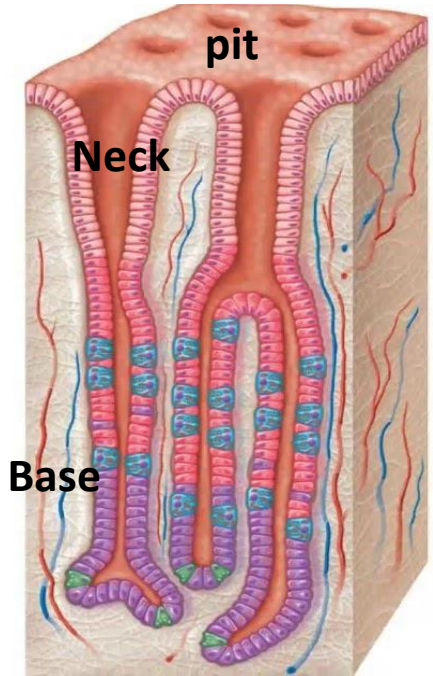
- They are present in the **lamina propria.**

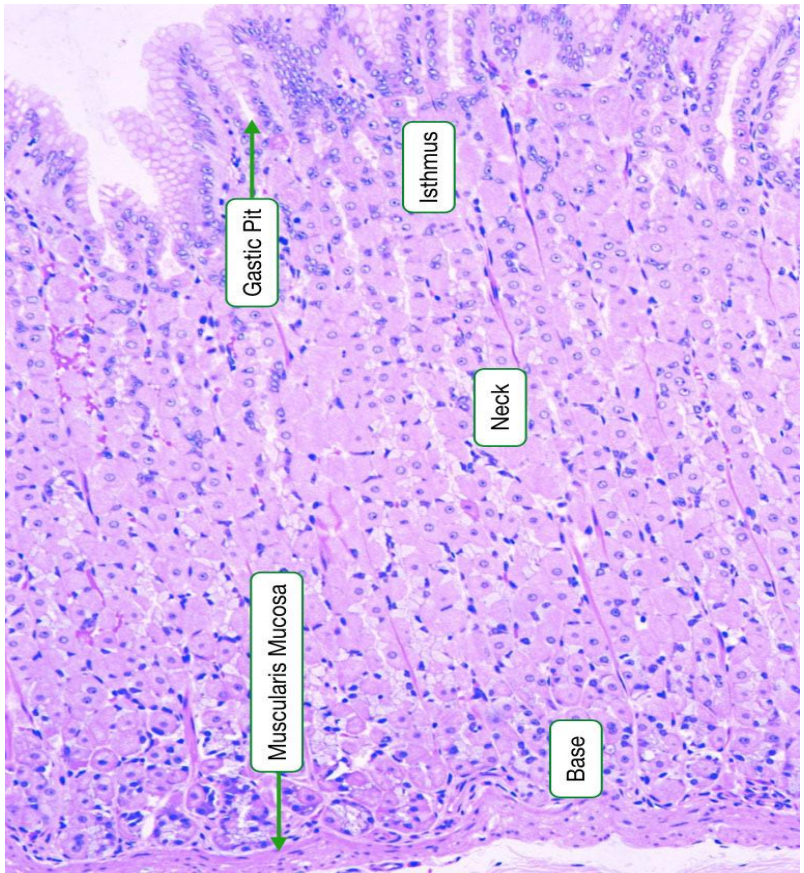
- They extend from gastric pits to muscularis mucosa.

- They are divided into:

1- **Neck,** the region following the pit.

2- **Base** the main part of the gland





The cells lining of gastric glands

1-**Chief cells** has basal basophilic cytoplasm and apical acidophilia (protein synthesizing cells).

They secrete enzymes (pepsinogen, lipase, rennin).

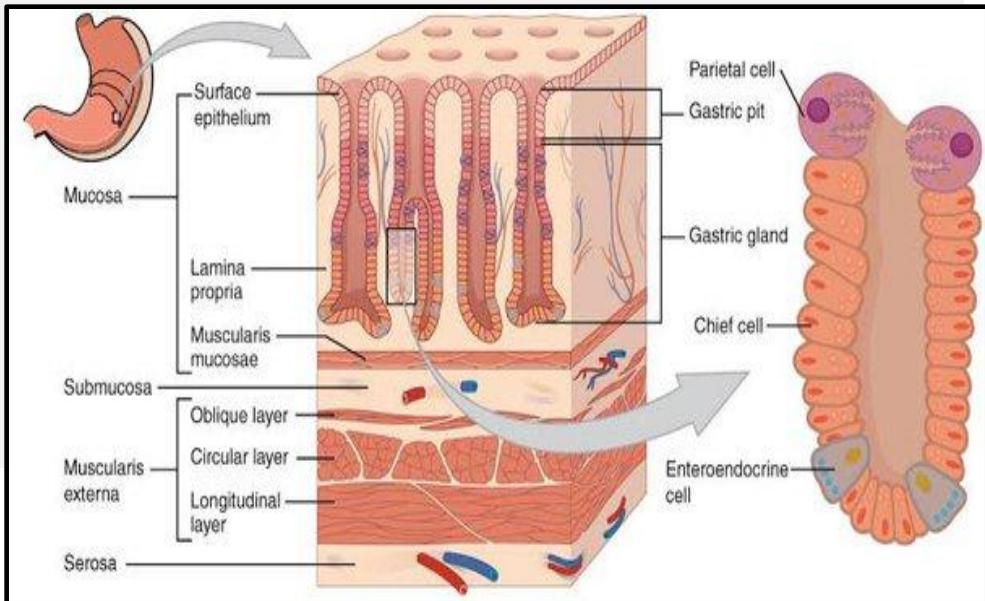
2-Parietal cells rounded, have acidophilic cytoplasm, secrete Hcl & interinsic factor for absorption of vitamin B_{12}.

3-Mucous neck cells secrete mucous. They have pale vacuolated cytoplasm and flattened basal nuclei

4- Entero-endocrine cells, small, pyramidal, secrete peptide hormones.

5- Stem cells, in the neck.

They show mitotic figure and give all other types.



Small Intestine

The small intestine is composed of 3 parts: Duodenum, jejunum and ileum

Functions:

- Selective absorption of useful substances.
- Completing digestion.

General characteristics:

- The wall of the small intestine is formed of: Mucosa, submucosa, musculosa and serosa.

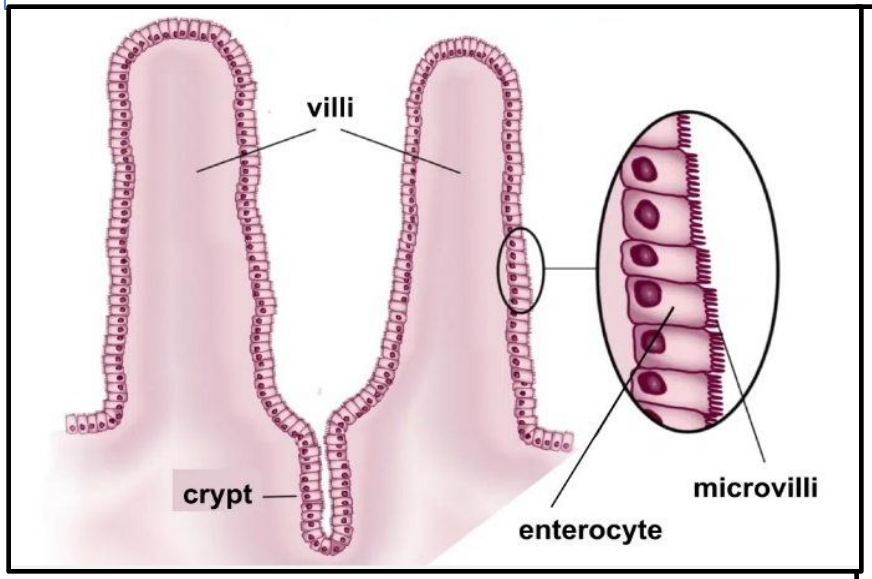
I- Mucosa:

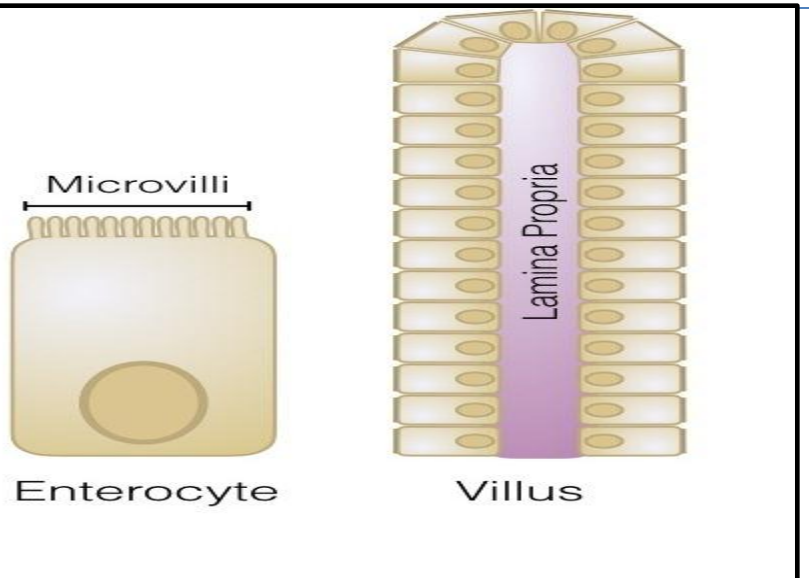
1-Epith: simple columnar absorptive epithelium (enterocytes) with goblet cells. It shows with the lamina propria:

- **Villi:** Epithelial finger like projections- **core of L.P cover with epith.**
- **Crypts:** epithelial invaginations *in between* the villi into the L.P. forming intestinal glands (**Cryps of Lieberkuhn).**

2- L.P.: Loose C.T. **containing intestinal glands.** In the **ileum,** it contains large **lymphoid follicles** (Peyer's patches).

3-Musclaris Mucosa smooth muscle fibers arranged as inner circular & outer longitudinal.





II- Submucosa:

It is formed of loose C.T. rich in blood vessels, nerves and lymphatics.

- in the **duodenum**; it contains **Brunner's glands** that secrete mucus.
- The jejunum has **no Brunner's glands or Peyer's patches**.

III- Musculosa: 2 layers of smooth muscle

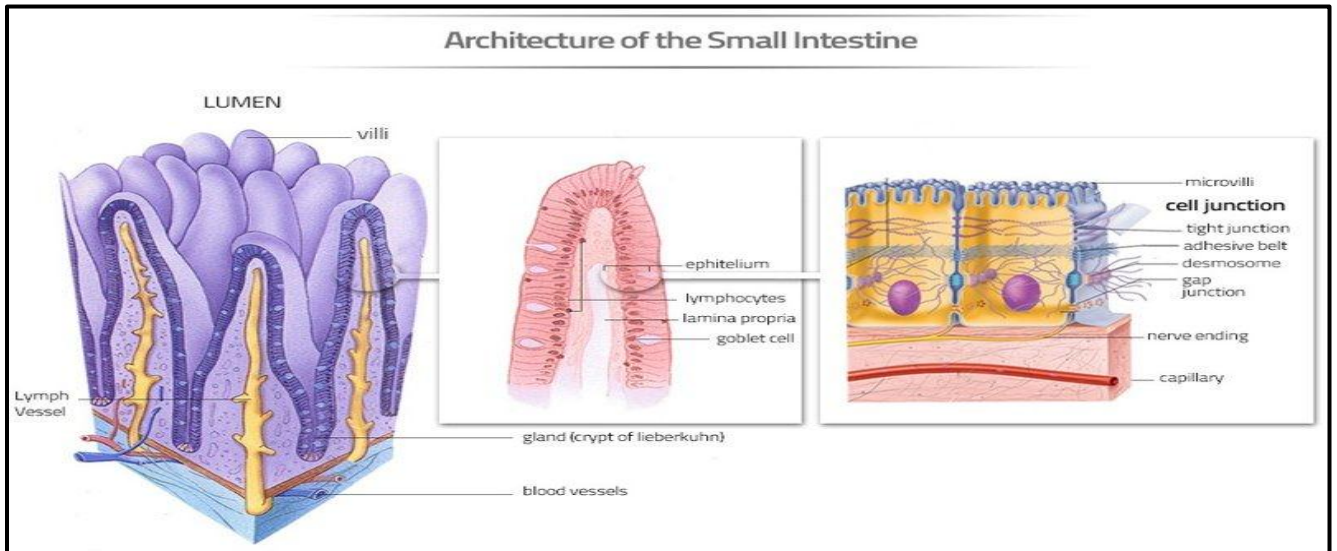
- inner circular
- outer longitudinal layers.

IV- Serosa:

It consists of loose C. T. covered by mesothelium.

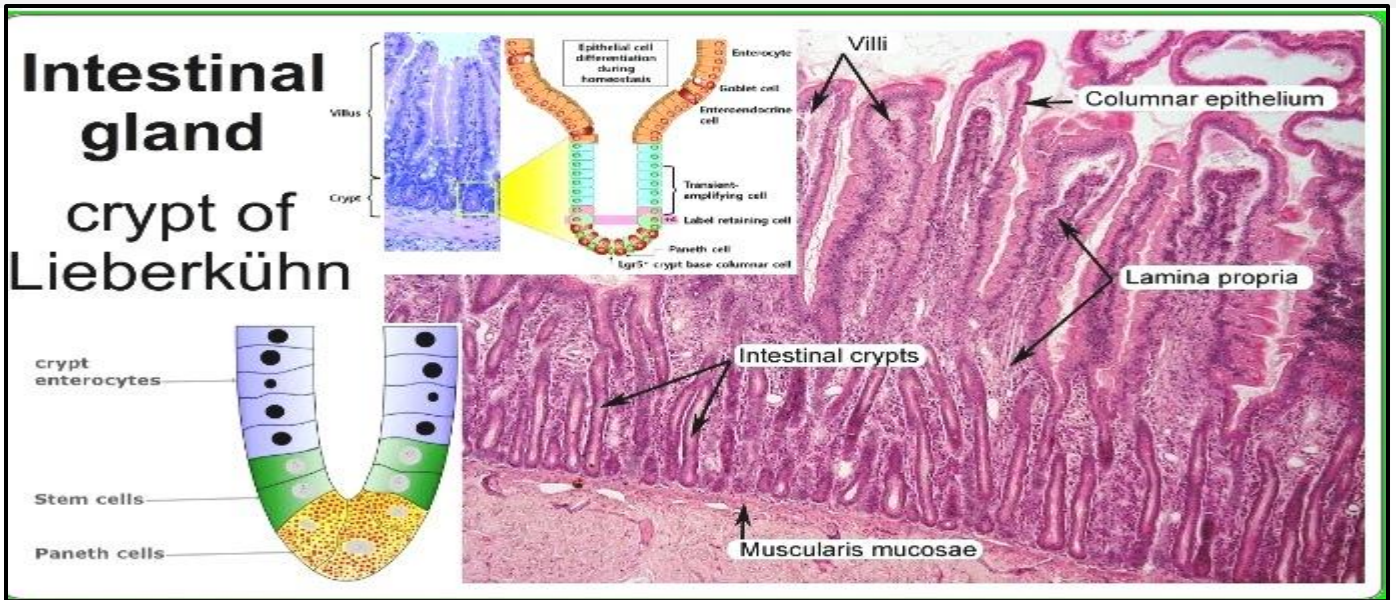
The epithelium covering the villi:

1. Simple columnar absorptive cells (90%) with brush border due to the presence of large number of long microvilli.
2. Goblet cells: secrete mucus.
3. Entero-endocrine cells: secrete intestinal hormones (e.g. secretin) regulating secretions in the stomach, pancreas, and liver.



The epithelium lining the intestinal glands (Crypts of Lieberkuhn)

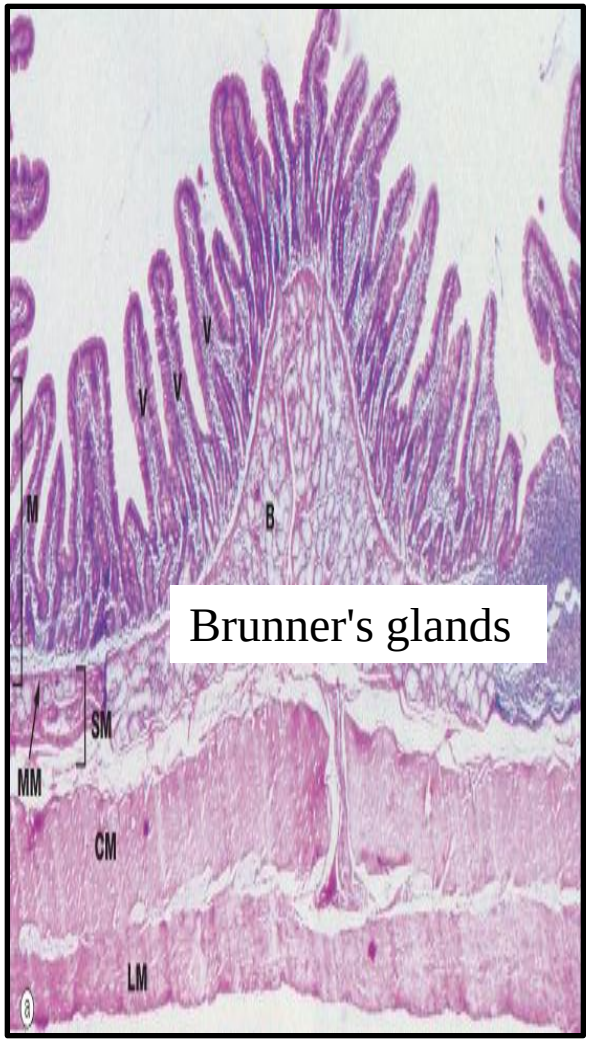
1. Simple columnar cells with striated (brush) border.
2. Goblet cells.
3. Entero-endocrine cells
4. Paneth cells at the bases of the glands. They secrete bactericidal enzyme as lysozyme that kills bacteria.
5. Stem cells undergo mitosis to replace cells of villi and crypts.

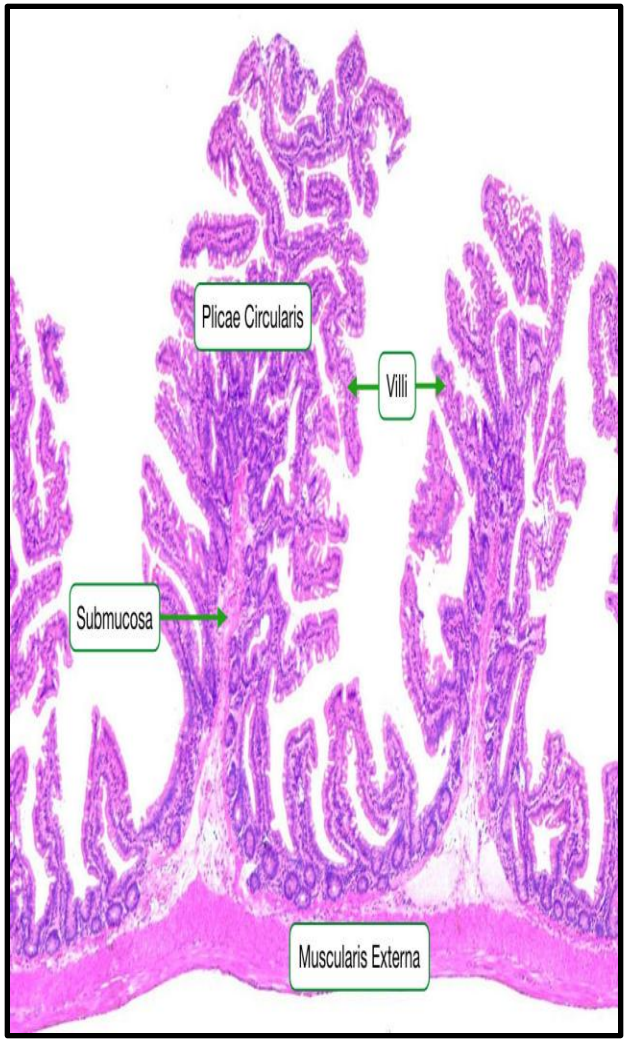


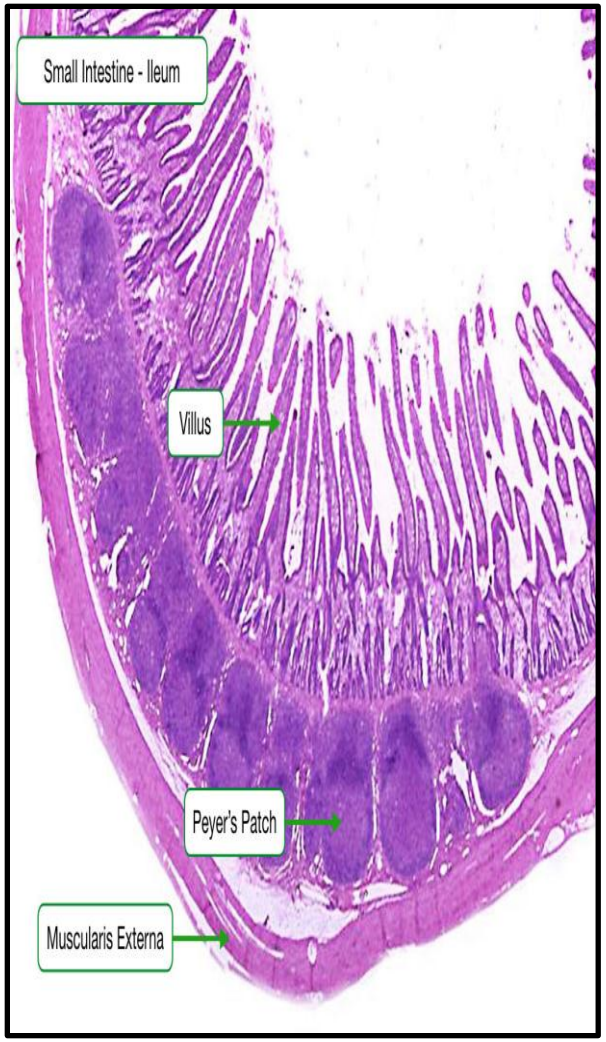
Different parts of intestine

Duodenum	Jejunum	Ileum
broad leaf-like (long) villi	(short) villi	finger-like villi
Less numerous goblet cells	More	More
Brunner's glands in submucosa	No Brunner’s glands nor Payer’s patches	Payer’s patches in LP & submucosa

Duodenum Jejunum Ileum



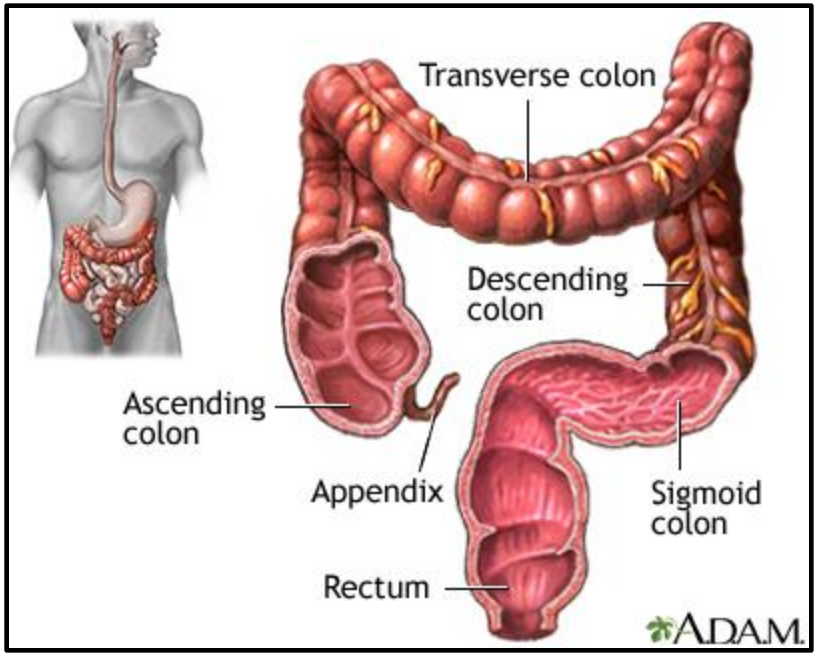




Large Intestine

- **Functions:**
  - Absorption of water.
  - Secretion of protective mucus.
  - Formation of fecal mass.

- It consists of caecum, appendix, ascending, transverse, descending and pelvic colons, and rectum.



Microscopic structure:

I- Mucosa:

It has **no villi**, only crypts are present.

a) Epithelium: simple columnar absorptive cells with ***numerous*** goblet cells.

- ***The crypts (glands)*** **are lined by simple columnar cells, large numbers of goblet cells, entero-endocrine cells (few) and undifferentiated stem cells.**

b) Lamina propria is rich in lymphocytes and **lymphatic nodules.**

c) Muscularis mucosa ":2layers of smooth muscle; Inner circular and outer longitudinal.

II- Submucosa:

Loose connective tissue, lymph nodules may extend to it from mucosa. It has no glands.

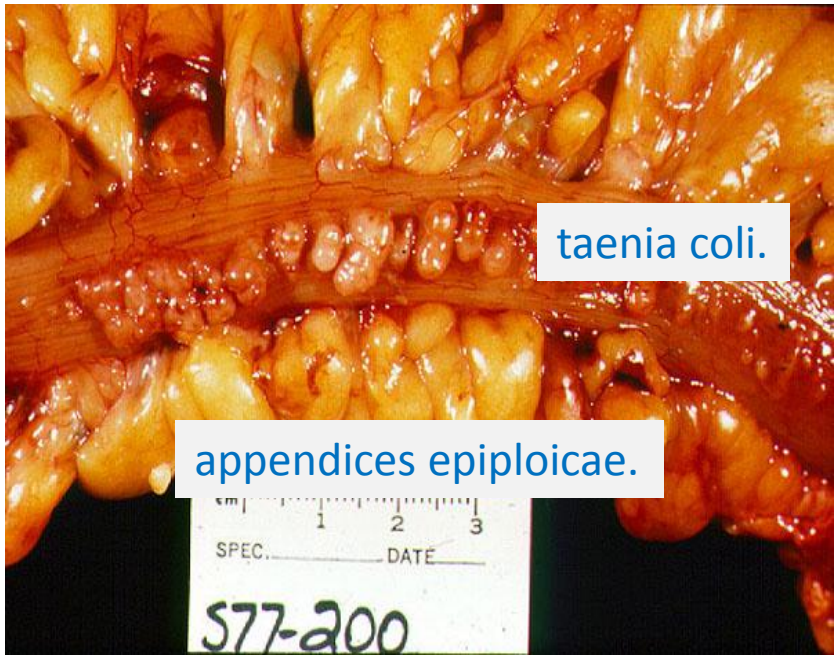
III- Musculosa:

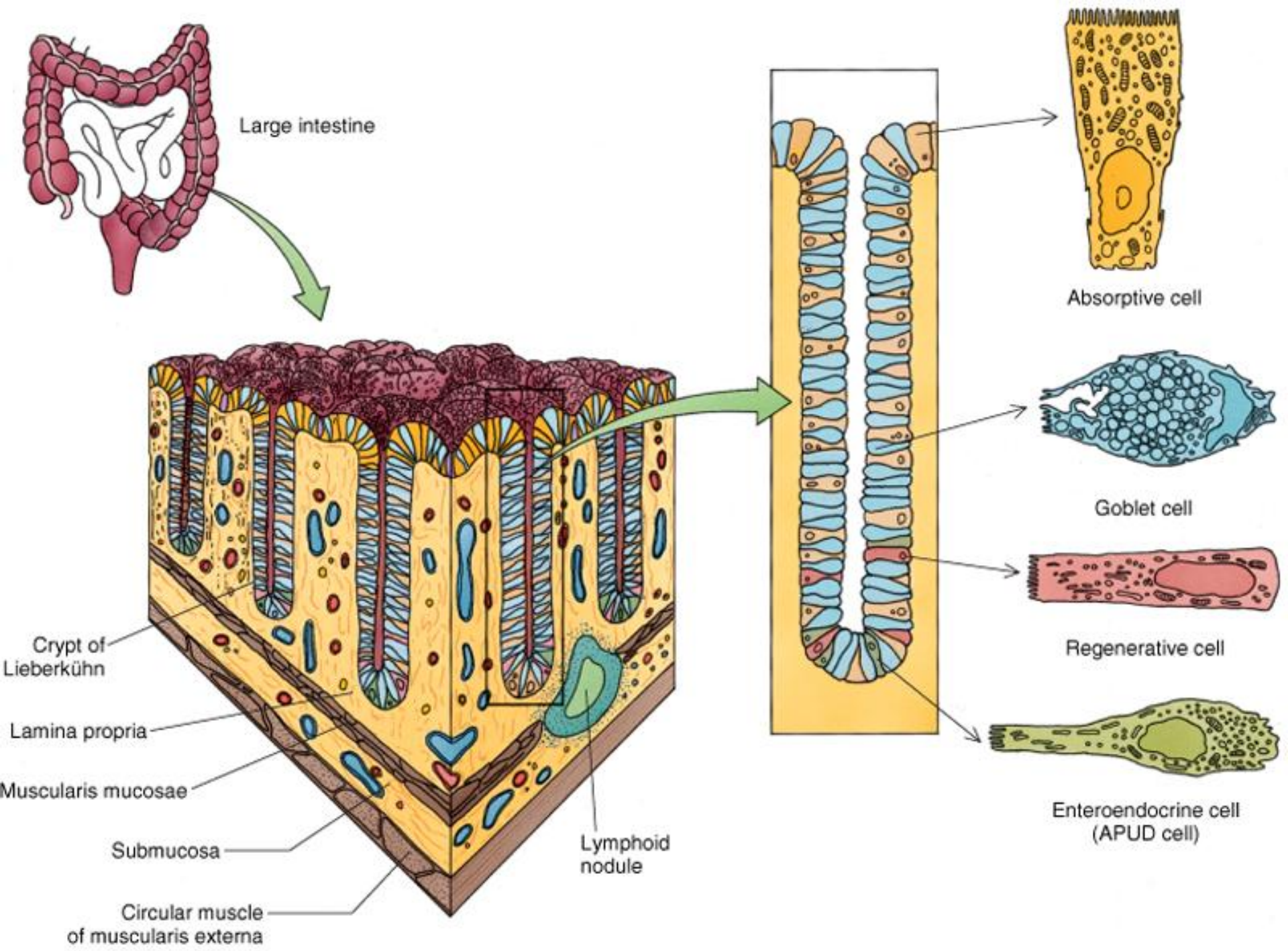
It is formed of :

- continuous inner circular,
- while the outer longitudinal are collected into 3 bands called taenia coli.

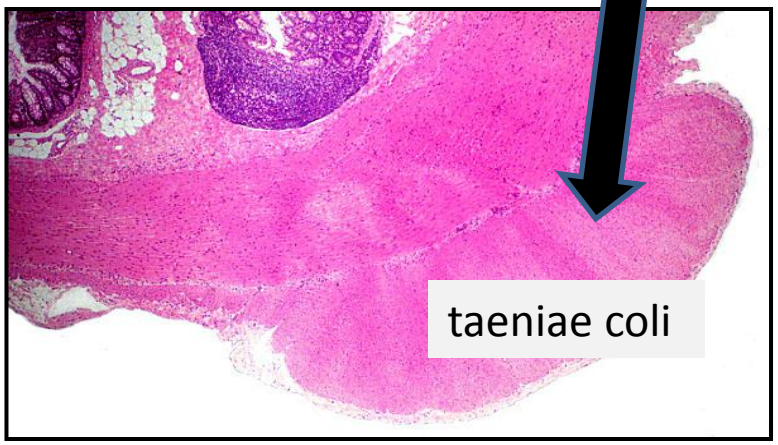
IV- Serosa:

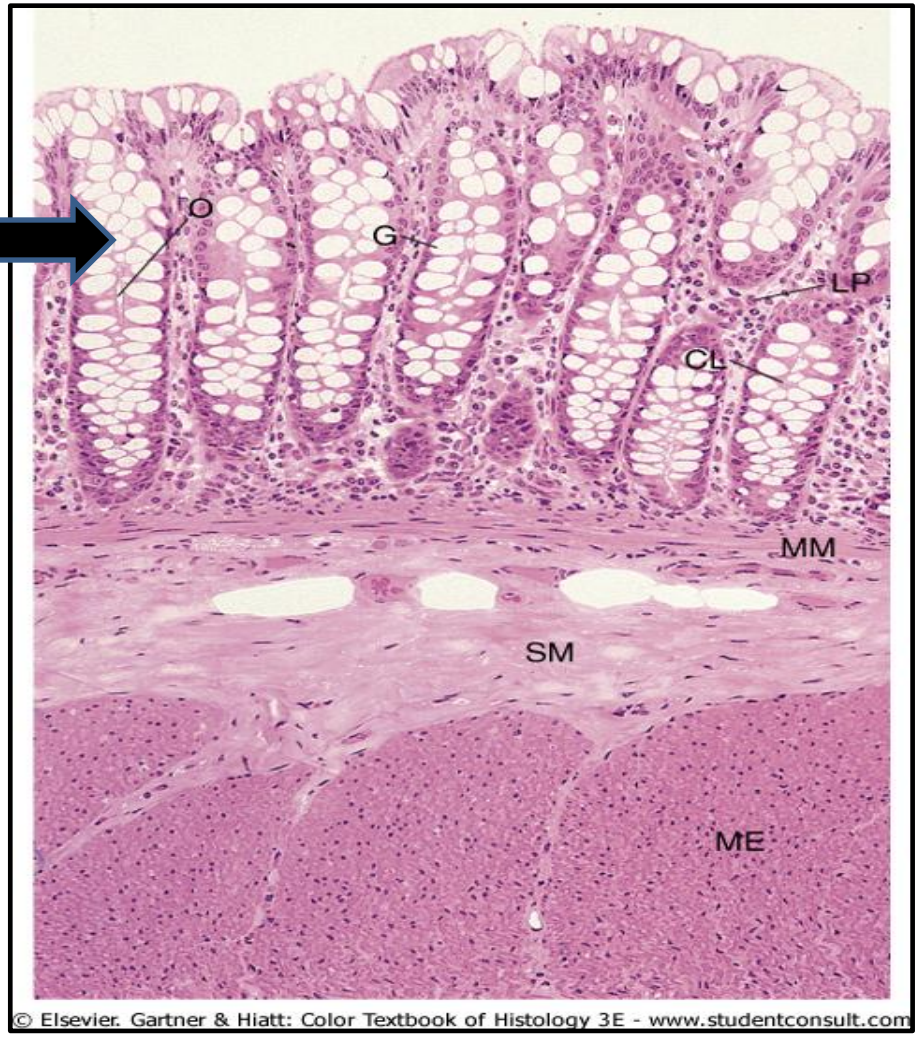
The serous membrane enclose adipose tissue in sac like structure called appendices epiploicae.





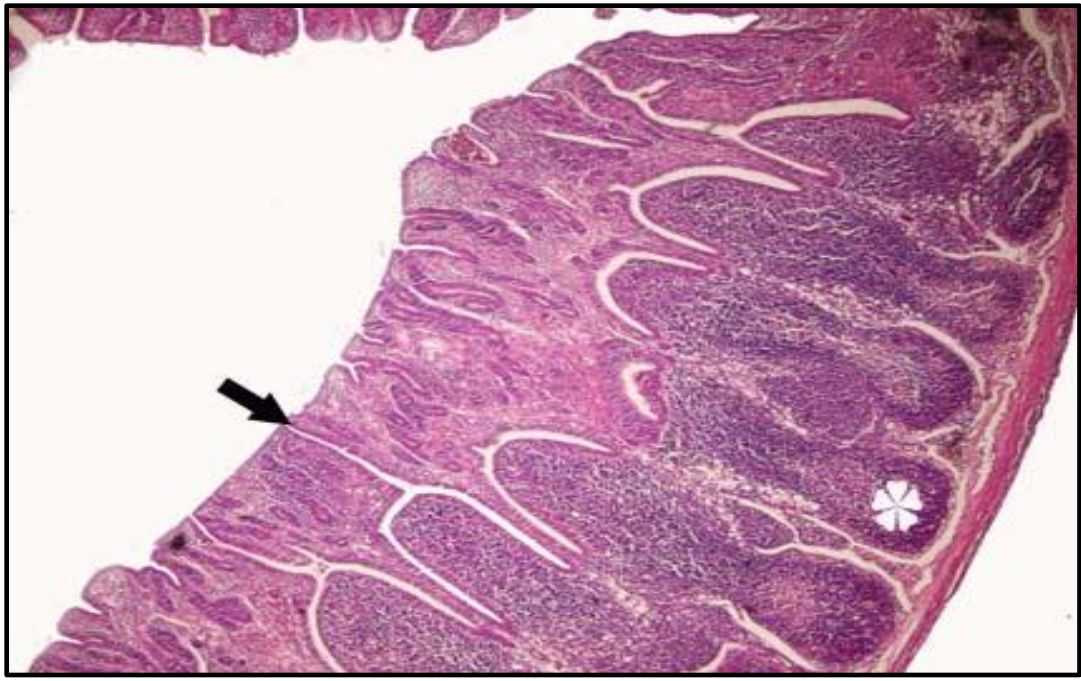
Large Intestine





Appendix

- The lumen is small and irregular.
- Abundant lymphoid follicles in the wall.
- Few and short crypts.
- Muscularis mucosa is not well developed.
- No taeniae coli.

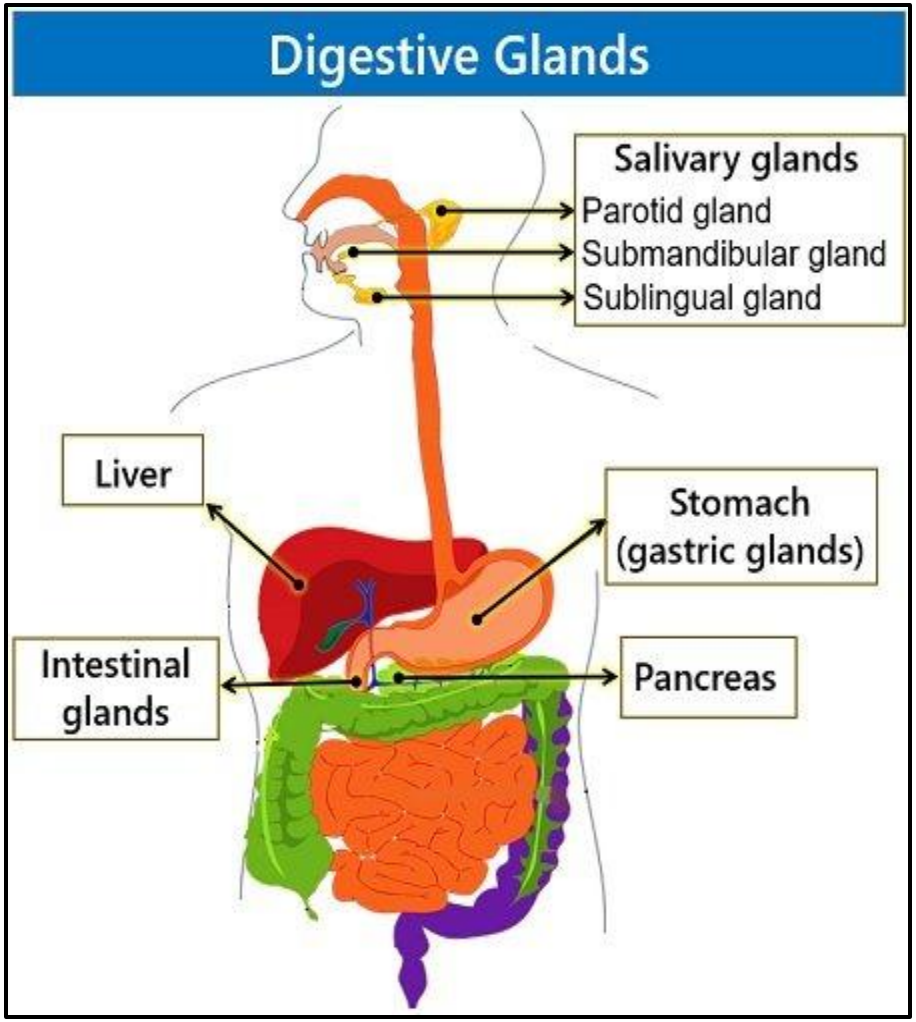


III- Glands associated with digestive tract

I- Salivary glands.

II- Pancreas.

III- Liver.

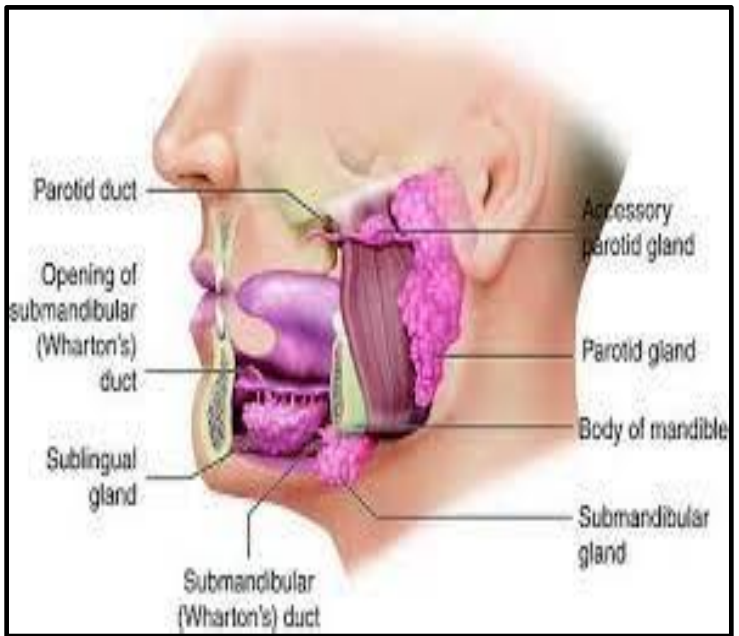


Salivary Glands

I- Accessory salivary glands are simple tubulo-alvoelar small glands present in the **oral cavity.**

II- Major salivary glands are **paired** compound tubulo-alvoelar exocrine glands:

- Parotid glands
- Submandibular glands
- Sublingual glands.



General structure of salivary Glands :

A) Stroma:

a) Capsule: Each gland is surrounded by C. T. capsule.

b) C. T. septa arise from the capsule containing blood vessels, nerves and ducts and dividing the gland into **lobes and lobules.**

c)Reticular network.

B) Parenchyma:

It is formed of secretory part (acinus) and excretory part (duct)

I-The secretory part **(The acini)** 3 types:

The acinus has a lumen and is lined by epithelial cells that are resting on a basement membrane.

Serous acini:

- They have narrow lumen.
- The cells are pyramidal, with central rounded nuclei, basal basophilia and apical acidophilic cytoplasm.
- They secrete watery secretion containing enzymes.

Mucous tubules:

- They have wide lumen.
- The cells are cuboidal, with peripheral flat nuclei and apical foamy pale cytoplasm.
- They secrete viscid fluid (mucus).

Mixed acini:

They are mucous **tubules t**hat have a crescent **(demilune)** of serous cells.

Myoepithelial cells

- are present between the cells and the basement membrane.
- They have contractile activity to squeeze the acinus.

II- The excretory part (ducts):

- **Intralobular ducts** include:

a) Intercalated ducts :

started from the lumen of the acinus.

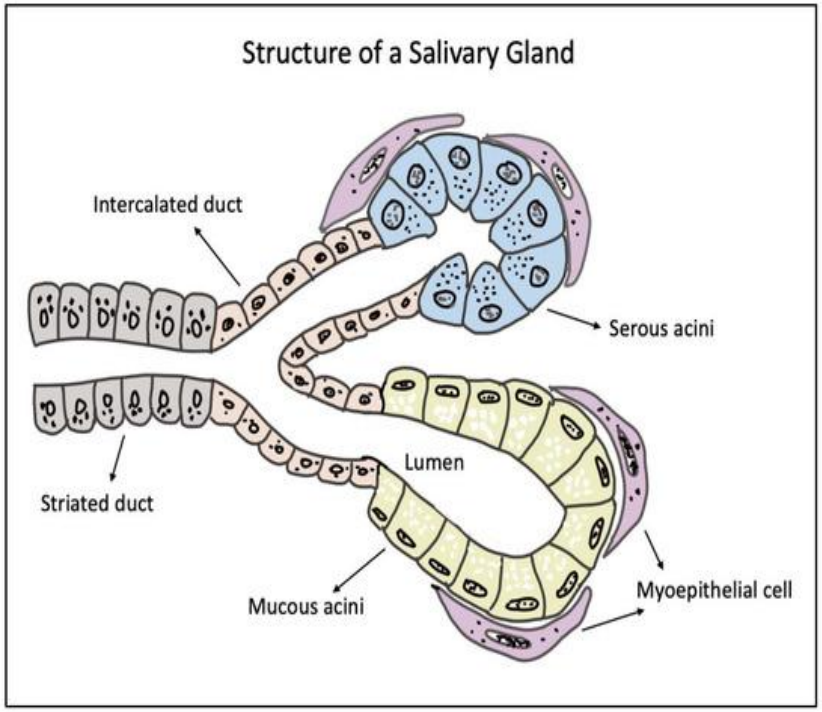
lined with simple cubical epithelium.

b)Striated ducts

lined with simple columnar cell

which are **ion transporting cells.**

- **Extralobular ducts**



include; interlobular, interlobar and main ducts which open in the oral cavity.

* **The parotid glands** Have serous acini only.

* **The submandibular glands:**

mainly serous acini and some mucous tubules with serous demilunes.

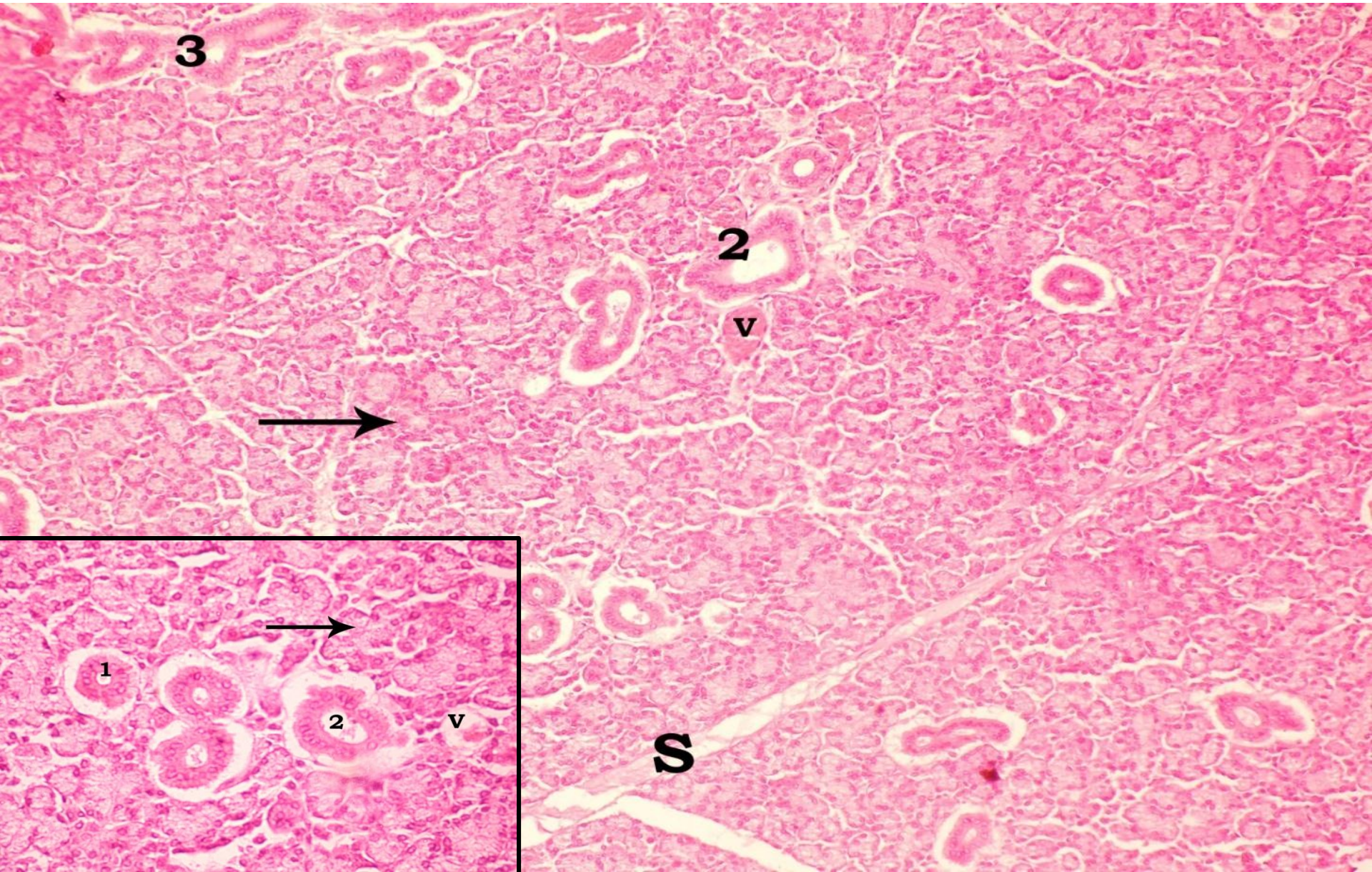
***The sublingual glands:**

mainly mucous tubules with some serous demilunes (no free serous acini).

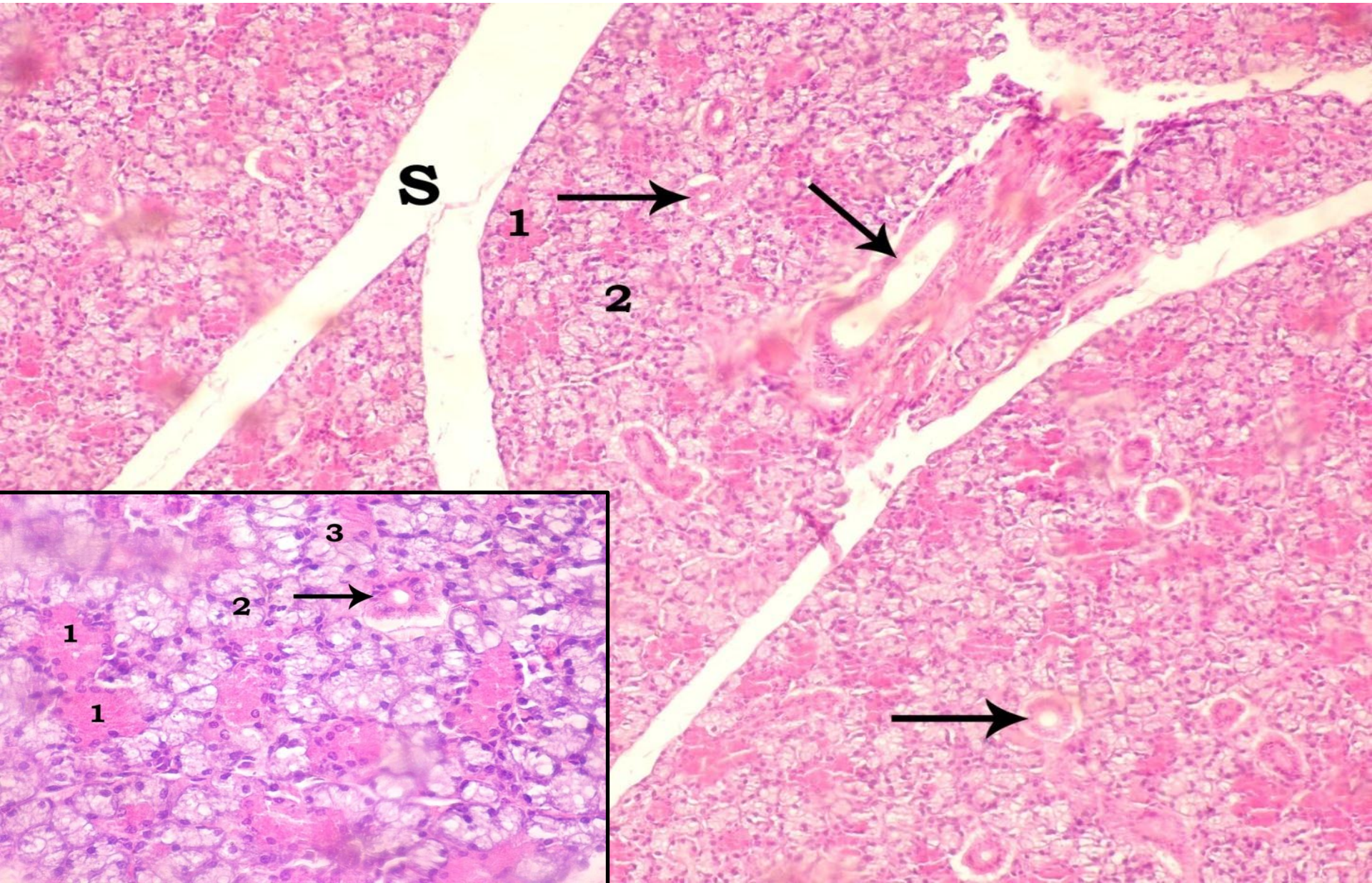
Function: Secretion of saliva which

1. Lubricates the oral cavity.
2. Initiates the digestion of carbohydrates
3. contains lysozyme, IgA

Parotid Gland



The submandibular glands (Mixed Salivary Gland)



Pancreas

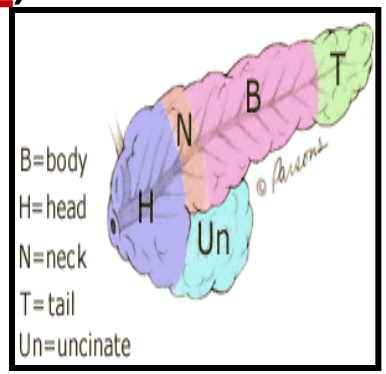
- It is an intra-abdominal *mixed* exocrine and endocrine gland. It is formed of head, body and tail.

1- Stroma: C. T. capsule and septa are very thin.

II - Parenchyma

A) The exocrine portion:

It is **similar in structure to the parotid gland**, but in the pancreas: The striated ducts are absent.



The serous cells show:

- **Prominent** basal basophilia (more rER).
- Prominent apical acidophilic granules.

-The function of exocrine pancreas is secretion of many digestive enzymes as trypsin, chymotrypsin, lipase, and amylase.

B) The endocrine portion:

It is called islets of Langerhans.

The islets are *more numerous* in the tail and less in the head.

They appear in H & E section as pale rounded groups of cells in between the deeply stained serous acini.

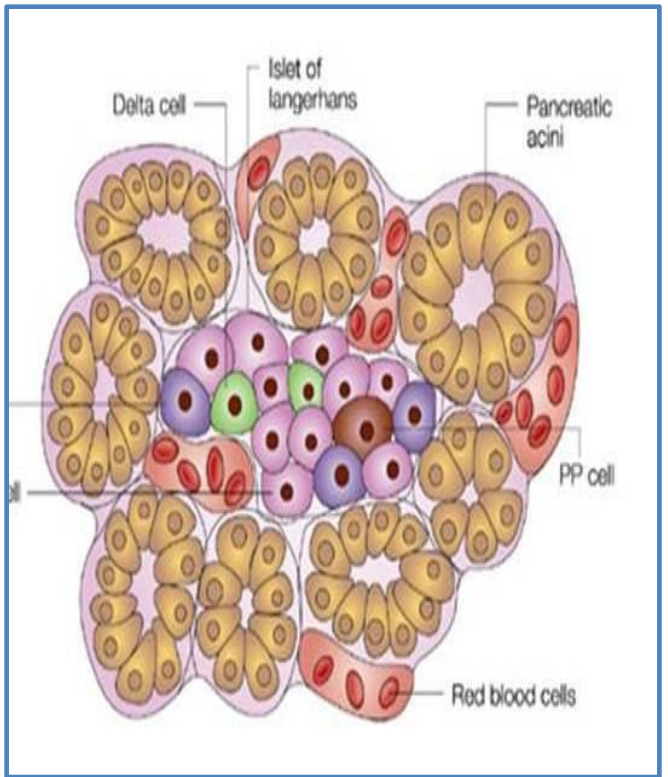
Each islet consists of four main types of cells separated by fenestrated blood capillaries:

1- **A cells**: 20% of cells. They are **large** cells which secrete glucagon (increases blood sugar).

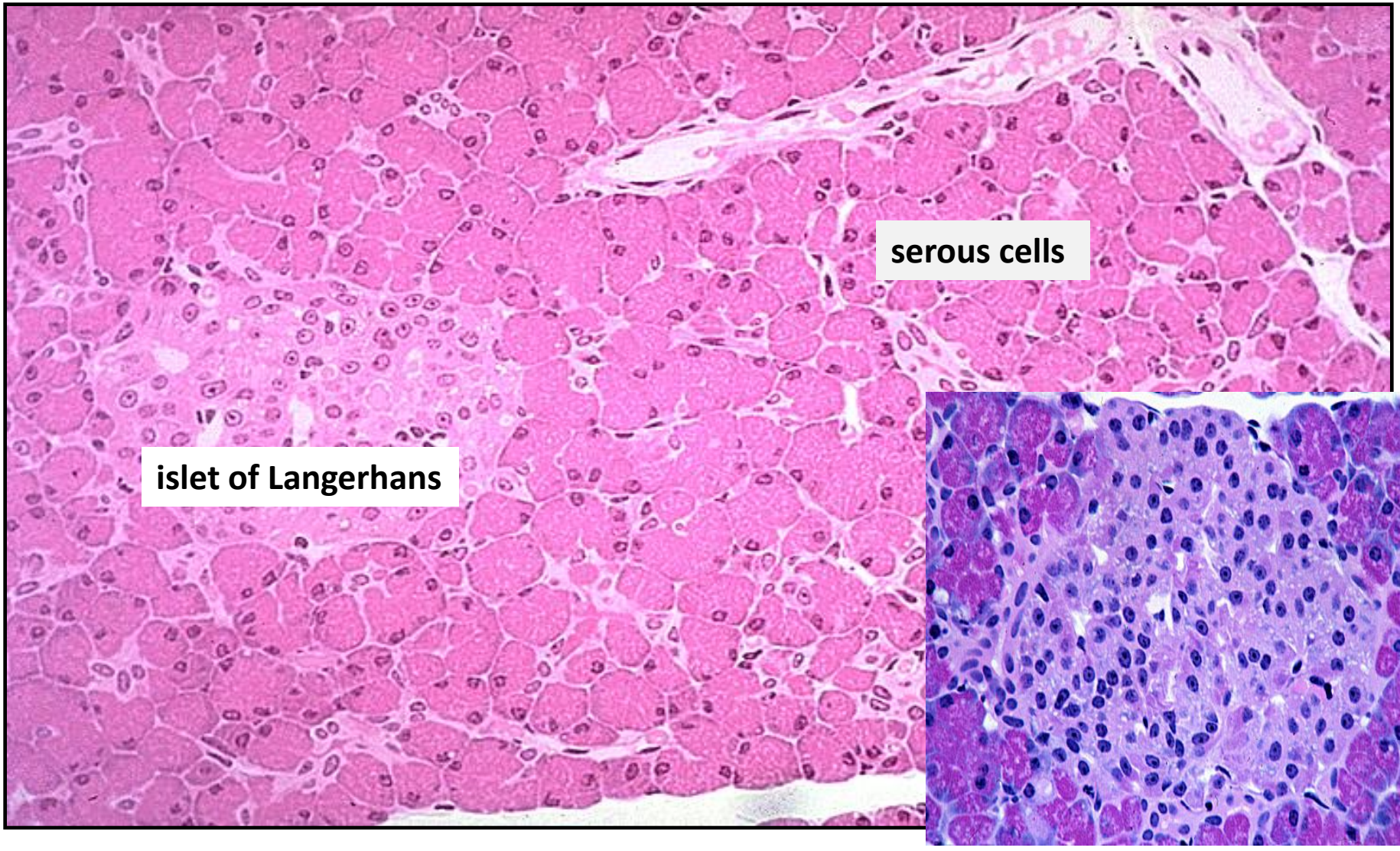
2- **B cells**:70% of cells. They are **small** cells which secrete insulin (decreases blood sugar level).

3- **D cells**: <5% of cells. They are small cells that secrete **somatostatin** (inhibits the release of growth hormone).

F cells: rare cells



Pancreas

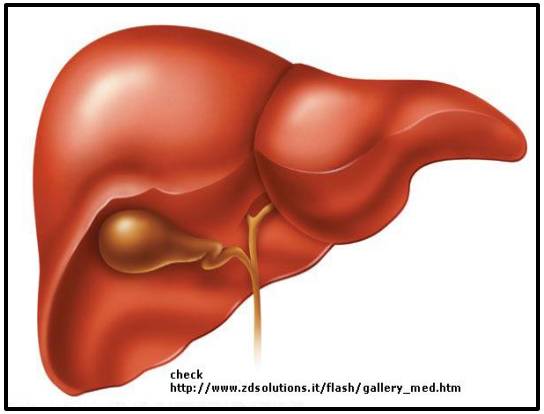


Liver

The liver is the largest gland in the body.

It is formed of two main lobes and two small ones.

Structure: The liver is composed of stroma and parenchyma.



1- Stroma:

a- Capsule of connective tissue

covered partially with peritoneum.

b- C.T. septa:

- The capsule sends C.T septa in between lobes and lobules.
- the amount of C.T. differs in different species of animals (very scanty in man, so the lobulation is indistinct).
- Reticular network formed of reticular fibers

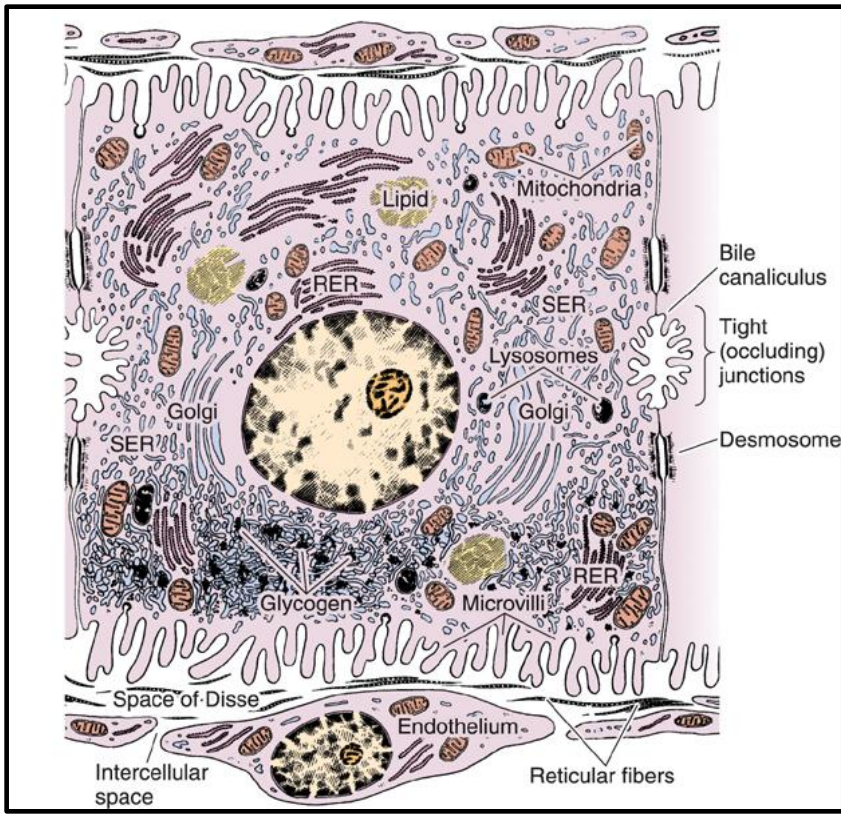
2- Parenchyma (hepatocytes-Bile canaliculi -Blood sinusoids)

1- liver cells (hepatocytes).

- They are acidophilic polyhedral cells.
- The hepatocytes are arranged in cords or plates of one or two cells thick.

EM of hepatocytes rich in

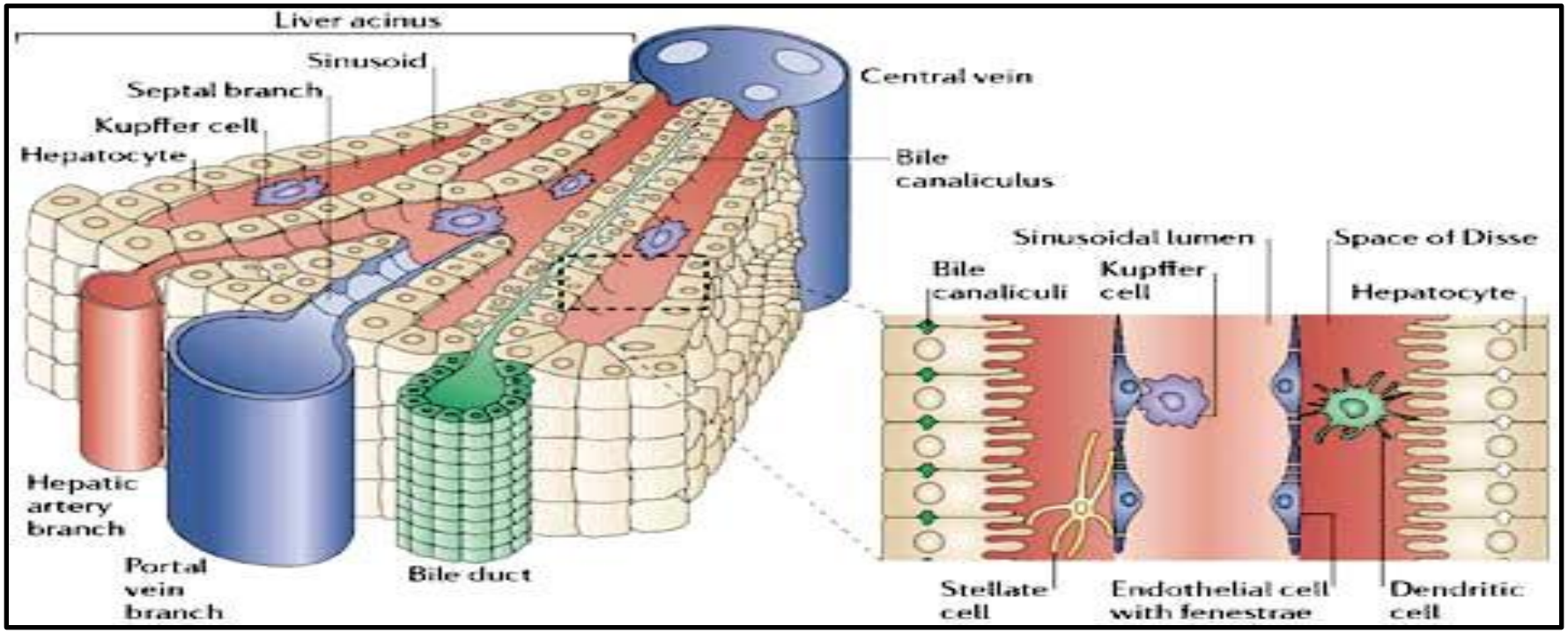
- Mitochondria (about 1000-2000)
- SER
- contain all the other organelles and inclusions.
- have one or two nuclei with fine chromatin granules.



2- Bile canaliculi are enclosed between the cells.

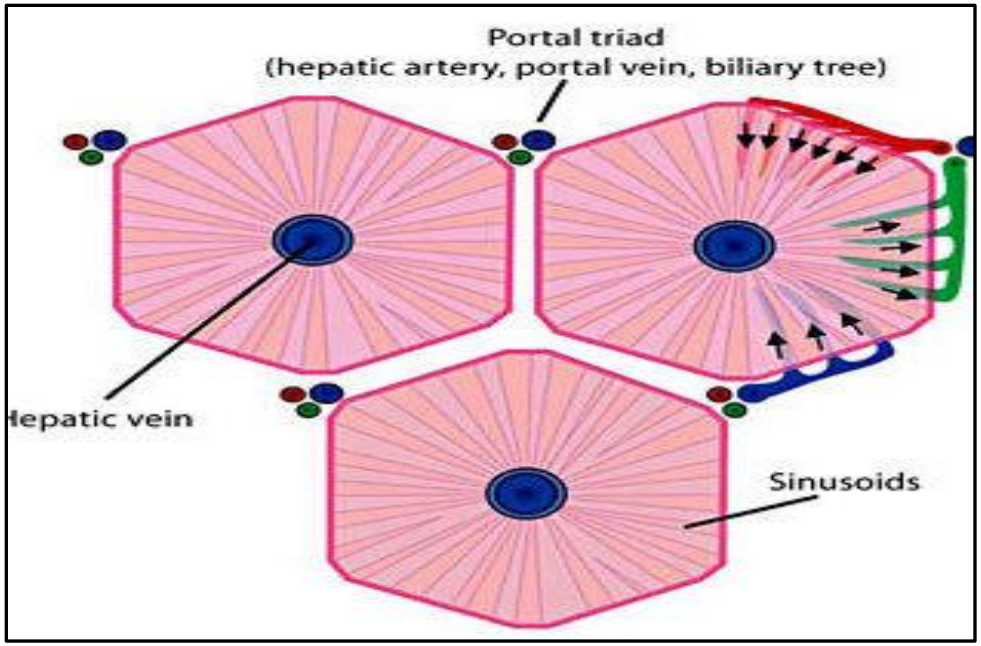
3- Blood sinusoids

- Present between the cords or plates of hepatocytes.
- They are irregularly dilated blood capillaries composed of *discontinuous layer of endothelial cells* associated with macrophages (Kupffer cells)

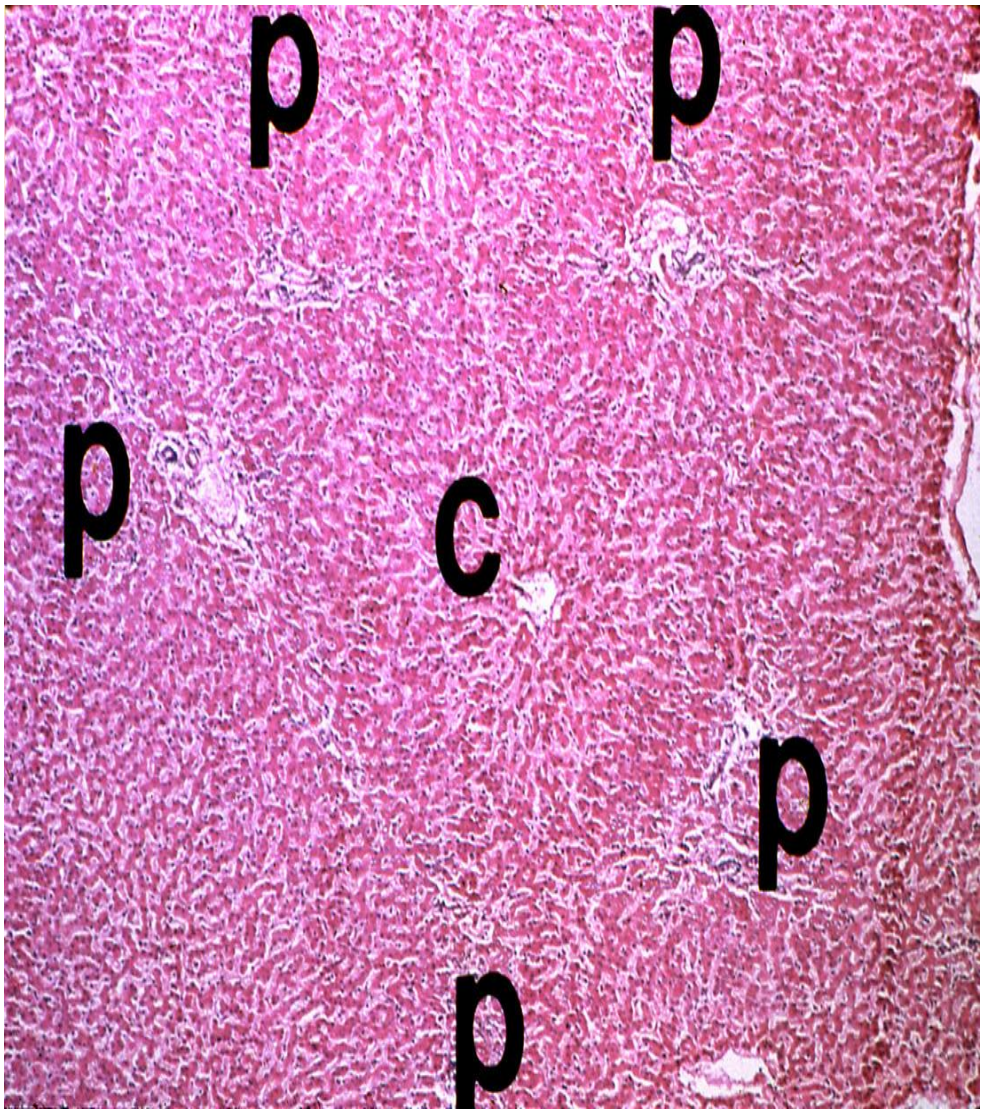


Classic hepatic lobule

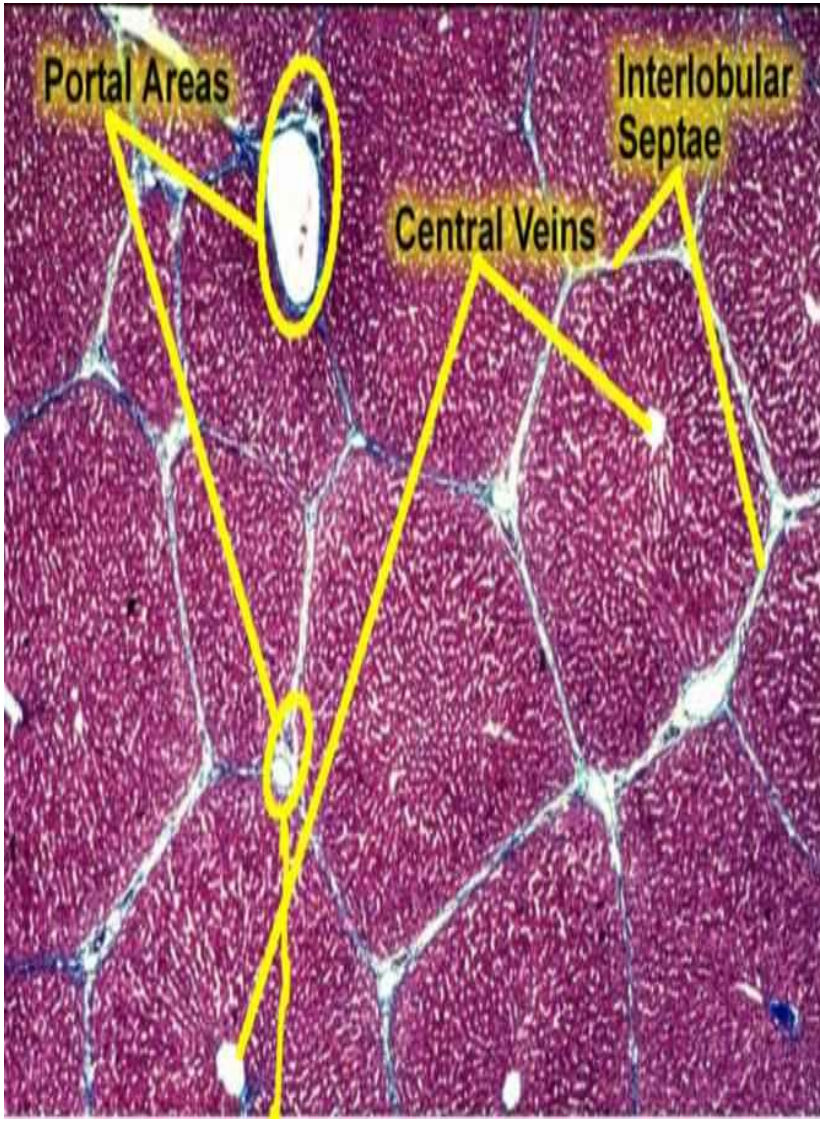
- Hepatic lobule is a polygonal mass of liver cells which drain into a vein in its center called ***central vein***.
- The ***cords*** of liver cells are directed from the periphery of hepatic lobule to its central vein.
- At the corners of each hepatic lobule there are ***portal areas (triad)*** which are formed of connective tissue containing **3** structures.
- Branch of portal vein.
- Branch of hepatic artery.
- Bile duct.



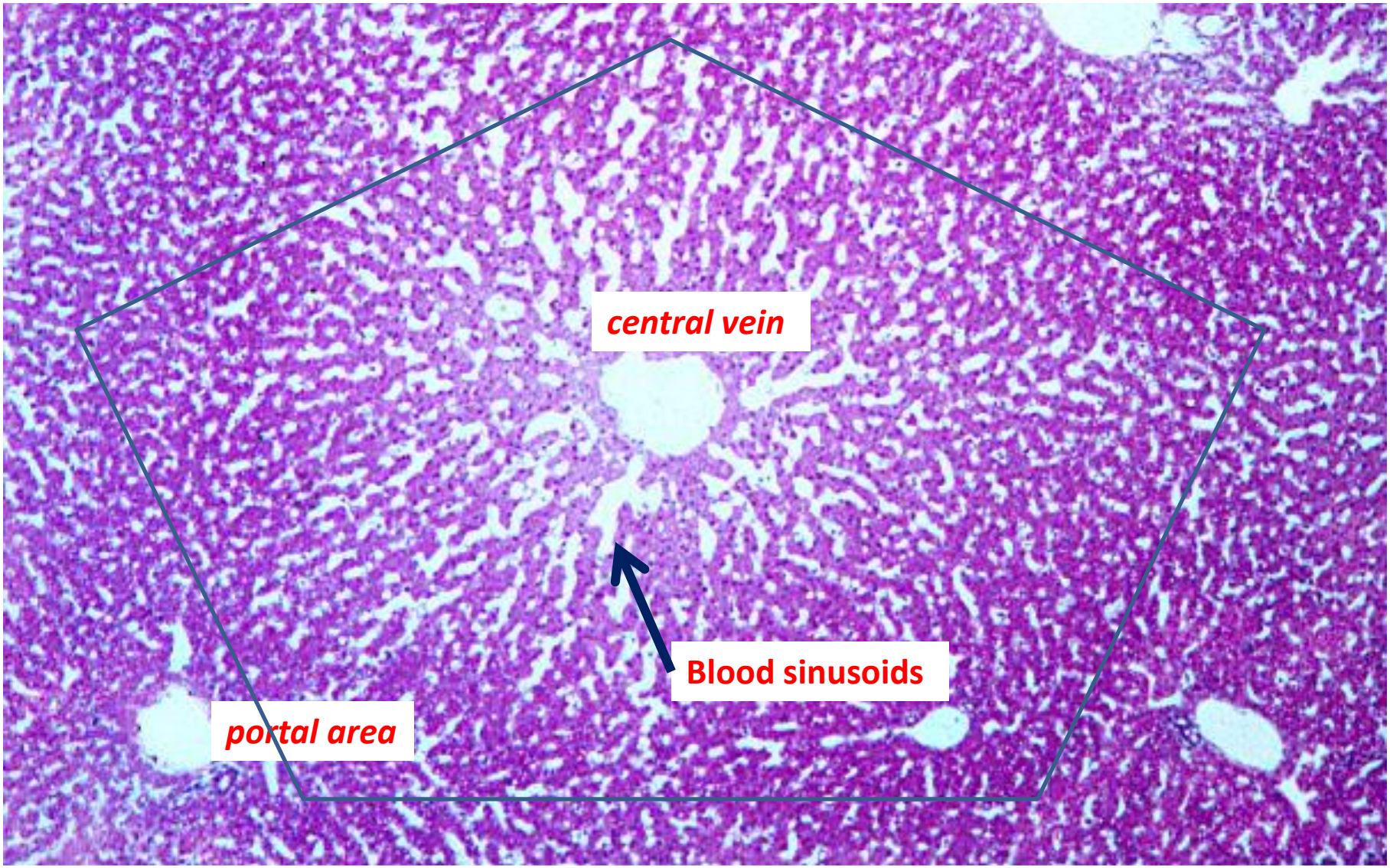
In human



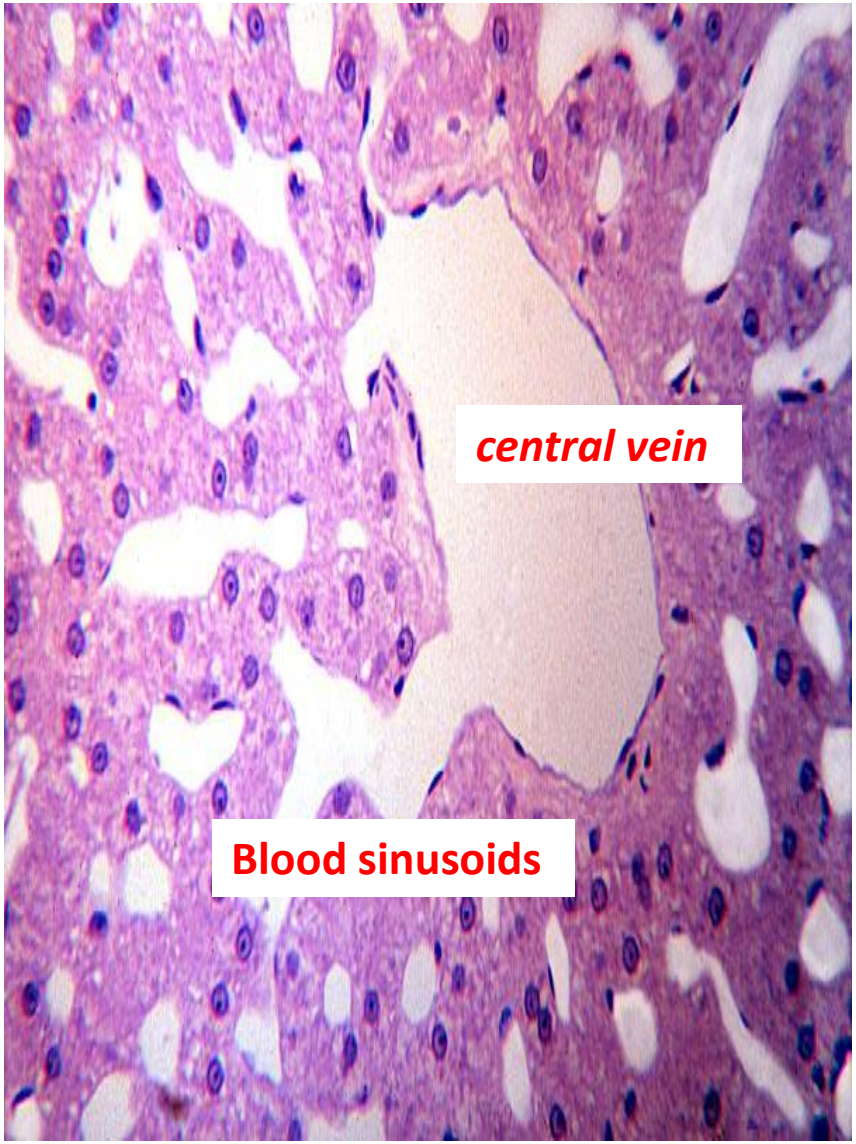
In pig

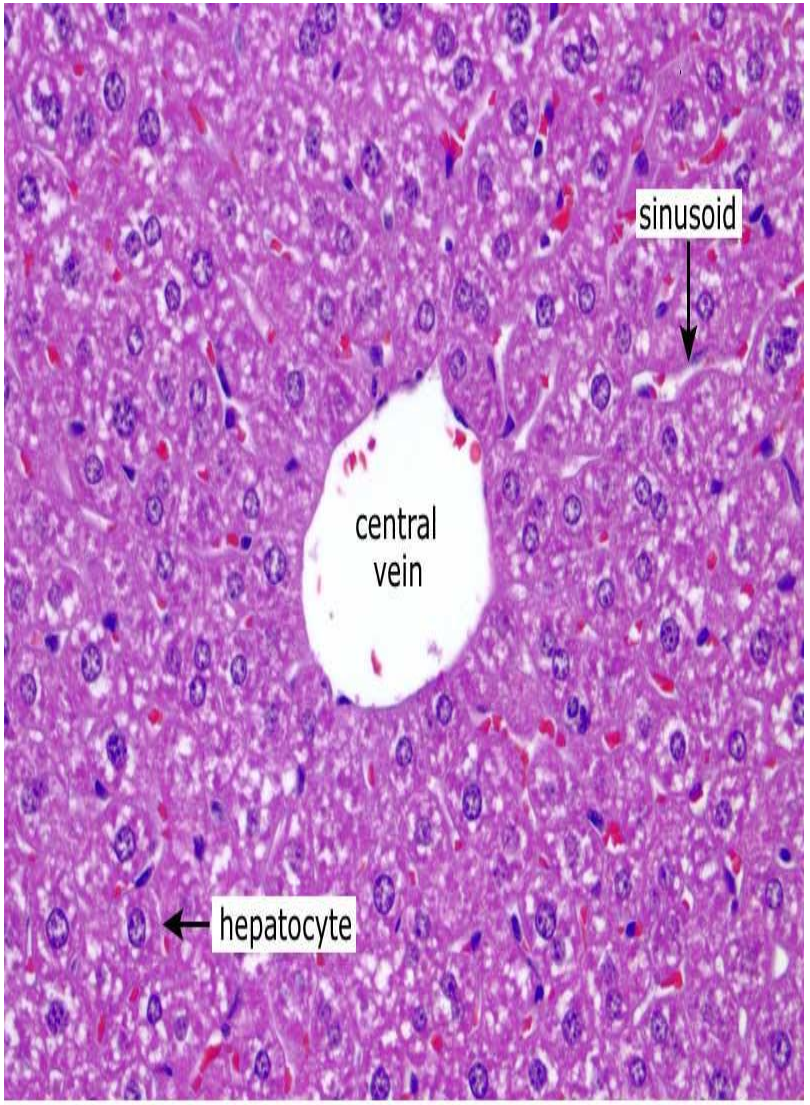


Classical hepatic lobule



Central vein & blood sinusoids





Functions of the liver:

All the liver functions are performed by the hepatocytes:

1. Exocrine function: bile secretion.
2. Endocrine function: secretion of glucose, plasma proteins (e. g. albumin, globulin, fibrinogen, lipoproteins).
3. Detoxification and inactivation of various drugs and substances.
4. Storage of metabolites (glycogen, lipids, vitamins)

Gall bladder

It is a cyst (sac-like) organ present on the lower surface of the liver.

Its wall consists of:

1- Mucosa:

Epith: Simple columnar epithelium.

LP: of loose C. T.

2- Muscle layer: of smooth muscle.

3- Perimuscular C.T

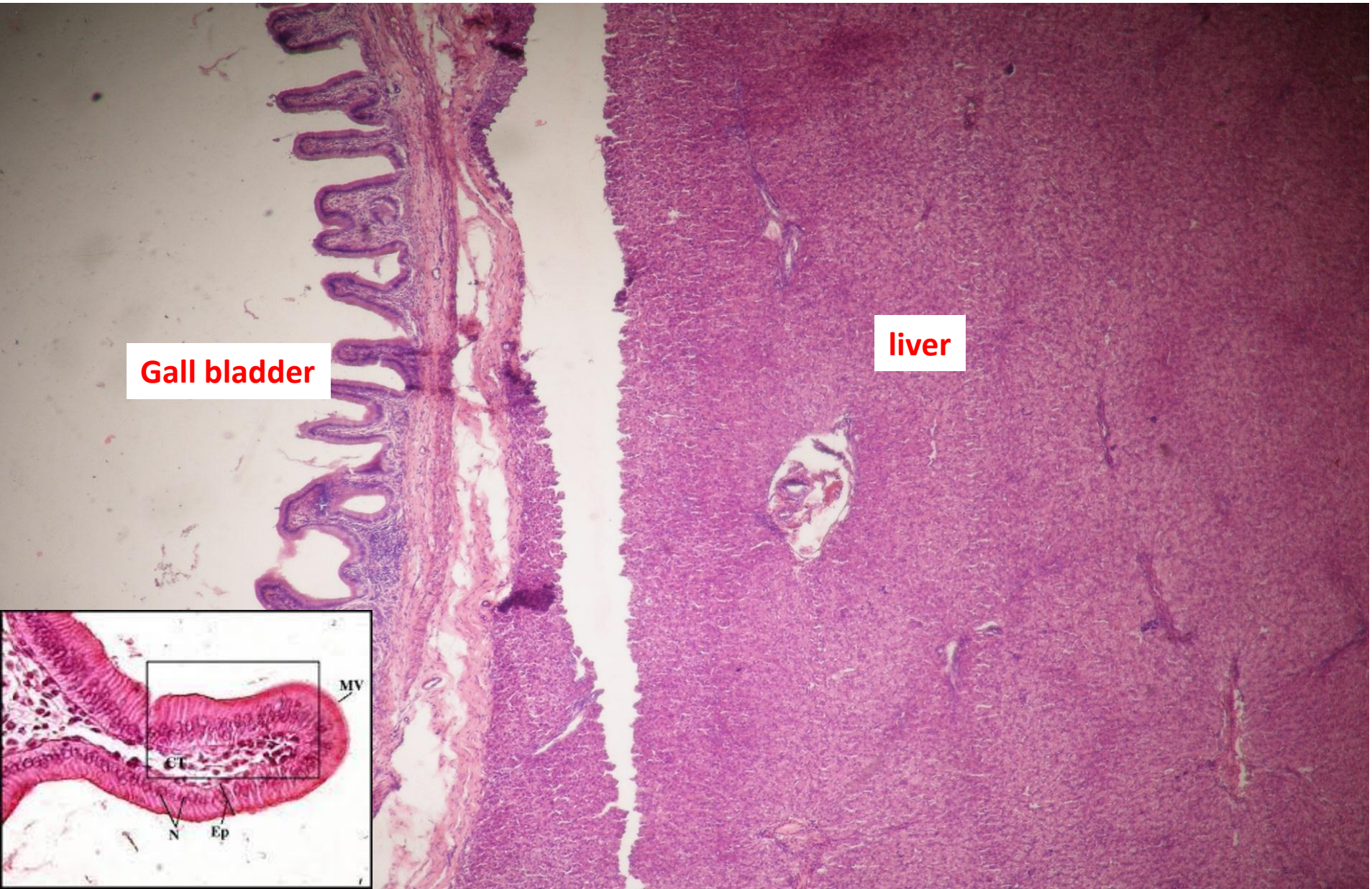
Gall bladder

lined partially by peritoneum.

has no villi, no goblet cells, no glands and no muscularis mucosa.

Function: storage and concentration of bile

Gall bladder



Thank you